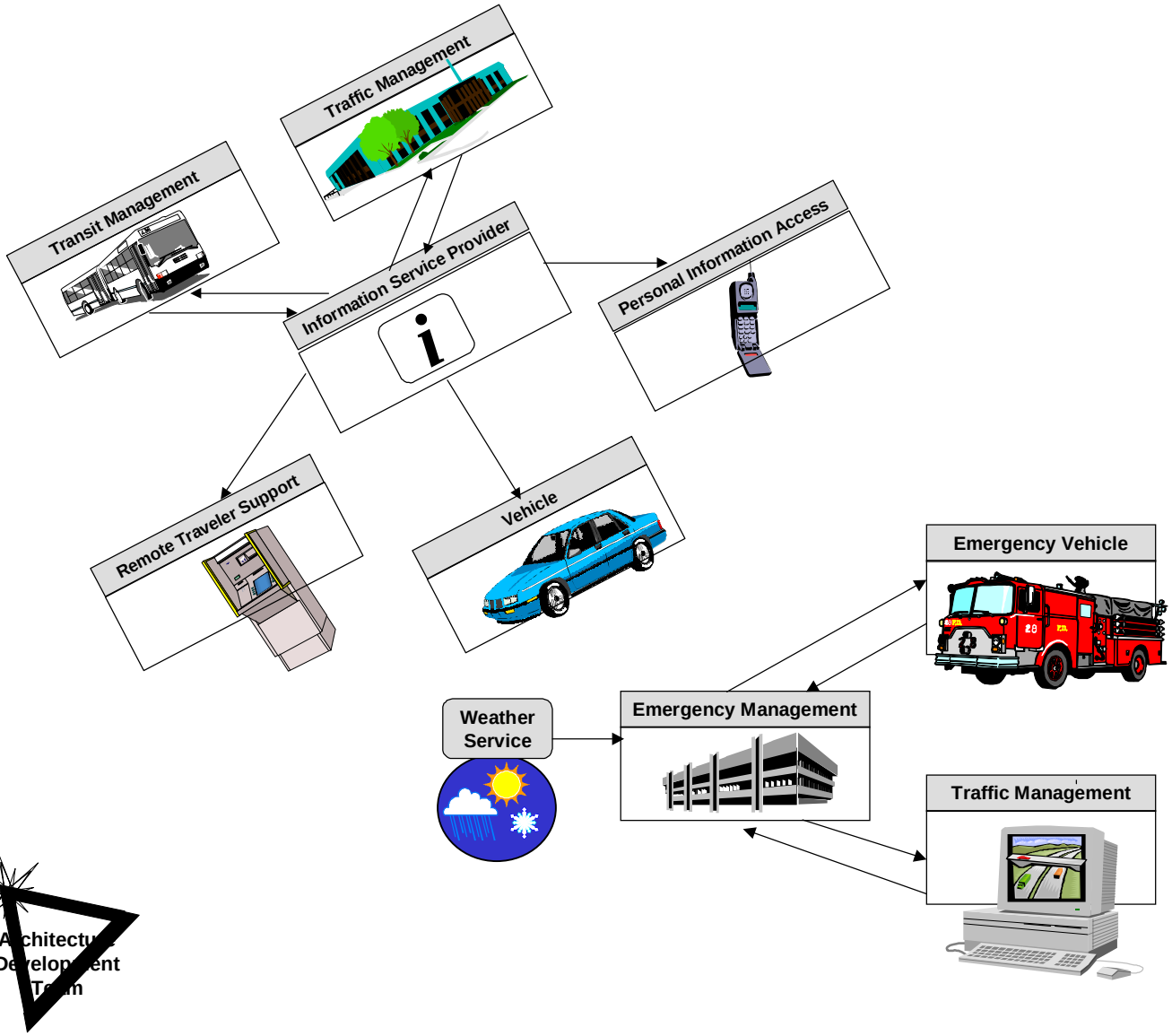
National ITS Architecture
Development Team

Market Packages

A Tool For Viewing, Accessing, And Utilizing The National ITS Architecture



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1 Introduction

Market Packages provide an accessible, deployment oriented perspective to the National ITS Architecture. They are tailored to fit, separately or in combination, real world transportation problems and needs. Market Packages collect together one or more Equipment Packages that must work together to deliver a given transportation service and the Architecture Flows that connect them and other important external systems. In other words, they identify the pieces of the Physical Architecture that are required to implement a particular transportation service. This chapter outlines the purpose and structure of the Market Package document and describes some of the guiding principles used in developing the Market Packages.

1.1 Document Purpose

This Market Packages document is one of a series of deliverables documenting the National Intelligent Transportation System (ITS) Architecture developed under contract to the U.S. Department of Transportation (DOT). This document defines the Market Packages, provides a series of analyses centered on the Market Packages, and includes a number of examples that illustrate ways Market Packages can be applied in regional and project architecture development activities. Through these definitions, analyses, and examples, the Market Packages document provides a comprehensive review of the Market Packages and how they can be used to plan and implement integrated transportation systems customized to local needs.

This document is intended to serve the transportation professional who is involved in ITS planning and/or implementation and wants to leverage the opportunities presented by the National ITS Architecture. The document, along with the other National Architecture documents, will be of particular interest to those that are developing, or supporting the development of regional ITS systems. This group includes transportation planners, engineers, system integrators, and state and local implementors who are progressing towards integrated ITS implementations.

What does this Market Packages Document include?

- A summary of the National ITS Architecture and how Market Packages can be used to relate the Architecture to ITS implementations.
- A description of each of the 63 Market Packages and general information on the problems addressed, potential benefits, and enabling technologies associated with their use.
- A description of the relationships and synergies between Market Packages that can be used to plan cost-effective, time phased deployment of ITS.
- Examples and illustrations of some of the ways that Market Packages can be applied to transportation system planning and project deployment.

What is not included in this Market Packages Document?

- A prescribed process for using the Market Packages. Different stakeholders must adapt the general processes identified herein to address prevailing local conditions and requirements.
- A prescription for ownership, financial, and operational responsibilities for each of the Market Package components. The identification of public sector and private sector roles will be dependent on the needs of each community.
- Evaluations of Market Packages. While the document details many of the likely benefits resulting from Market Package implementation and provides some guidance for pre-implementation assessment, the impact of implementing Market Packages will vary depending on local factors such as regional transportation supply and demand, technology choices, operational context, and intensity of deployment.

1.2 Guiding Principles

Wide spread implementation of ITS will depend on a multitude of individual deployment decisions by public agencies and the private sector. The National ITS Architecture preserves choice for each of these implementors by limiting its scope to include only those interfaces and functional descriptions that address key system interoperability issues. This conservative scope allows each implementor to make maximum use of existing assets and provides a variety of evolutionary paths for maturing ITS capabilities based on individual priorities. This conservative scope carries over into the Market Packages, which bundle together the elements of the architecture that apply to representative ITS implementations.

The National ITS Architecture was developed by a diverse group of private companies, public agencies, and technical specialists which represent a microcosm of the range of stakeholders who will ultimately influence the scope and character of future ITS deployments. The Architecture has benefited from participation by public agencies at the national, state, regional, and local levels. The issues that resonate from these organizations include preservation of local autonomy, effective utilization of existing systems as well as those in development, and flexibility to expand the system as local authorities deem appropriate.

These issues were echoed by the private sector with the additional recommendation that utilizing existing infrastructure enables rapid early deployment, reduces risk through utilization of known technologies and organizations, and allows more reliable cost estimation. Leveraging the existing and emerging national communications infrastructure (e.g., the Internet) was a unique idea when the architecture was originally conceived. Today, ITS, like the broader economy, is swept up in the adaptation and use of the Internet for its own business needs.

These considerations resulted in this Market Packages document which is based on several key principles:

- The Market Packages are not a prescription for every region, or even one region. They identify the key ingredients from the Architecture that support representative ITS deployments. The recipe for a particular region must be based on identified needs and available resources. As a result, tailoring a regional architecture derived from the Market Packages is a mandatory step to ensure that the architecture supports specific regional needs.
- A set of basic Market Packages was identified that support the critical needs of public organizations to maintain and improve existing systems. Initial ITS implementations will build on these systems.
- Distinct Market Packages are identified that provide enabling infrastructure that is aimed at the most critical operational problems of today's transportation systems. Early implementations enhance management of the transportation network and form a basis for many of the value-added information services associated with ITS.
- Staged implementation can begin with these "islands" of basic ITS capability that are deployed in response to local needs. Increased travel demand, greater traveler expectations, and evolving needs encourages service expansion and eventual linking of these ITS islands. Geographic expansion will be paralleled by technology growth resulting in new capabilities, new products, and new features. Market Packages are defined to capture these progressions.
- ITS standards provide a unifying framework that will enhance the interoperability of these diverse, locally-responsive ITS implementations. The Market Packages are linked with, and supported by, ITS standards that are required to achieve the interoperability objectives of US DOT for ITS.

1.3 Document Structure

The Market Packages Document begins with a summary of the core physical architecture definition and builds outward to define Market Packages and their potential application in regional and project architecture development. The contents of each of the document chapters are summarized in the following paragraphs.

Chapter 2. Relating Market Packages to the National ITS. This chapter provides a brief review of the National ITS Architecture and describes how the Market Packages fit in this context. Detailed definitions of all the Market Packages are presented and a discussion of the relationship between Market Packages and the User Services is provided.

Chapter 3. Relating Market Packages to ITS Programmatic Focus Areas .

This chapter also shows how the Market Packages relate to the Metropolitan Transportation Infrastructure, rural ITS, and the Commercial Vehicle Information Systems and Networks (CVISN).

Chapter 4. Market Package Analysis. This chapter includes a series of analyses that further characterize and differentiate between the Market Packages. Institutional issues that arise from multi-faceted public sector and private sector participation in ITS implementation are identified and their implications for the Market Packages are assessed. Major technology and standards requirements that are associated with the range of potential ITS implementations are identified. Important early deployments and synergies that enable efficient incremental implementation of more advanced services are also defined.

Chapter 5. Using the Market Packages. This chapter illustrates ways in which Market Packages can be applied to support transportation planning and project definition processes. Examples of how the Market Packages can be used as an aid in the development of regional and project architectures are provided. This chapter also enumerates major implementation options associated with each Market Package.

2 Relating Market Packages to the National ITS Architecture

The National ITS Architecture provides a framework for designing transportation systems that implement the ITS User Services. The User Services were developed as part of the National ITS Program Planning process and were the key source requirements for the Architecture development effort. The Architecture defines the functions that must be performed, the Subsystems that provide these functions, and the information that must be exchanged to support these User Services. The Market Packages are directly traceable to both the Architecture Framework and the User Services. This section describes each of the 63 Market Packages and connects the Market Packages to the Architecture Framework and the User Services.

This section introduces the National ITS Architecture definition and relates this definition to the range of ITS services and implementation options that will be considered by implementors. This relationship between Architecture and implementation is presented using a defined set of *Market Packages*.

2.1 Relating Market Packages to the Architecture Definition

Market Packages represent particular groupings of entities defined in the Physical Architecture that correspond to specific transportation services. The Physical Architecture is comprised of transportation, communications, and institutional layers. The transportation layer includes the various transportation-related processing centers, distributed roadside equipment, vehicle equipment, and other equipment used by travelers to access ITS services. The transportation layer is fully documented in the separate Physical Architecture document. The communication layer provides for the transfer of information between the transportation layer elements. The technical details associated with the communication layer are presented in the Communications document. The institutional layer introduces the policies, funding incentives, working arrangements, and jurisdictional structure that support the technical layers of the Architecture.

The Transportation and Communication Layers together are the *Architecture Framework* that coordinates overall system operation by defining interfaces between equipment which may be deployed by different procuring and operating sectors. The Architecture Framework defines what each major transportation system element does and how they interact to provide all user services. This Framework of Subsystems and interfaces is specified in an implementation independent fashion to preserve maximum implementation flexibility.

Figure 2.1-1 provides a high-level view of the Architecture Framework. The figure includes both the transportation and communication layers of the Architecture

since it depicts both the Subsystems (transportation layer elements) and the major communications interconnects (communication layer elements) required to support the user services

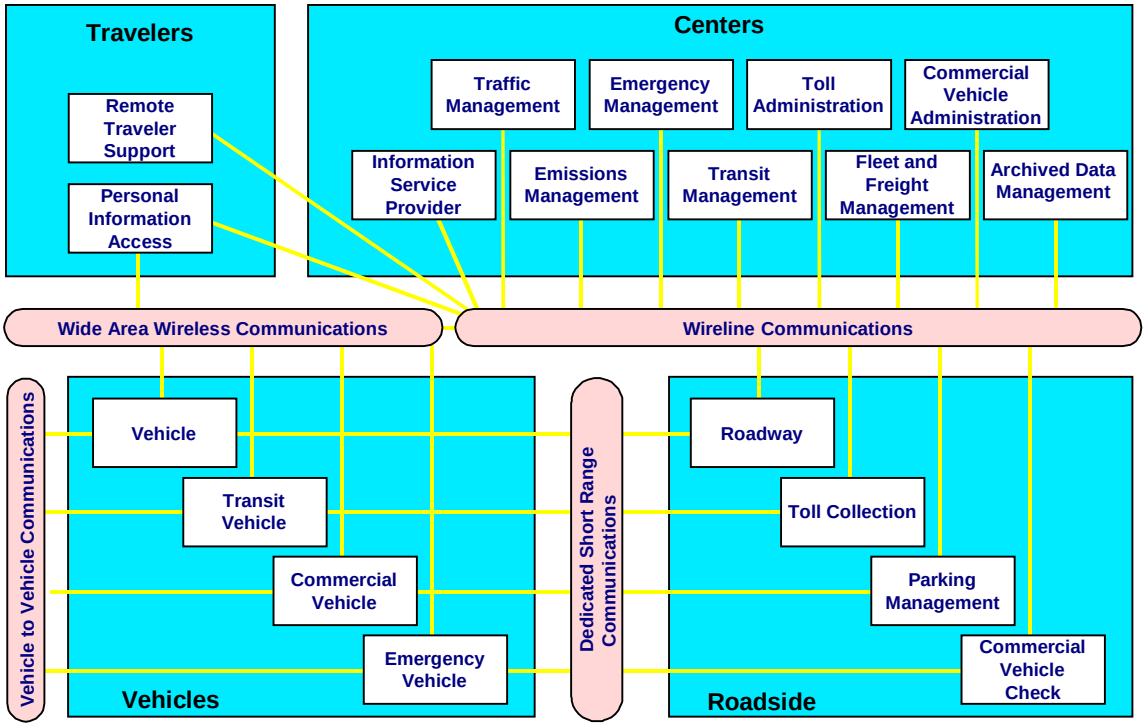


Figure 2.1-1: National ITS Architecture Subsystems and Communications

2.1.1 Market Packages and Subsystems

The Transportation Layer includes the nineteen interconnected Subsystems identified in Figure 2.1-1. The selected Subsystems align closely with existing jurisdictional and physical boundaries that underscore the operation and maintenance of current transportation systems. By mirroring the current transportation environment with the identified Subsystems, the Subsystem boundaries identify the likely candidates for interface standardization. The Architecture recognizes these boundaries to minimize the impact associated with adoption of the Architecture. Maximum commonality between existing transportation system boundaries and Architecture boundaries serves to minimize the number of artificial boundaries which are imposed (and constrained) by the Architecture. Complete definitions of the Subsystems and other Physical Architecture entities can be found in the Physical Architecture document.

Before describing how Subsystems combined for a particular Market Package application, an important distinction must be made between the “center”

Subsystems and the transportation management "centers" that are familiar to most transportation professionals.

In simplest terms, the center Subsystems are not "brick and mortar". Each Subsystem is a cohesive set of functional definitions with required interfaces to other Subsystems. Subsystems are *functionally*, not physically, defined. A regional implementation may include a single physical center that collocates the capabilities from several of the center Subsystems. For instance, a single Transportation Management Center may include Traffic Management Subsystem, Transit Management Subsystem, Emergency Management Subsystem, and Information Service Provider Subsystem capabilities. Conversely, a single Subsystem may be replicated in many different physical centers in a complex metropolitan area system. For instance, multiple traffic management Subsystems may be implemented in a region reflecting distinct State freeway and local arterial management centers. Figure 2.1-2 provides an indication of the range of ways that center Subsystems may be implemented in physical centers.

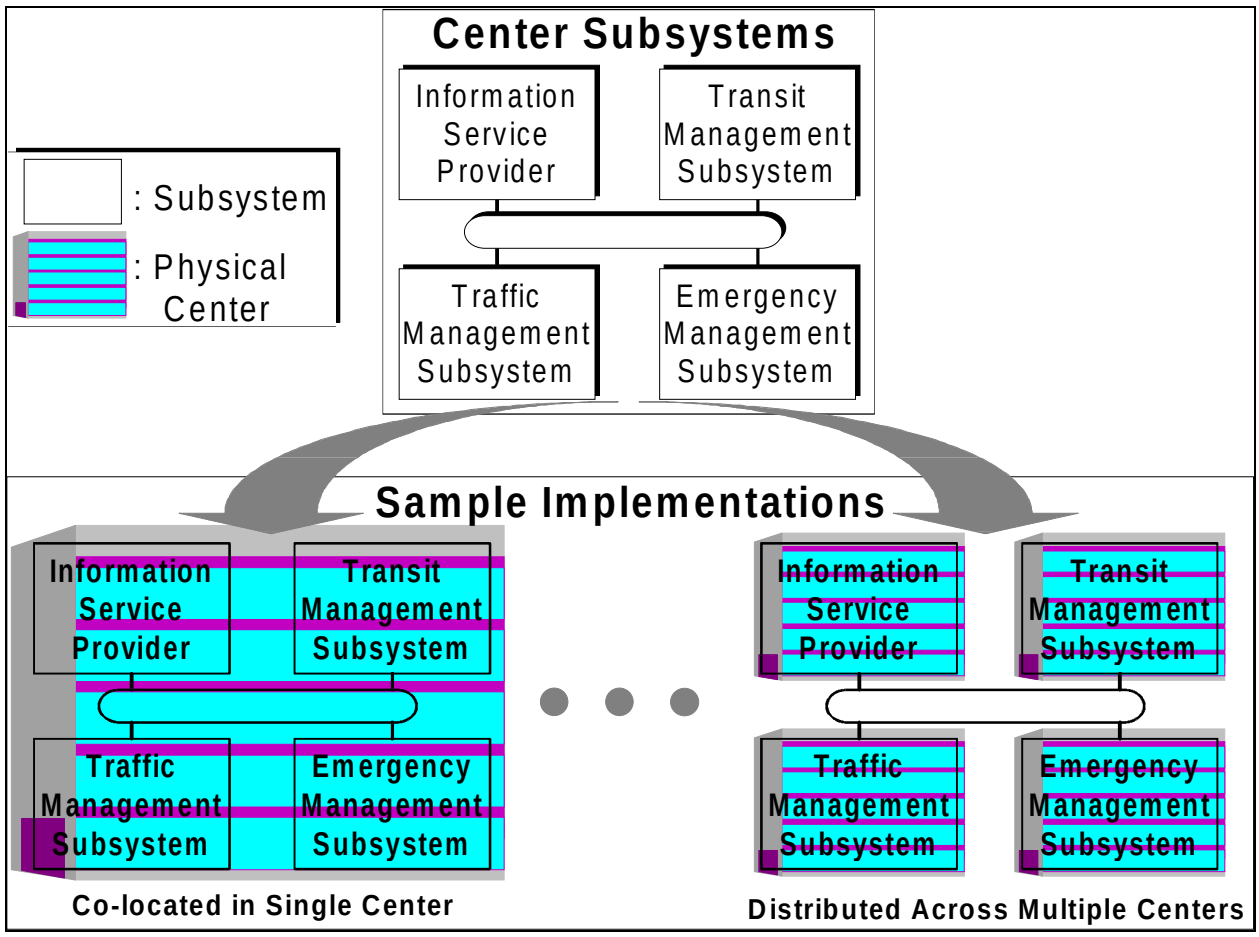


Figure 2.1-2: Center Subsystems May Be Implemented In Various Regional Configurations

A Market Package is implemented with a combination of interrelated equipment; this equipment often resides in several different Subsystems within the Architecture Framework and may be operated by different stakeholders. For instance, the Transit Vehicle Tracking Market Package includes vehicle location equipment in the Transit Vehicle Subsystem and a base station element in the Transit Management Subsystem. In this example, all Market Package elements are owned and operated by the same transit stakeholder.

In other cases, the Market Package elements are owned and operated by different stakeholders. Many of the ATIS Market Packages require equipment in the Information Service Provider Subsystem that is owned and operated by a public or private information provider and equipment that is acquired and operated by the consumer as part of the Vehicle Subsystem or Personal Information Access Subsystem. Since equipment in different Subsystems may be purchased and operated by different end-users, these Subsystem-specific components may encounter varied deployment.

2.1.2 Market Packages and Equipment Packages

To understand and analyze these potential deployment variations, the defined Market Packages must be decomposed to their constituent elements. The portion of the Market Package capabilities that are allocated to each Subsystem are segregated and defined as Equipment Packages to support this additional resolution. An *Equipment Package* represents a set of equipment/capabilities that are likely to be purchased by an end-user as a component to an overall system.

Since Equipment Packages are both the most detailed elements of the Physical Architecture and associated with specific Market Packages, there is clear traceability between the interface-oriented Architecture Framework and the deployment-oriented Market Packages. Figure 2.1-3 depicts the relationship between the user services, Architecture elements, and Market Packages.

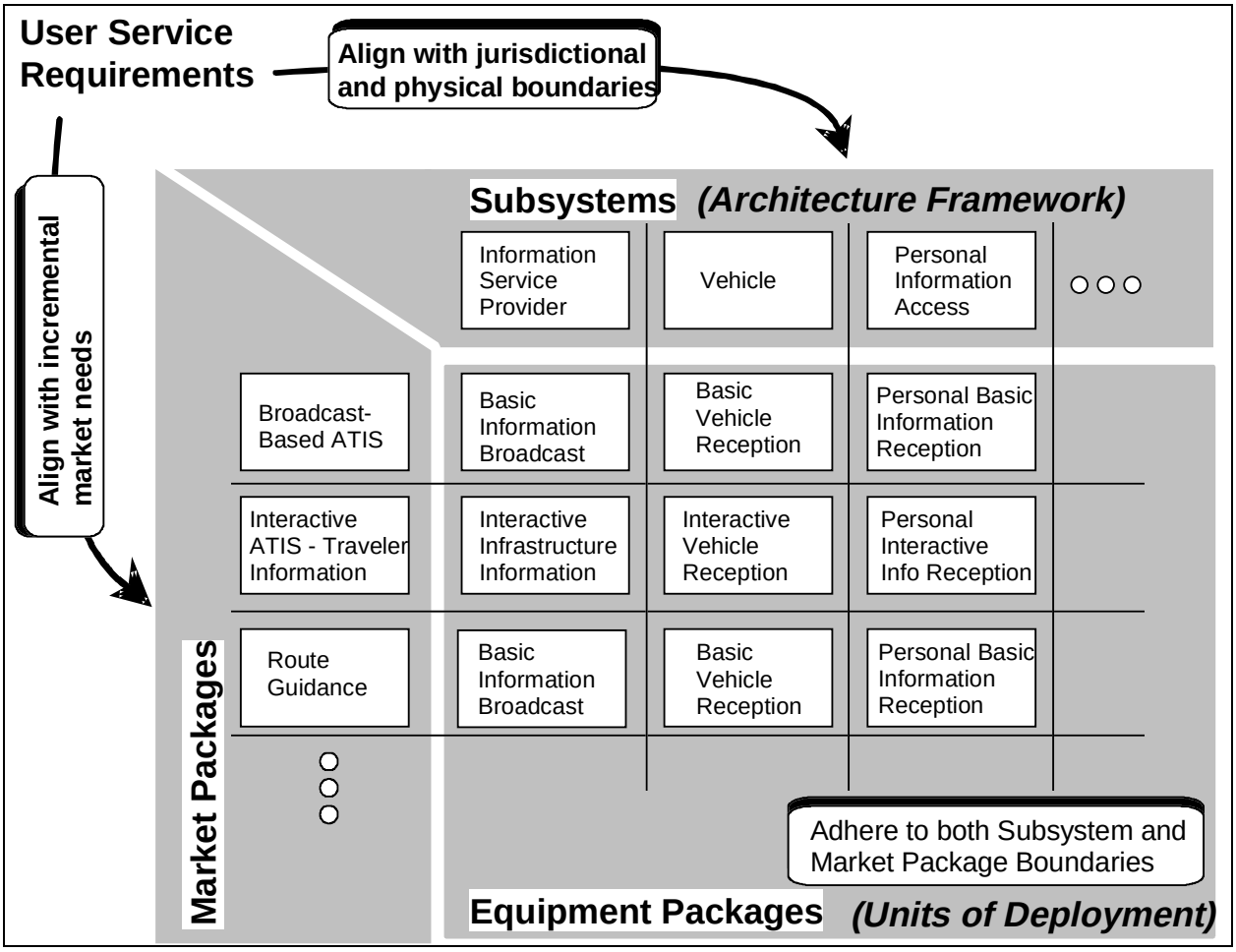


Figure 2.1-3: Architecture Element Relationships

Table 2.1-1 provides a complete listing of the Equipment Packages for each valid Market Package/Subsystem combination. In the table, the rows represent the defined Market Packages, the columns represent the Subsystems, and the center section of the table identifies the associated Equipment Packages. Related Market Packages are grouped along the left side so the reader can see the total set of Equipment Packages that make up a particular Market Package deployment. The Physical Architecture deliverable provides detailed specifications for each of the Equipment Packages identified in the table.

Table 2.1-1 Complete listing of the Equipment Packages for each valid Market Package/Subsystem Combination

Market Package	Market Package Name	Archived Data Management Subsystem	Commercial Vehicle Administration	Commercial Vehicle Check	Commercial Vehicle Subsystem	Emergency Management	Emergency Vehicle Subsystem	Emissions Management	Fleet and Freight Management	Information Service Provider	Parking Management	Personal Information Access	Remote Traveler Support	Roadway Subsystem	Toll Administration	Toll Collection	Traffic Management	Transit Management	Transit Vehicle Subsystem	Vehicle
AD1	ITS Data Mart	◆Government Reporting Systems Support ◆ITS Data Repository ◆Traffic and Roadside Data Archival	CV Data Collection			Emergency Data Collection		Emissions Data Collection		ISP Data Collection	Parking Data Collection			Roadside Data Collection	Toll Data Collection		Traffic Data Collection	Transit Data Collection		
AD2	ITS Data Warehouse	◆Government Reporting Systems Support ◆ITS Data Repository ◆On-Line Analysis and Mining ◆Traffic and Roadside Data Archival	CV Data Collection			Emergency Data Collection		Emissions Data Collection		ISP Data Collection	Parking Data Collection			Roadside Data Collection	Toll Data Collection		Traffic Data Collection	Transit Data Collection		
AD3	ITS Virtual Data Warehouse	◆ITS Data Repository ◆Virtual Data ◆Warehouse Services																		
APTS1	Transit Vehicle Tracking																	Transit Center Tracking and Dispatch	On-board Transit Trip Monitoring	Vehicle Location Determination
APTS2	Transit Fixed-Route Operations																	◆Transit Center Fixed-Route Operations ◆Transit Garage Operations	◆On-board Fixed ◆Route Schedule Management	
APTS3	Demand Response Transit Operations																	◆Transit Center ◆Paratransit Operations ◆Transit Garage Operations	On-board Paratransit Operations	
APTS4	Transit Passenger and Fare Management												Remote Transit Fare Management					Transit Center Fare and Load Management	On-board Transit Fare and Load Management	
APTS5	Transit Security												Remote Mayday I/F Secure Area Monitoring					Transit Center Security	On-board Transit Security	
APTS6	Transit Maintenance																	Transit Garage Maintenance	On-board Maintenance	
APTS7	Multi-modal Coordination													Roadside Signal Priority			TMC Multi-Modal Coordination	Transit Center Multi-Modal Coordination	On-board Transit Signal Priority	
APTS8	Transit Traveler Information												Remote Transit Information Services					Transit Center Information Services	On-board Transit Information Services	
ATIS1	Broadcast Traveler Information									Basic Information Broadcast		Personal Basic Information Reception	Remote Basic Information Reception							Basic Vehicle Reception
ATIS2	Interactive Traveler Information									Interactive Infrastructure Information		Personal Interactive Information Reception	Remote Interactive Information Reception							Interactive Vehicle Reception
ATIS3	Autonomous Route Guidance											Personal Autonomous Route Guidance Personal Location Determination								◆Vehicle Autonomous Route Guidance ◆Vehicle Location Determination
ATIS4	Dynamic Route Guidance									Basic Information Broadcast		Personal Autonomous Route Guidance Personal Location Determination								◆Vehicle Autonomous Route Guidance ◆Vehicle Location Determination
ATIS5	ISP Based Route Guidance									Infrastructure Provided Route Selection		Personal Location Determination Personal Provider-Based Route Guidance	Remote Interactive Information Reception							◆Vehicle Location Determination ◆Vehicle Provider-Based Route Guidance
ATIS6	Integrated Transportation Management/Route Guidance									Infrastructure Provided Route Selection ISP Advanced Integrated Control Support		Personal Location Determination Personal Provider-Based Route Guidance								◆Vehicle Location Determination ◆Vehicle Provider-Based Route Guidance
ATIS7	Yellow Pages and Reservation									Infrastructure Provided Yellow Pages & Reservation		Personal Interactive Information Reception	Remote Interactive Information Reception							Interactive Vehicle Reception
ATIS8	Dynamic Ridesharing									Infrastructure Provided Dynamic Ridesharing Infrastructure Provided Route Selection		Personal Interactive Information Reception	Remote Interactive Information Reception							Interactive Vehicle Reception
ATIS9	In Vehicle Signing													Roadway In-Vehicle Signing			TMC Input to In-Vehicle Signing			In-Vehicle Signing System
ATMS01	Network Surveillance													Roadway Basic Surveillance			◆Collect Traffic Surveillance ◆Traffic Maintenance			

Table 2.1-1 Complete listing of the Equipment Packages for each valid Market Package/Subsystem Combination

Market Package	Market Package Name	Archived Data Management Subsystem	Commercial Vehicle Administration	Commercial Vehicle Check	Commercial Vehicle Subsystem	Emergency Management	Emergency Vehicle Subsystem	Emissions Management	Fleet and Freight Management	Information Service Provider	Parking Management	Personal Information Access	Remote Traveler Support	Roadway Subsystem	Toll Administration	Toll Collection	Traffic Management	Transit Management	Transit Vehicle Subsystem	Vehicle
ATMS02	Probe Surveillance									ISP Probe Information Collection				Roadway Probe Beacons			TMC Probe Information Collection			Vehicle Location Determination Vehicle Probe Support
ATMS03	Surface Street Control													Roadway Signal Controls			TMC Signal Control Traffic Maintenance			
ATMS04	Freeway Control													Roadway Freeway Control			◆TMC Freeway Management ◆Traffic Maintenance			
ATMS05	HOV Lane Management													Roadway HOV Control			TMC HOV Lane Management			
ATMS06	Traffic Information Dissemination													Roadway Traffic Information Dissemination			TMC Traffic Information Dissemination			
ATMS07	Regional Traffic Control																TMC Regional Traffic Control			
ATMS08	Incident Management System					Emergency Response Management								Roadway Incident Detection			TMC Incident Detection TMC Incident Dispatch Coordination/Communication			
ATMS09	Traffic Forecast and Demand Management																◆TMC Toll/Parking Coordination ◆TMC Traffic Network Performance Evaluation			
ATMS10	Electronic Toll Collection														Toll Administration	Toll Plaza Toll Collection				Vehicle Toll/Parking Interface
ATMS11	Emissions Monitoring and Management							Emissions Data Management						Roadway Emissions Monitoring						
ATMS12	Virtual TMC and Smart Probe Data													Automated Road Signing Roadway Probe Beacons						In-vehicle Signing System Smart Probe
ATMS13	Standard Railroad Grade Crossing													Standard Rail Crossing			HRI Traffic Management			
ATMS14	Advanced Railroad Grade Crossing													Advanced Rail Crossing			HRI Traffic Management			
ATMS15	Railroad Operations Coordination																Rail Operations Coordination			
ATMS16	Parking Facility Management										Parking Electronic Payment Parking Management Parking Surveillance									Vehicle Toll/Parking Interface
ATMS17	Reversible Lane Management													Roadway Reversible Lanes			TMC Reversible Lane Management			
ATMS18	Road Weather Information System													Roadway Environmental Monitoring			TMC Road Weather Monitoring			
ATMS19	Regional Parking Management										Parking Coordination Parking Management									
AVSS01	Vehicle Safety Monitoring																			Vehicle Safety Monitoring System
AVSS02	Driver Safety Monitoring																			Driver Safety Monitoring System
AVSS03	Longitudinal Safety Warning																			Vehicle Longitudinal Warning System
AVSS04	Lateral Safety Warning																			Vehicle Lateral Warning System
AVSS05	Intersection Safety Warning													Roadway Intersection Collision Warning						Vehicle Intersection Collision Warning
AVSS06	Pre-Crash Restraint Deployment																			Vehicle Pre-Crash Safety Systems
AVSS07	Driver Visibility Improvement																			Driver Visibility Improvement System
AVSS08	Advanced Vehicle Longitudinal Control																			Vehicle Longitudinal Control
AVSS09	Advanced Vehicle Lateral Control																			Vehicle Lateral Control

Table 2.1-1 Complete listing of the Equipment Packages for each valid Market Package/Subsystem Combination

Market Package	Market Package Name	Archived Data Management Subsystem	Commercial Vehicle Administration	Commercial Vehicle Check	Commercial Vehicle Subsystem	Emergency Management	Emergency Vehicle Subsystem	Emissions Management	Fleet and Freight Management	Information Service Provider	Parking Management	Personal Information Access	Remote Traveler Support	Roadway Subsystem	Toll Administration	Toll Collection	Traffic Management	Transit Management	Transit Vehicle Subsystem	Vehicle
AVSS10	Intersection Collision Avoidance													Roadway Intersection Collision Warning						Vehicle Intersection Control
AVSS11	Automated Highway System													Roadway Systems for AHS			TMC for AHS			Vehicle Systems for AHS
CVO01	Fleet Administration				On-board Trip Monitoring				Fleet Administration Fleet Maintenance Management											Vehicle Location Determination
CVO02	Freight Administration				On-board Cargo Monitoring				Freight Administration and Management											
CVO03	Electronic Clearance		CV Information Exchange	Roadside Electronic Screening	On-board CV Electronic Data															
CVO04	CV Administrative Processes		◆Credentials and Taxes Administration ◆CV Information Exchange						Fleet Credentials and Taxes Management and Reporting											
CVO05	International Border Electronic Clearance		◆CV Information Exchange ◆International CV Administration	International Border Crossing	On-board CV Electronic Data				Fleet Credentials and Taxes Management and Reporting											
CVO06	Weigh-In-Motion			Roadside WIM	On-board CV Electronic Data															
CVO07	Roadside CVO Safety		◆CV Information Exchange ◆CV Safety Administration	◆Citation and Accident Electronic Recording ◆Roadside Safety Inspection	On-board CV Electronic Data															
CVO08	On-board CVO Safety		◆CV Information Exchange CV Safety Administration	Citation and Accident Electronic Recording	◆On-board Cargo Monitoring ◆On-board CV Safety ◆On-Board Trip Monitoring															
CVO09	CVO Fleet Maintenance				On-board Trip Monitoring				Fleet Maintenance Management											
CVO10	HAZMAT Management				On-Board Cargo Monitoring	◆Emergency Response Management ◆Mayday Support			Fleet HAZMAT Management								◆TMC Incident Dispatch ◆Coordination/Communication			Vehicle Mayday I/F
EM1	Emergency Response					◆Emergency Call-Taking Emergency Response Management	On-board EV Incident Management Communication													
EM2	Emergency Routing					Emergency Dispatch	On-board EV En Route Support							Roadside Signal Priority						Vehicle Location Determination
EM3	Mayday Support					Mayday Support						◆Personal Location Determination ◆Personal Mayday I/F	Remote Mayday I/F							◆Vehicle Location Determination ◆Vehicle Mayday I/F

2.2 The National ITS Architecture Market Packages

The Architecture definition summarized in the previous section is intended to be extremely accommodating.

- Its breadth supports the complete range of ITS services from basic signal control improvements to automated highway systems.
- Its scalability supports implementations suitable for major metropolitan areas as well as remote rural areas.
- Its technological neutrality ensures that it will remain viable in the future and receptive to technology changes.

This high degree of flexibility is necessary since the Architecture must accommodate the range of possible ITS implementations across the United States over a twenty year timeframe. Unfortunately, this flexibility also complicates the task of determining which pieces of the Architecture are applicable and how they can best be applied in addressing a particular community's current and future transportation needs (see figure 2.2-1).

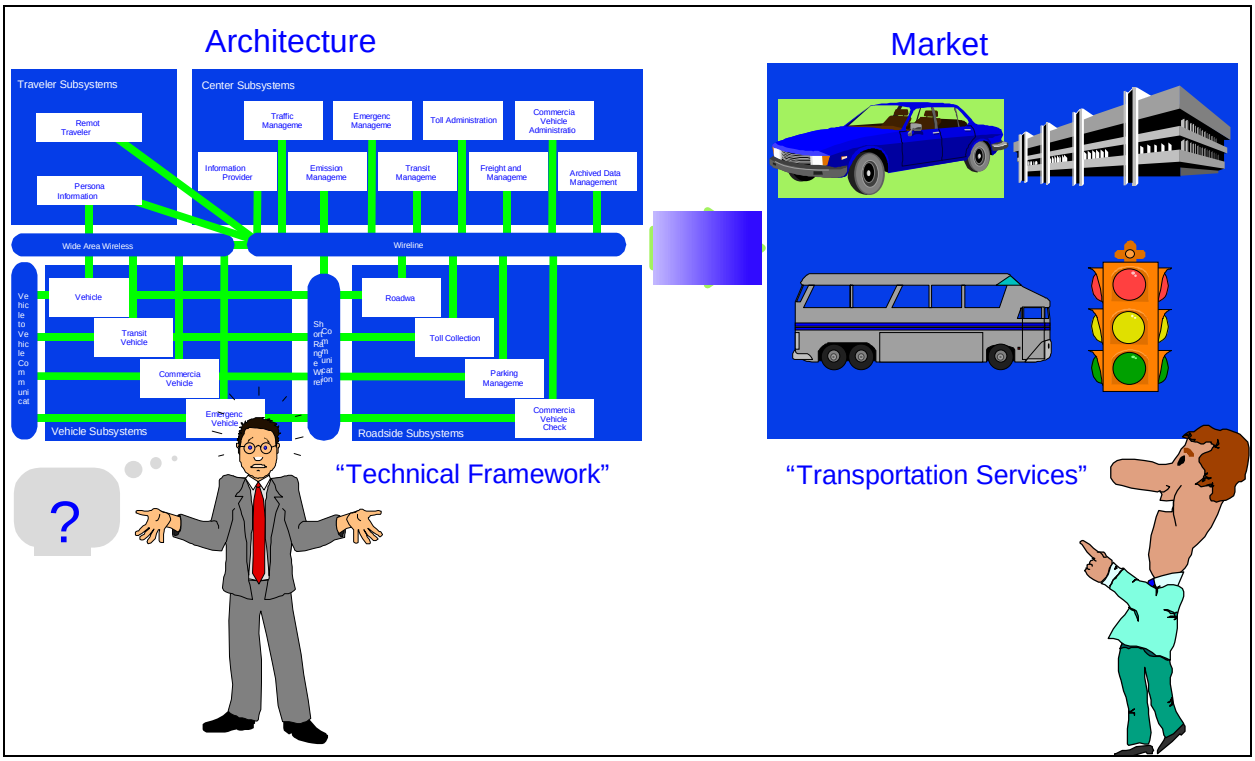


Figure 2.2-1: Translating Architecture to Implementation through Market Packages

To provide visibility into the service options that will be considered by ITS planners and implementors, a set of *Market Packages* have been defined. The Market Packages provide an accessible, deployment oriented perspective to the national Architecture. They are tailored to fit, separately or in combination, real world transportation problems and needs. They address the specific service requirements of traffic managers, transit operators, travelers, and other ITS stakeholders. The Market Packages were defined with enough granularity to support specific benefits analyses.

Several different Market Packages are defined in each major application area which provides a palette of service options at various costs. Market Packages are also structured to segregate services that are likely to encounter technical or non-technical challenges from lower risk services. This approach allows the identification of a subset of the Market Packages that are likely early deployments. At the other end of the spectrum, several of the Market Packages represent advanced products or services that will not be available for some time. Many of the Market Packages are also incremental so that more advanced packages can be efficiently implemented by building on common elements that were deployed earlier with more basic packages.

The complete set of Market Packages are identified in Table 2.2-1. In order to more accurately specify Market Packages in tables, each is given an abbreviation indicating the general class of stakeholder and an index (e.g., ATMS1 is a Market Package primarily of interest to transportation managers).

Table 2.2-1: Market Packages Summary

Market Package	Market Package Name
APTS1	Transit Vehicle Tracking
APTS2	Transit Fixed-Route Operations
APTS3	Demand Response Transit Operations
APTS4	Transit Passenger and Fare Management
APTS5	Transit Security
APTS6	Transit Maintenance
APTS7	Multi-modal Coordination
APTS8	Transit Traveler Information
ATIS1	Broadcast Traveler Information
ATIS2	Interactive Traveler Information
ATIS3	Autonomous Route Guidance
ATIS4	Dynamic Route Guidance
ATIS5	ISP Based Route Guidance
ATIS6	Integrated transportation Management/Route Guidance
ATIS7	Yellow Pages and Reservation
ATIS8	Dynamic Ridesharing
ATIS9	In Vehicle Signing

Market Package	Market Package Name
ATMS1	Network Surveillance
ATMS2	Probe Surveillance
ATMS3	Surface Street Control
ATMS4	Freeway Control
ATMS5	HOV Lane Management
ATMS6	Traffic Information Dissemination
ATMS7	Regional Traffic Control
ATMS8	Incident Management System
ATMS9	Traffic Forecast and Demand Management
ATMS10	Electronic Toll Collection
ATMS11	Emissions Monitoring and Management
ATMS12	Virtual TMC and Smart Probe Data
ATMS13	Standard Railroad Grade Crossing
ATMS14	Advanced Railroad Grade Crossing
ATMS15	Railroad Operations Coordination
ATMS16	Parking Facility Management
ATMS17	Reversible Lane Management
ATMS18	Road Weather Information System
ATMS19	Regional Parking Management
AVSS1	Vehicle Safety Monitoring
AVSS2	Driver Safety Monitoring
AVSS3	Longitudinal Safety Warning
AVSS4	Lateral Safety Warning
AVSS5	Intersection Safety Warning
AVSS6	Pre-Crash Restraint Deployment
AVSS7	Driver Visibility Improvement
AVSS8	Advanced Vehicle Longitudinal Control
AVSS9	Advanced Vehicle Lateral Control
AVSS10	Intersection Collision Avoidance
AVSS11	Automated Highway System
CVO1	Fleet Administration
CVO2	Freight Administration
CVO3	Electronic Clearance
CVO4	CV Administrative Processes
CVO5	International Border Electronic Clearance
CVO6	Weigh-In-Motion
CVO7	Roadside CVO Safety
CVO8	On-board CVO Safety
CVO9	CVO Fleet Maintenance
CVO10	HAZMAT Management
EM1	Emergency Response
EM2	Emergency Routing
EM3	Mayday Support
AD1	ITS Data Mart
AD2	ITS Data Warehouse
AD3	ITS Virtual Data Warehouse

The deployment oriented Market Packages are traceable to the interface-oriented Architecture definition. Once a particular Market Package is selected for

implementation, the required Subsystems, Equipment Packages, and interface requirements are readily identified due to this traceability. This approach allows the planner or implementor to first consider service needs and later concentrate on those pieces of the Architecture necessary to provide the selected service.

It is important to note that the Market Packages are illustrative rather than prescriptive. The actual implementation variations that are possible across the country are myriad and cannot be enumerated through a finite set of packages. The Market Packages are tools that allow this Implementation Strategy to discuss incremental deployment of ITS services in a manner that is relevant to the underlying Architecture definition.

The remainder of this chapter defines each of the Market Packages in more detail. A description of the service offered by each Market Package is coupled with a graphic that identifies how the Architecture Framework supports the Market Package. Where several major implementation options are supported by the Market Package, these are also identified and differentiated in the descriptions.

Figure 2.2-2 provides a legend to assist in interpretation of the Market Package diagrams. In general, only the most salient elements from the Architecture definition (e.g., directly involved Subsystems, system terminators, and the highest level data flows) are depicted in each graphic to ensure clarity.

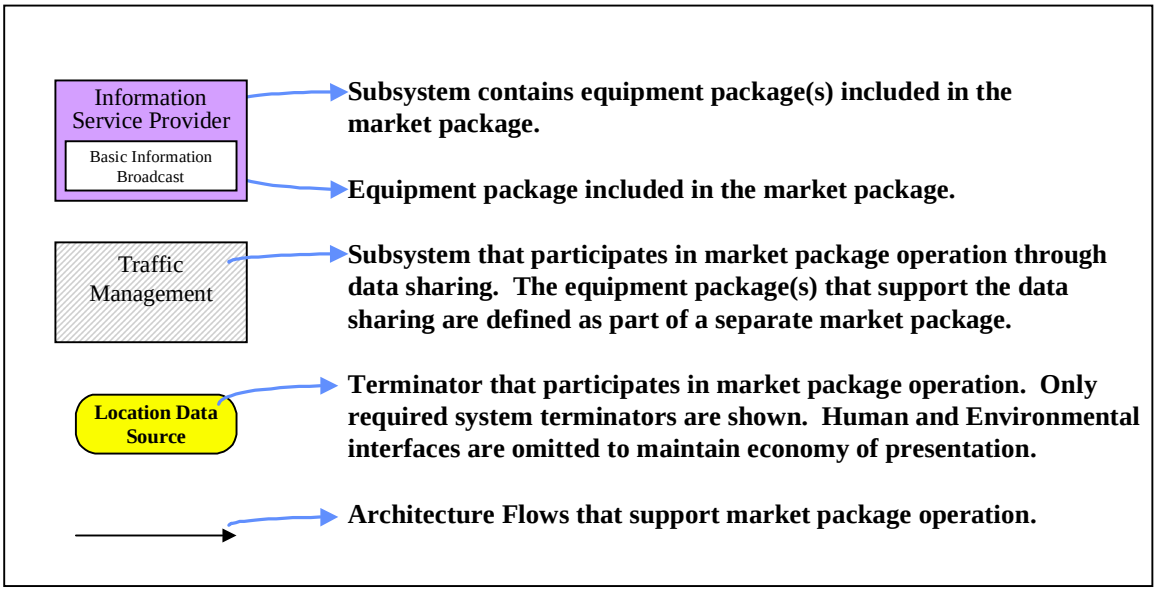
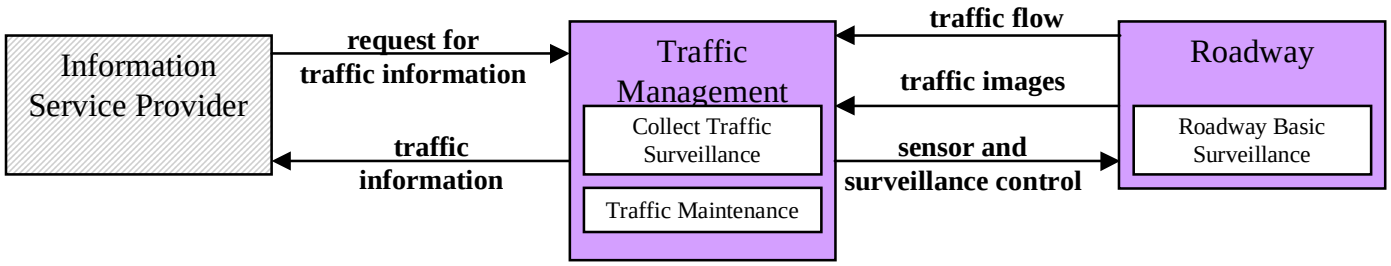


Figure 2.2-2: Market Package Diagram Elements

2.2.1 Traffic Management Market Packages

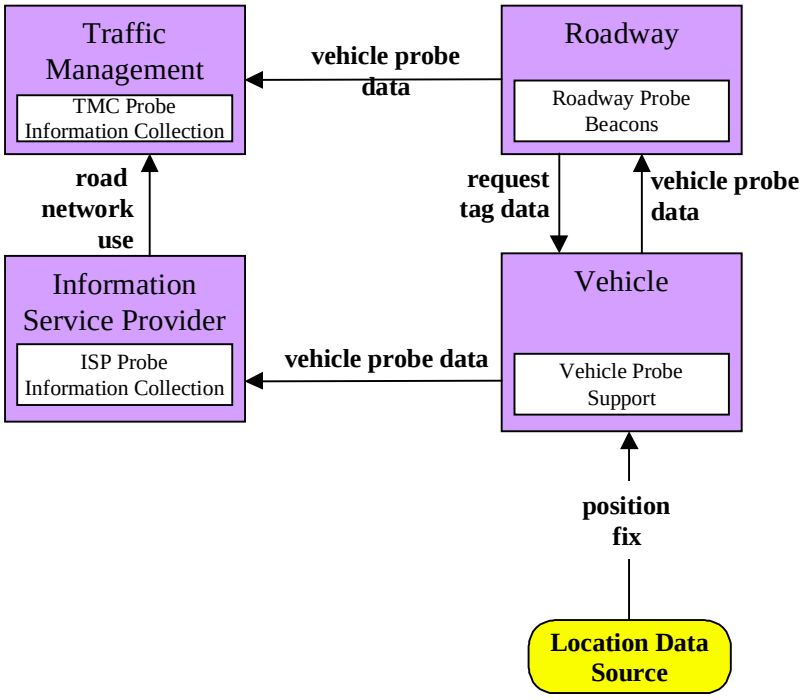
Network Surveillance (ATMS1)
This Market Package includes traffic detectors, environmental sensors, other surveillance equipment, the supporting field equipment, and wireline communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this Market Package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Probe Surveillance (ATMS2)

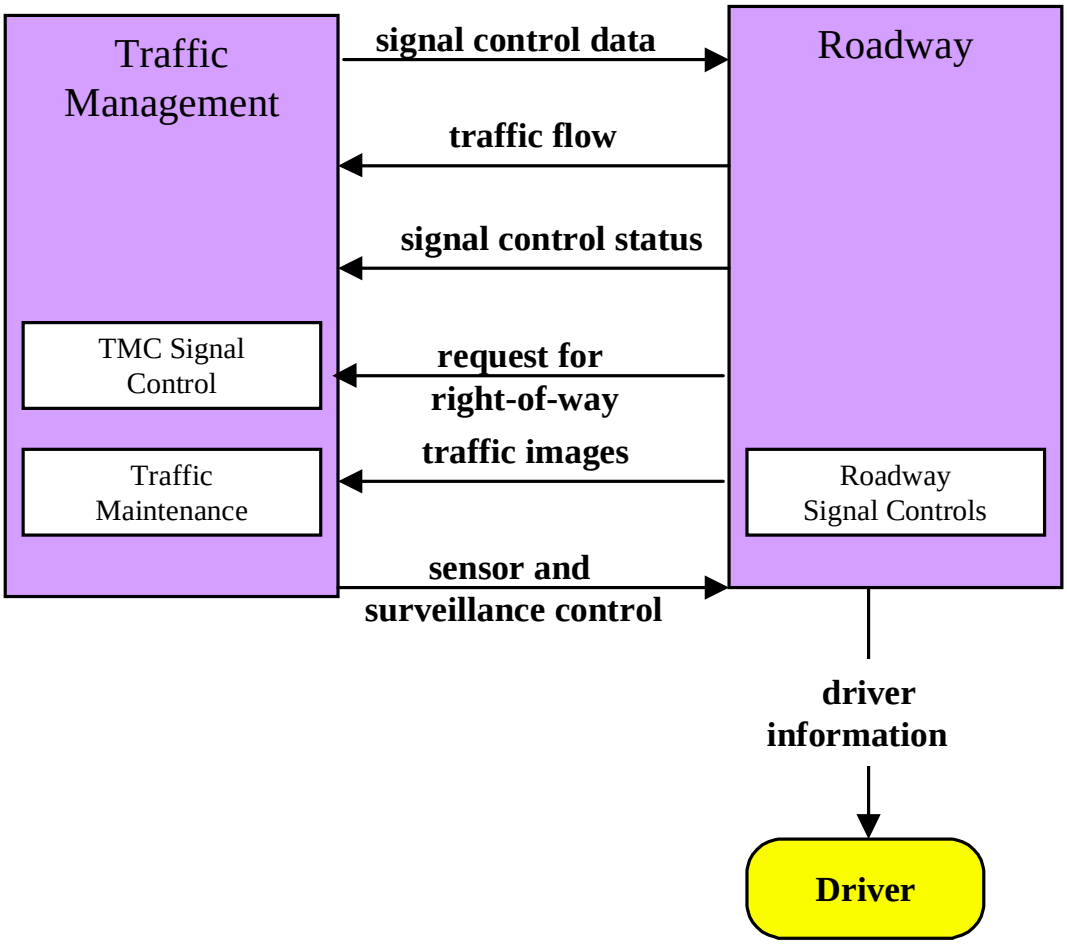
This Market Package provides an alternative approach for surveillance of the roadway network. Two general implementation paths are supported by this Market Package: 1) wide-area wireless communications between the vehicle and Information Service Provider is used to communicate current vehicle location and status, and 2) dedicated short range communications between the vehicle and roadside is used to provide equivalent information back to the Traffic Management Subsystem. The first approach leverages wide area communications equipment that may already be in the vehicle to support personal safety and advanced traveler information services. The second approach utilizes vehicle equipment that supports toll collection, in-vehicle signing, and other short range communications applications identified within the Architecture. The Market Package enables traffic managers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. It requires one of the communications options identified above, roadside beacons and wireline communications for the short range communications option, data reduction software, and utilizes wireline links between the Traffic Management Subsystem and Information Service Provider Subsystem to share the collected information. Both "Opt out" and "Opt in" strategies are available to ensure the user has the ability to turn off the probe functions to ensure individual privacy. Due to the large volume of data collected by probes, data reduction techniques are required in this Market Package, which include the ability to identify and filter out-of-bounds or extreme data reports.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Surface Street Control (ATMS3)

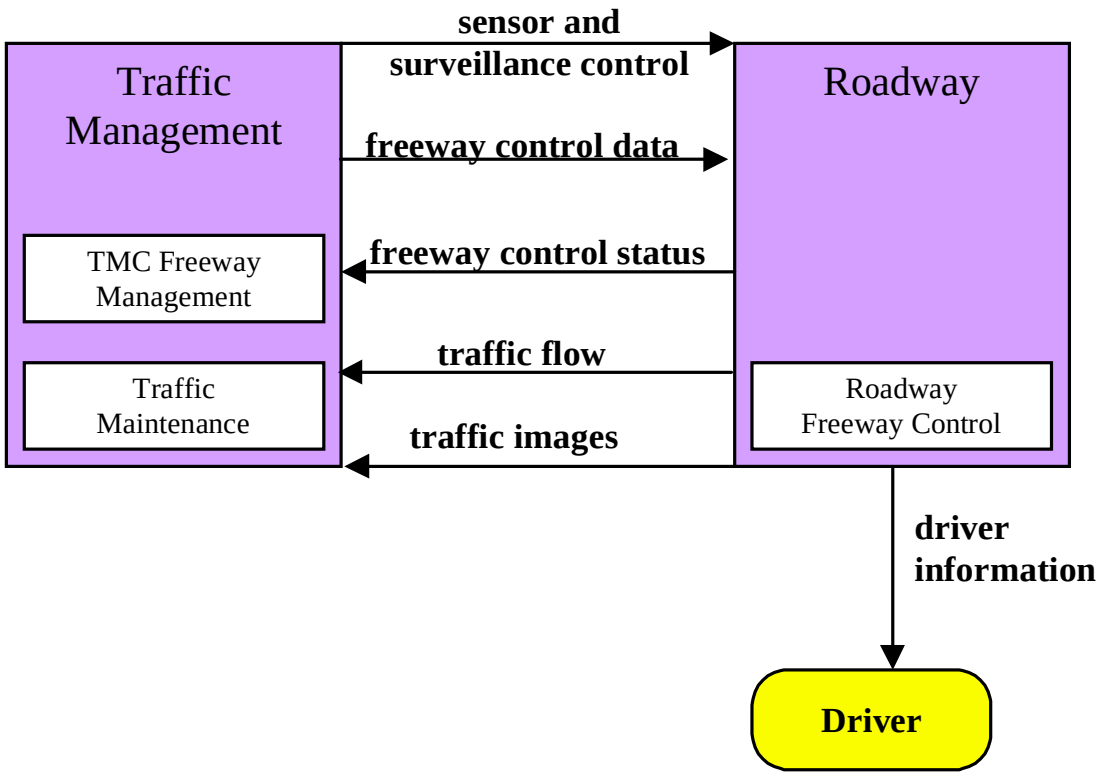
This Market Package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this Market Package ranging from static pre-timed control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. Additionally, general advisory and traffic control information can be provided to the driver while en-route. This Market Package is generally an intra-jurisdictional package that does not rely on real-time communications between separate control systems to achieve area-wide traffic signal coordination. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would be represented by this package. This Market Package is consistent with typical urban traffic signal control systems.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Freeway Control (ATMS4)
This Market Package provides the communications and roadside equipment to support ramp control, lane controls, and interchange control for freeways. Coordination and integration of ramp meters are included as part of this Market Package. This package is consistent with typical urban traffic freeway control systems. This package incorporates the instrumentation included in the Network Surveillance Market Package to support freeway monitoring and adaptive strategies as an option.

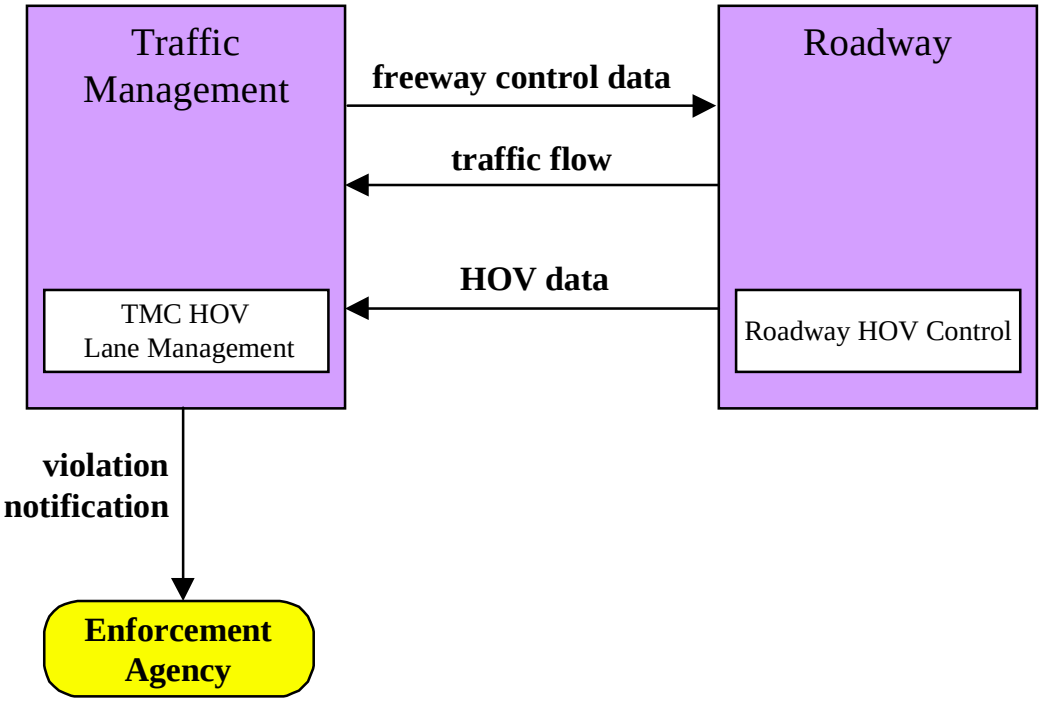
This Market Package also includes the capability to utilize surveillance information for detection of incidents. Typically, the processing would be performed at a traffic management center; however, developments might allow for point detection with roadway equipment. For example, a CCTV might include the capability to detect an incident based upon image changes. Additionally, this Market Package allows general advisory and traffic control information to be provided to the driver while en-route.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

HOV Lane Management (ATMS5)

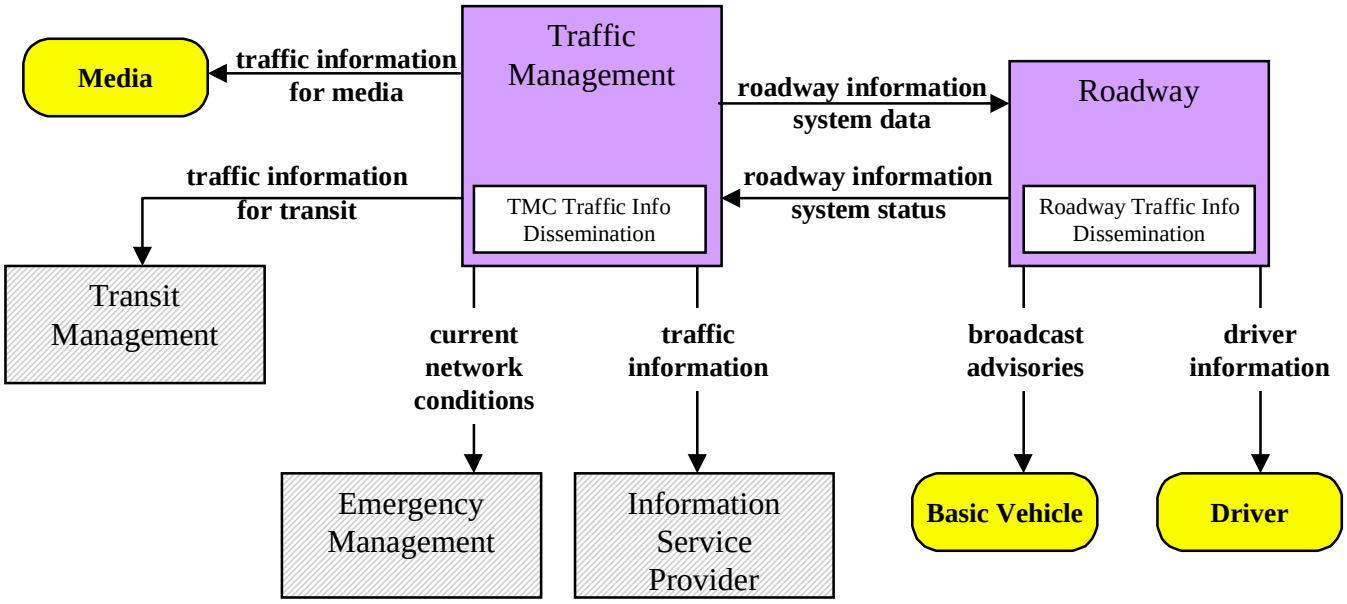
This Market Package manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Traffic Information Dissemination (ATMS6)

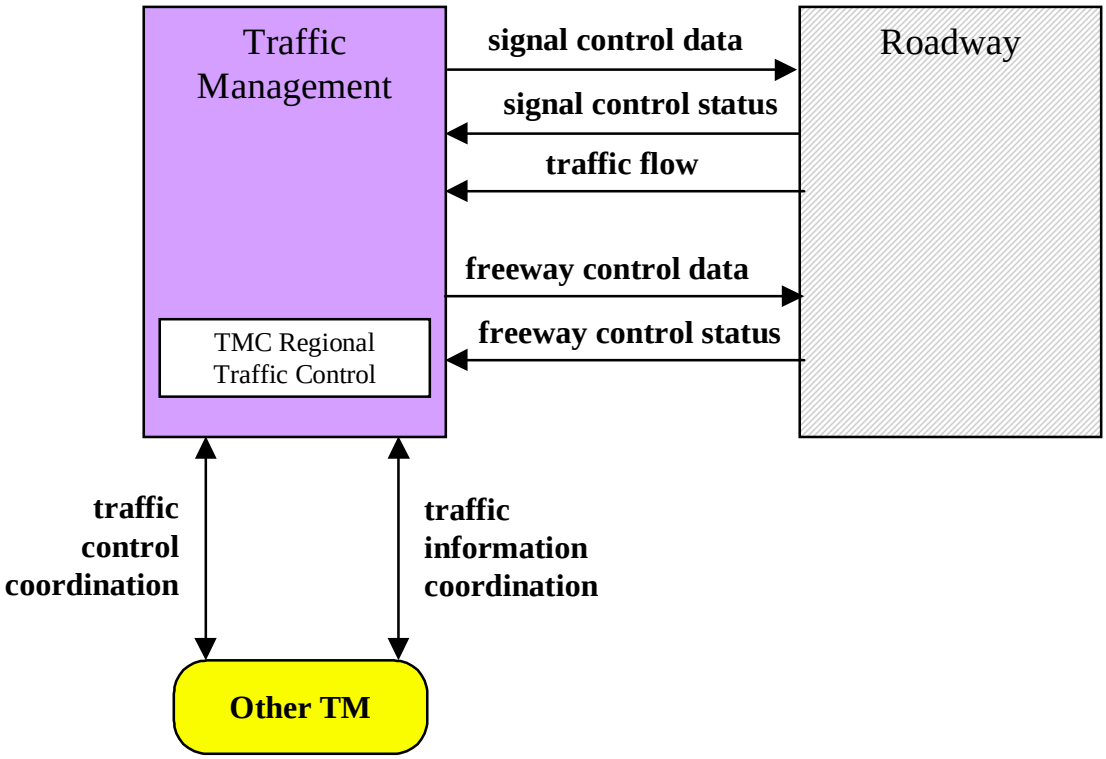
This Market Package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as dynamic message signs or highway advisory radio. This package provides a tool that can be used to notify drivers of incidents; careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), transit management center, emergency management center, and information service provider.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Regional Traffic Control (ATMS7)

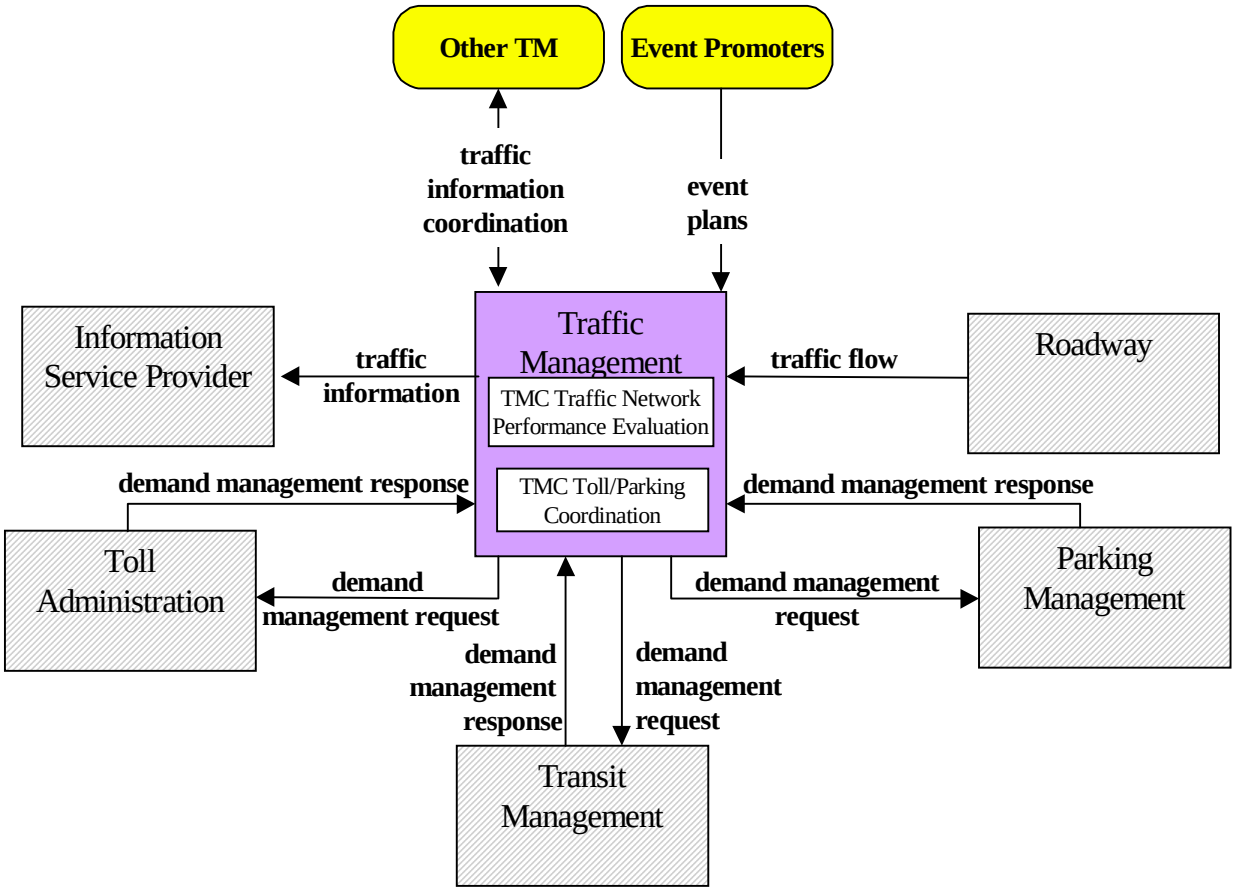
This Market Package advances the Surface Street Control and Freeway Control Market Packages by adding the communications links and integrated control strategies that enable integrated interjurisdictional traffic control. This Market Package provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Market Packages and adds hardware, software, and wireline communications capabilities to implement traffic management strategies which are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of control between traffic management centers.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

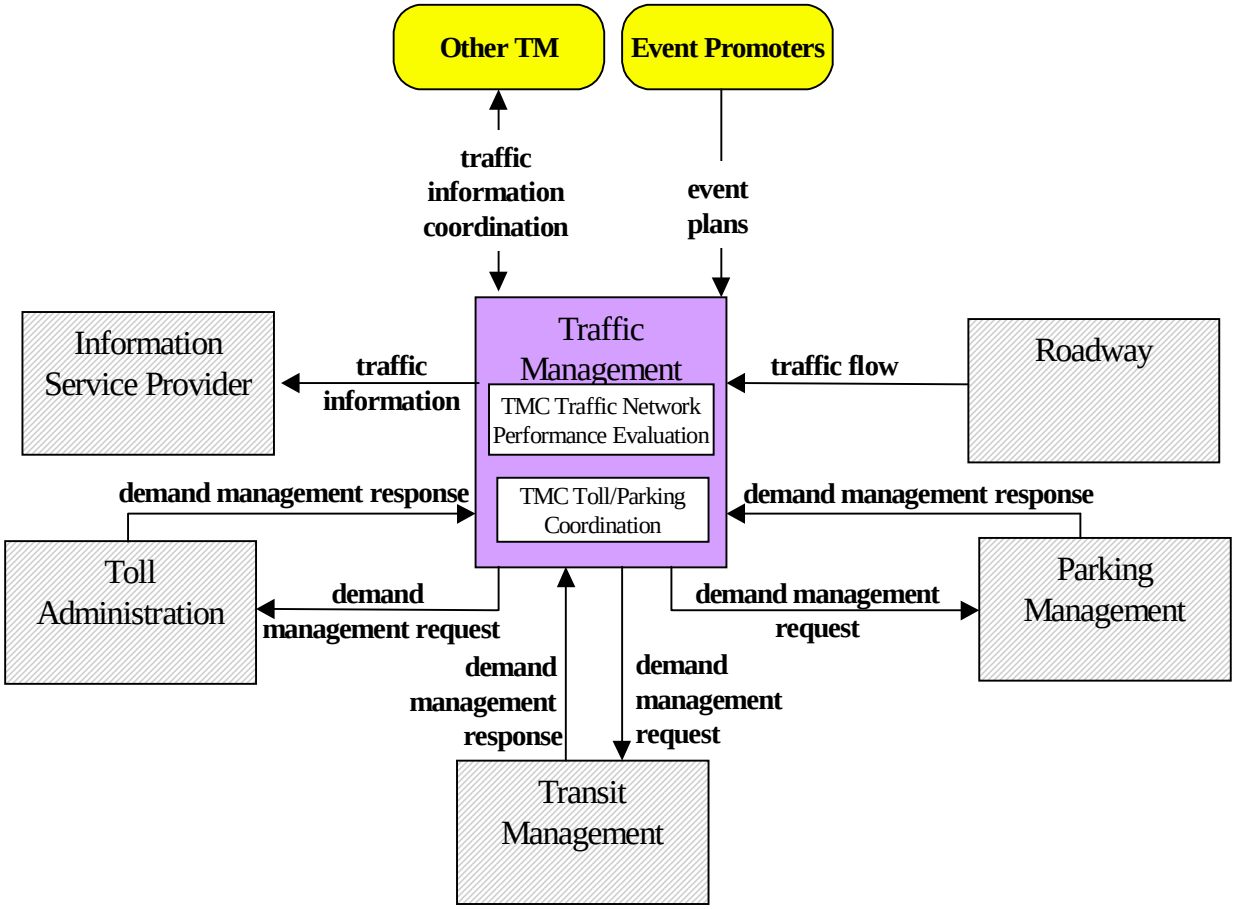
Incident Management System (ATMS8)

This Market Package manages both predicted and unexpected incidents so that the impact to the transportation network and traveler safety is minimized. Requisite incident detection capabilities are included in the freeway control Market Package and through the regional coordination with other traffic management and emergency management centers, weather service entities, and event promoters supported by this Market Package. Information from these diverse sources are collected and correlated by this Market Package to detect and verify incidents and implement an appropriate response. This Market Package provides Traffic Management Subsystem equipment that supports traffic operations personnel in developing an appropriate response in coordination with emergency management and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications and presentation of information to affected travelers using the Traffic Information Dissemination Market Package. The same equipment assists the operator by monitoring incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other field service personnel.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

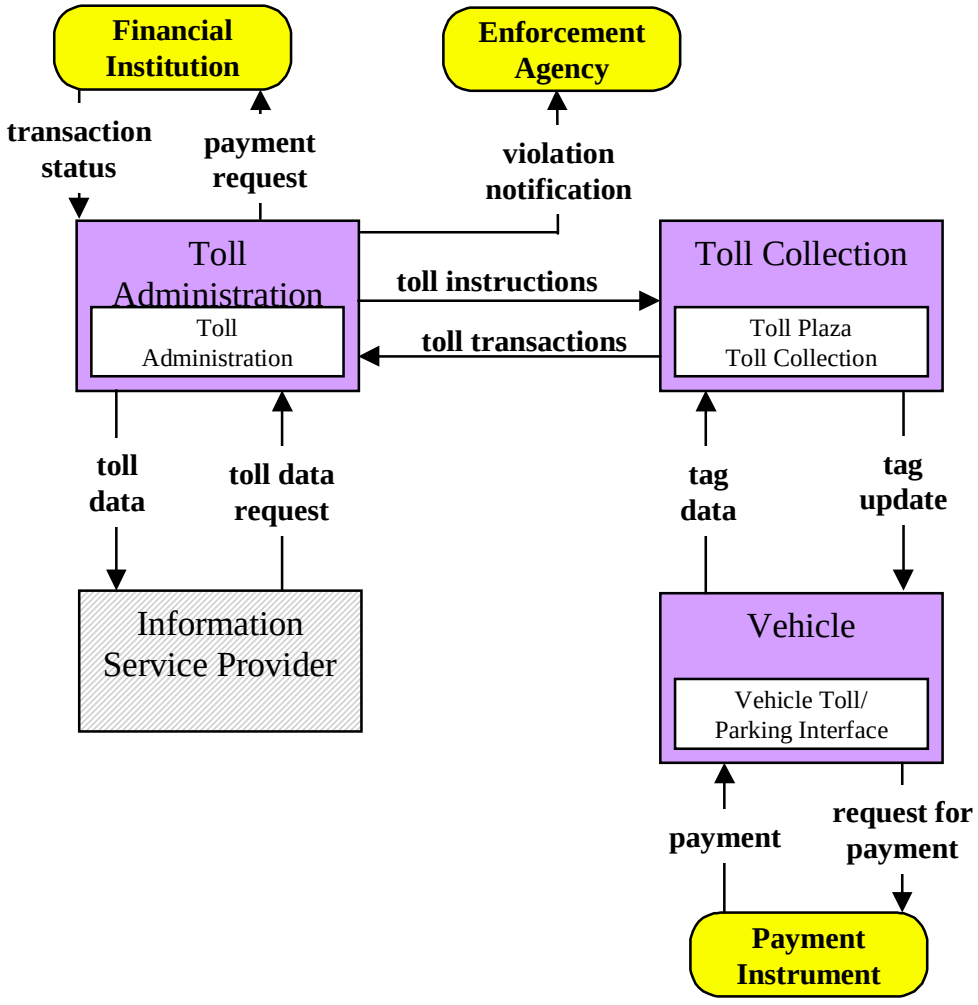
Traffic Forecast and Demand Management (ATMS9)
This Market Package includes advanced algorithms, processing, and mass storage capabilities that support historical evaluation, real-time assessment, and forecast of the roadway network performance. This includes the prediction of travel demand patterns to support better link travel time forecasts. The source data would come from the Traffic Management Subsystem itself as well as other traffic management centers and predicted traffic loads derived from route plans supplied by the Information Service Provider Subsystem. In addition to short term forecasts, this Market Package provides longer range forecasts that can be used in transportation planning. This Market Package provides data that supports the implementation of TDM programs, and policies managing both traffic and the environment. Information on vehicle pollution levels, parking availability, usage levels, and vehicle occupancy are collected by monitoring sensors to support these functions. Demand management requests can also be made to Toll Administration, Transit Management, and Parking Management Subsystems.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

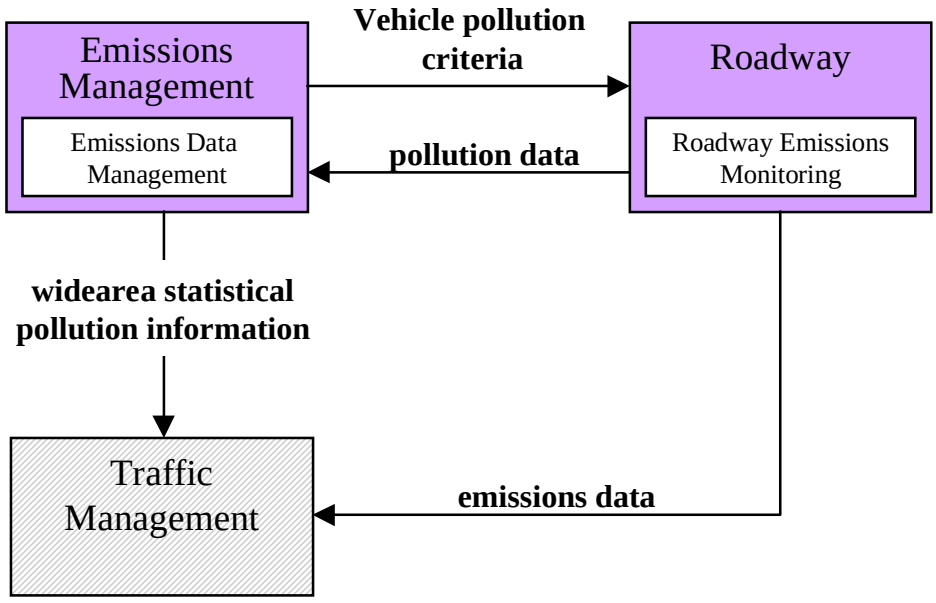
Electronic Toll Collection (ATMS10)

This Market Package provides toll operators with the ability to collect tolls electronically and detect and process violators. Variations in the fees that are collected enables implementation of demand management strategies. Dedicated short range communication between the roadway equipment and the vehicle is required as well as wireline interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Vehicle tags of toll violators are read and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional, and ultimately national interoperability for these services. The population of toll tags and roadside readers that these systems utilize can also be used to collect road use statistics for highway authorities. This data can be collected as a natural by-product of the toll collection process or collected by separate readers that are dedicated to probe data collection.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

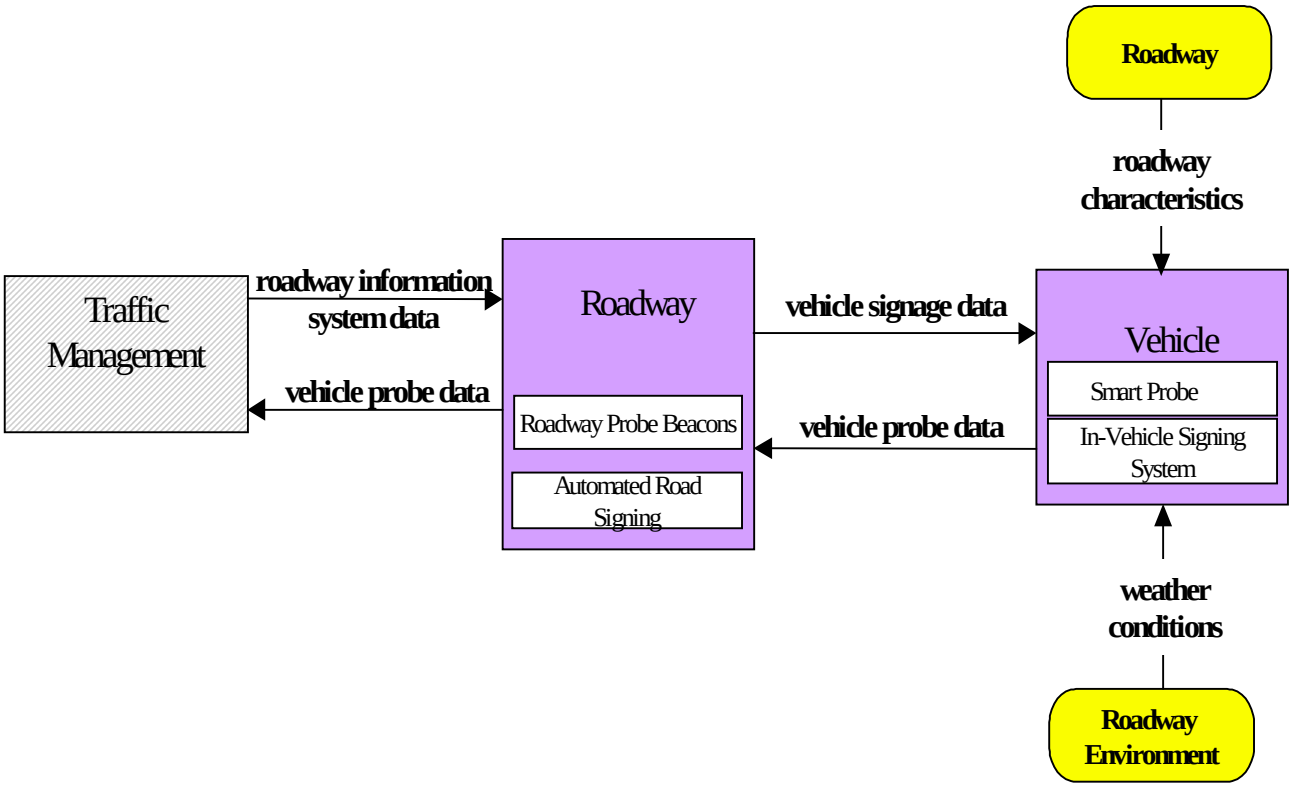
Emissions Monitoring and Management (ATMS11)
This Market Package monitors individual vehicle emissions and provides general air quality monitoring using distributed sensors to collect the data. The collected information is transmitted to the emissions management Subsystem for processing. Both individual detection and identification of vehicles that exceed emissions standards and general area-wide monitoring of air quality are supported by this Market Package. For area wide monitoring, this Market Package measures air quality, identifies sectors that are non-compliant with air quality standards, and collects, stores and reports supporting statistical data. For point emissions monitoring, this Market Package measures tail pipe emissions and identifies vehicles that exceed emissions standards. The gathered information can be used to implement environmentally sensitive TDM programs, policies, and regulations.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Virtual TMC and Smart Probe Data (ATMS12)

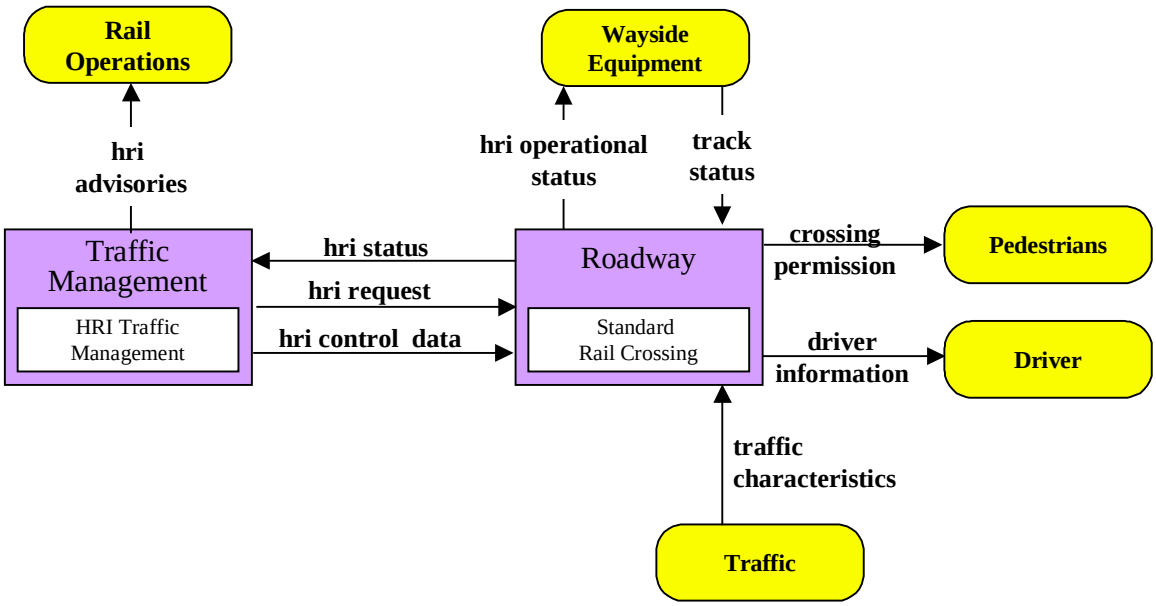
This Market Package provides for special requirements of rural road systems. Instead of a central TMC, the traffic management is distributed over a very wide area (e.g., a whole state or collection of states). Each locality has the capability of accessing available information for assessment of road conditions. The package uses vehicles as smart probes that are capable of measuring road conditions and providing this information to the roadway for relay to the Traffic Management Subsystem and potentially direct relay to following vehicles (i.e., the automated road signing equipment is capable of autonomous operation). In-vehicle sgning is used to inform drivers of detected road conditions.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Standard Railroad Grade Crossing (ATMS13)

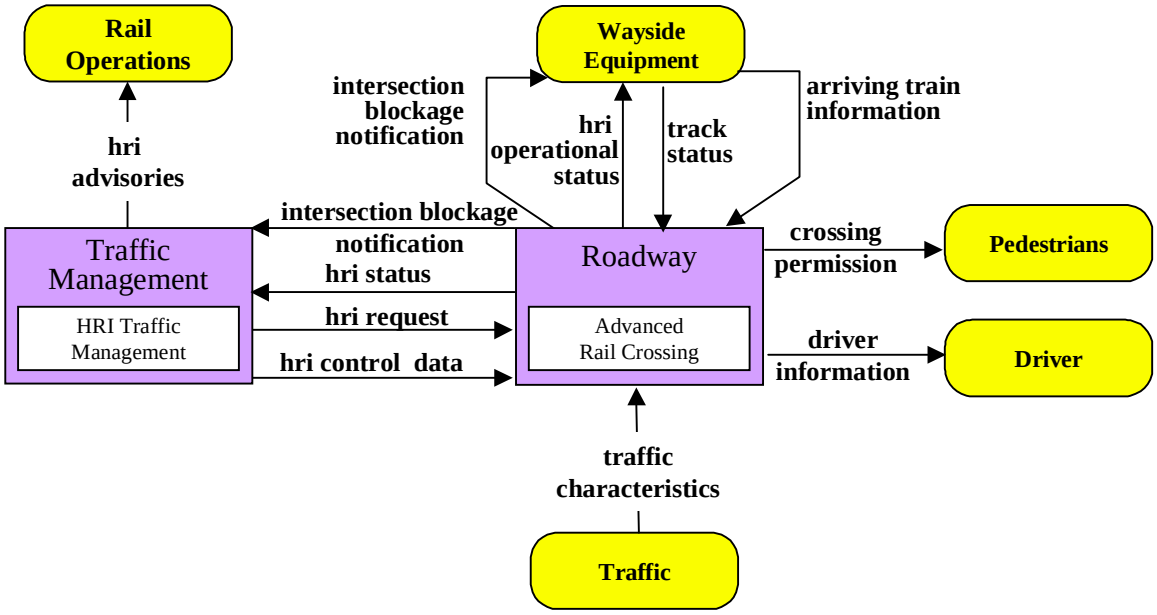
This market package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate more advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Both passive (e.g., the crossbuck sign) and active warning systems (e.g., flashing lights and gates) are supported. (Note that passive systems exercise only the single interface between the roadway subsystem and the driver in the architecture definition.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification by interfaced wayside equipment of an approaching train. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported to both highway and railroad officials through wayside interfaces and interfaces to the traffic management subsystem. Similar interfaces and services are provided for other types of multimodal crossings (e.g., draw bridges).



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Advanced Railroad Grade Crossing (ATMS14)

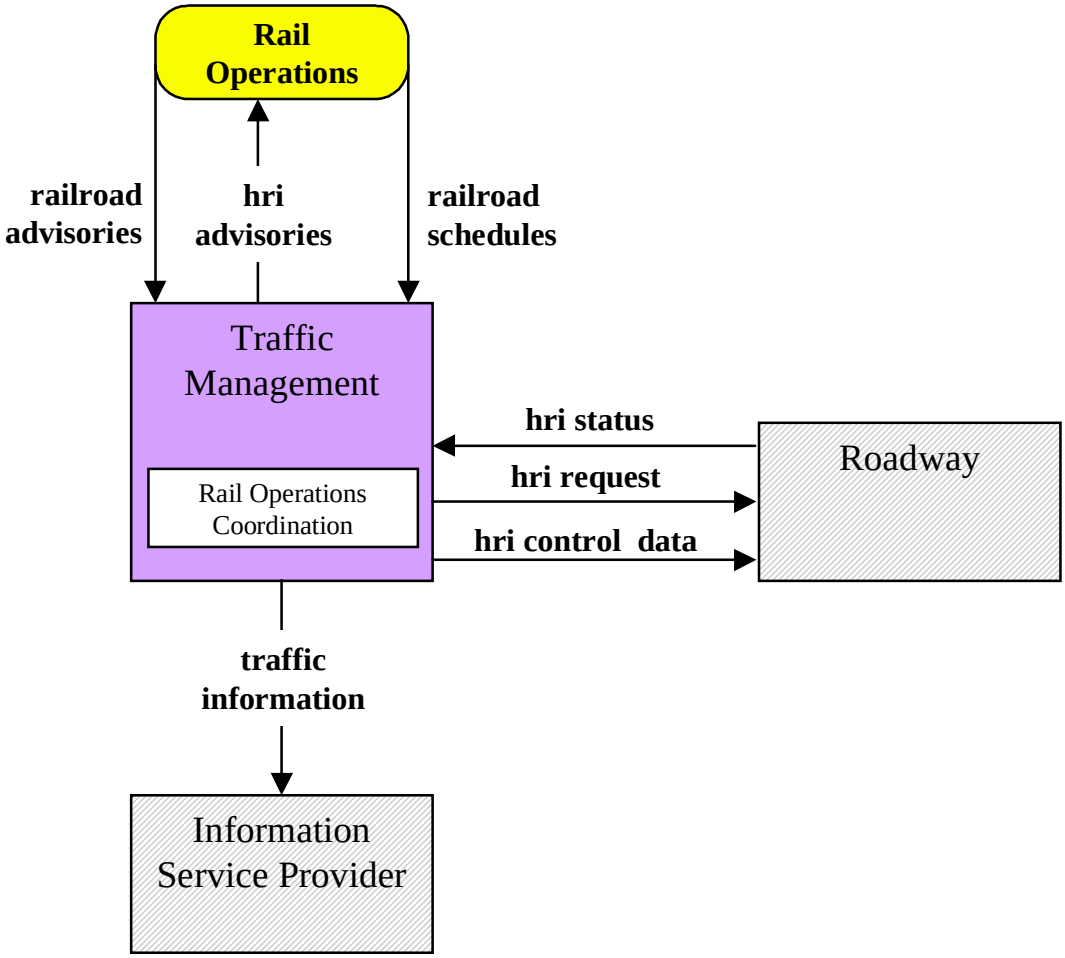
This market package manages highway traffic at highway-rail intersections (HRIs) where operational requirements demand advanced features (e.g., where rail operational speeds are greater than 80 miles per hour). This market package includes all capabilities from the Standard Railroad Grade Crossing Market Package and augments these with additional safety features to mitigate the risks associated with higher rail speeds. The active warning systems supported by this market package include positive barrier systems which preclude entrance into the intersection when the barriers are activated. Like the Standard Package, the HRI equipment is activated on notification by wayside interface equipment which detects, or communicates with the approaching train. In this market package, additional information about the arriving train is also provided by the wayside interface equipment so that the train's direction of travel, its estimated time of arrival, and the estimated duration of closure may be derived. This enhanced information may be conveyed to the driver prior to, or in context with, warning system activation. This market package also includes additional detection capabilities which enable it to detect an entrapped or otherwise immobilized vehicle within the HRI and provide an immediate notification to highway and railroad officials.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Railroad Operations Coordination (ATMS15)

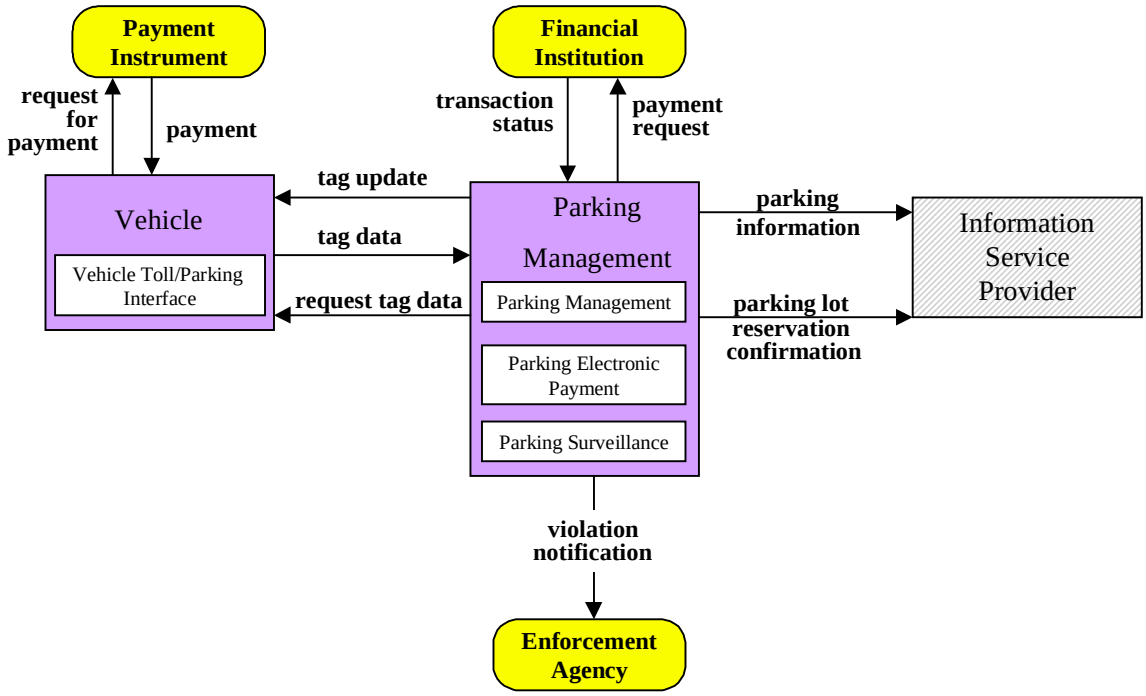
This market package provides an additional level of strategic coordination between rail operations and traffic management centers. Rail operations provides train schedules, maintenance schedules, and any other forecast events which will result in highway-rail intersection (HRI) closures. This information is used to develop forecast HRI closure times and durations which may be used in advanced traffic control strategies or to enhance the quality of traveler information.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Parking Facility Management (ATMS16)

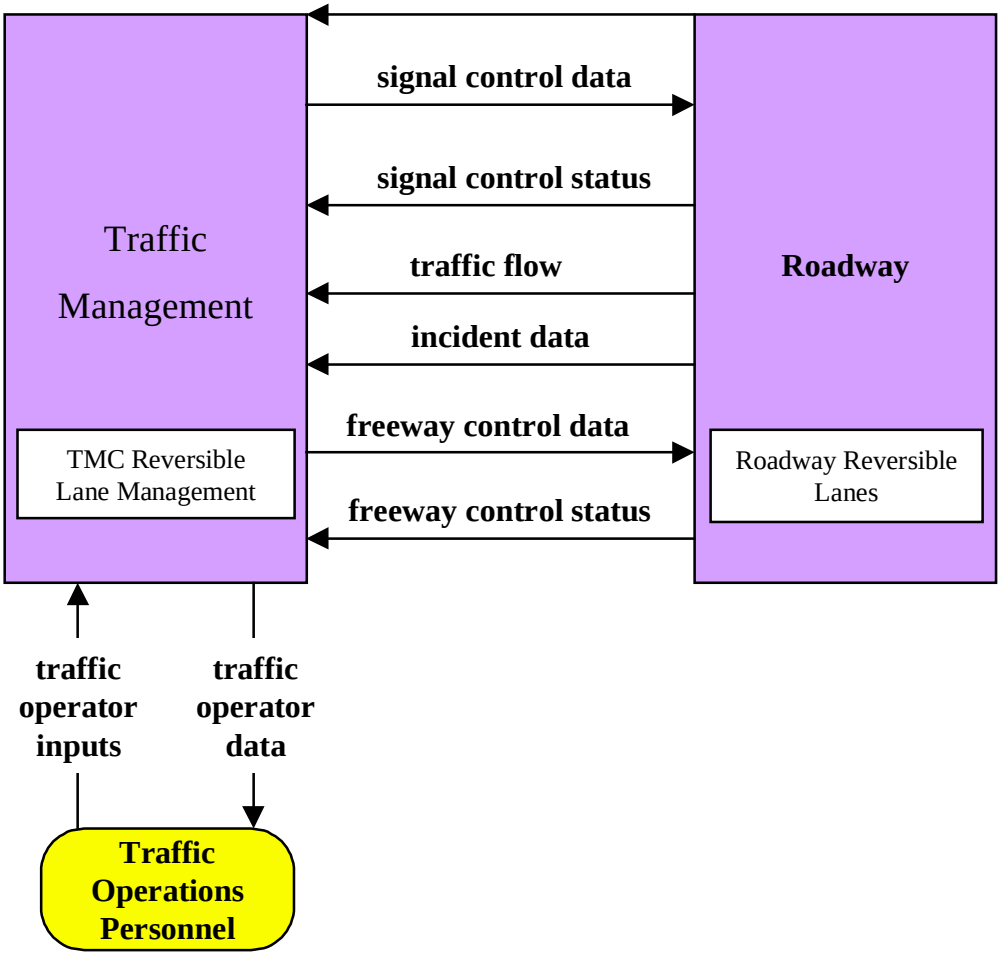
This market package provides enhanced monitoring and management of parking facilities. The included equipment assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This is performed by sensing and collecting current parking facilities status, sharing the data with information service providers and traffic operations, and automatic fee collection using short range communications with the same in-vehicle equipment utilized for electronic toll collection.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Reversible Lane Management (ATMS17)

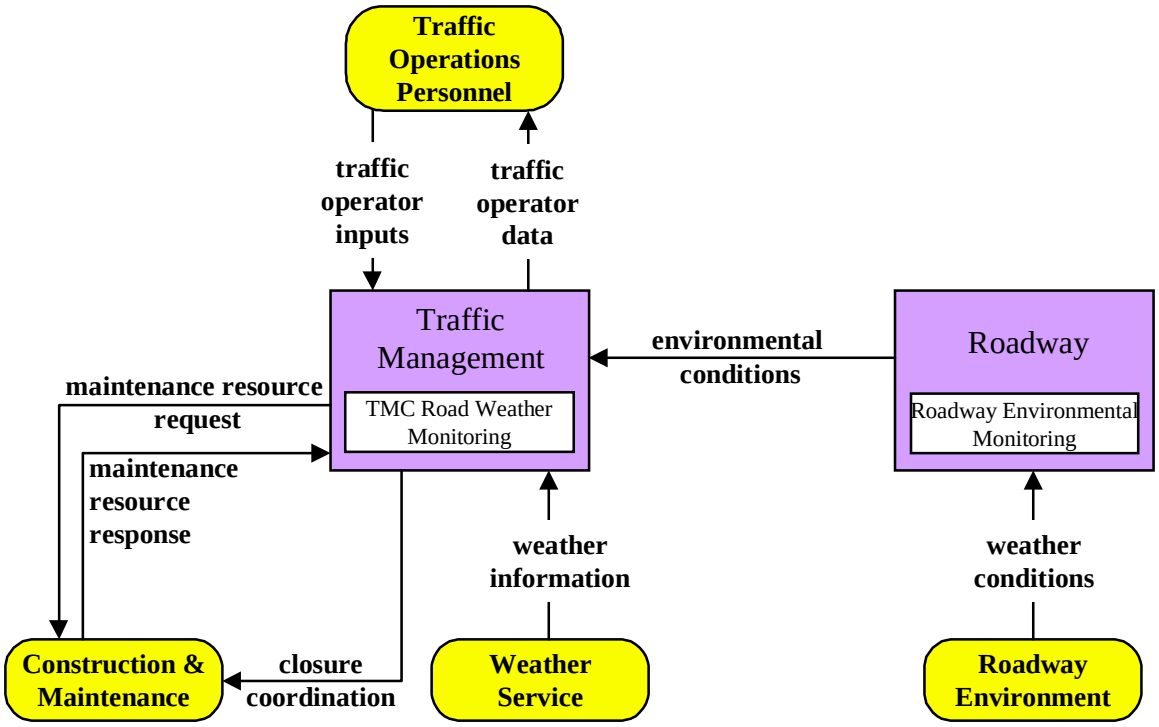
This market package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this market package includes sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This market package also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Road Weather Information System (ATMS18)

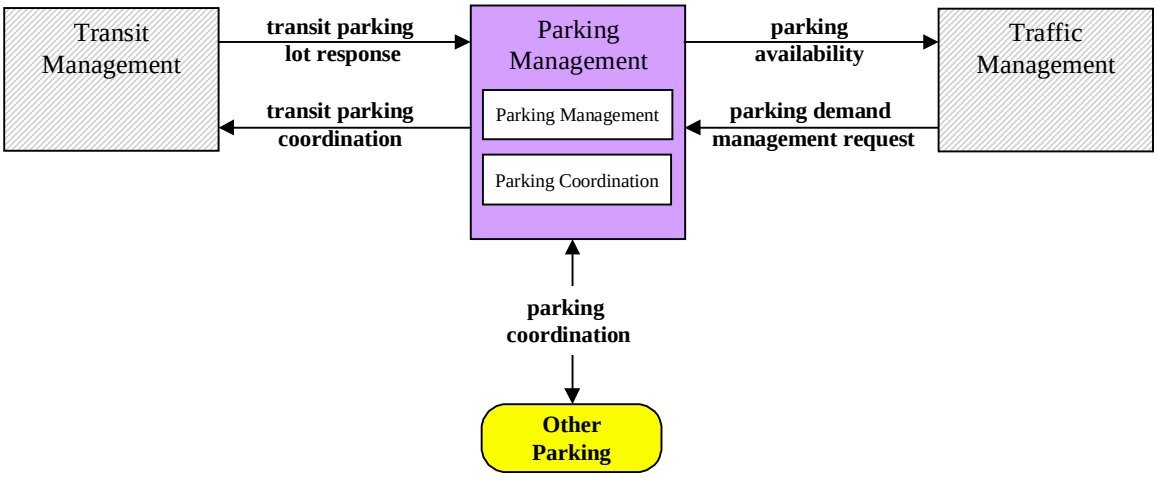
This market package monitors current and forecast road and weather conditions using a combination of weather service information and data collected from environmental sensors deployed on and about the roadway. The collected road weather information is monitored and analyzed to detect and forecast environmental hazards such as icy road conditions, dense fog, and approaching severe weather fronts. This information can be used to more effectively deploy road maintenance resources, issue general traveler advisories, and support location specific warnings to drivers using the Traffic Information Dissemination Market Package.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Regional Parking Management (ATMS19)

This market package supports coordination between parking facilities to enable regional parking management strategies.

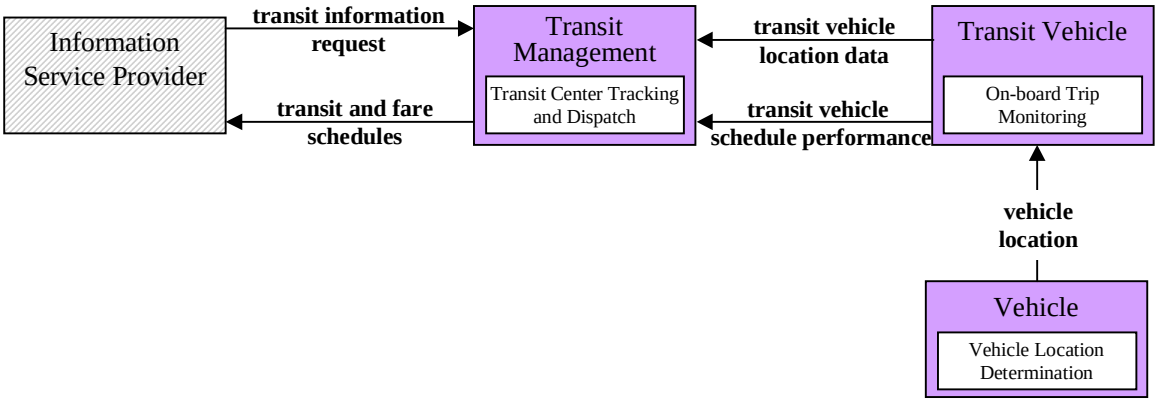


*Note: Graphic shows key market package elements. Some elements are omitted for clarity

2.2.2 Public Transportation Market Packages

Transit Vehicle Tracking (APTS1)

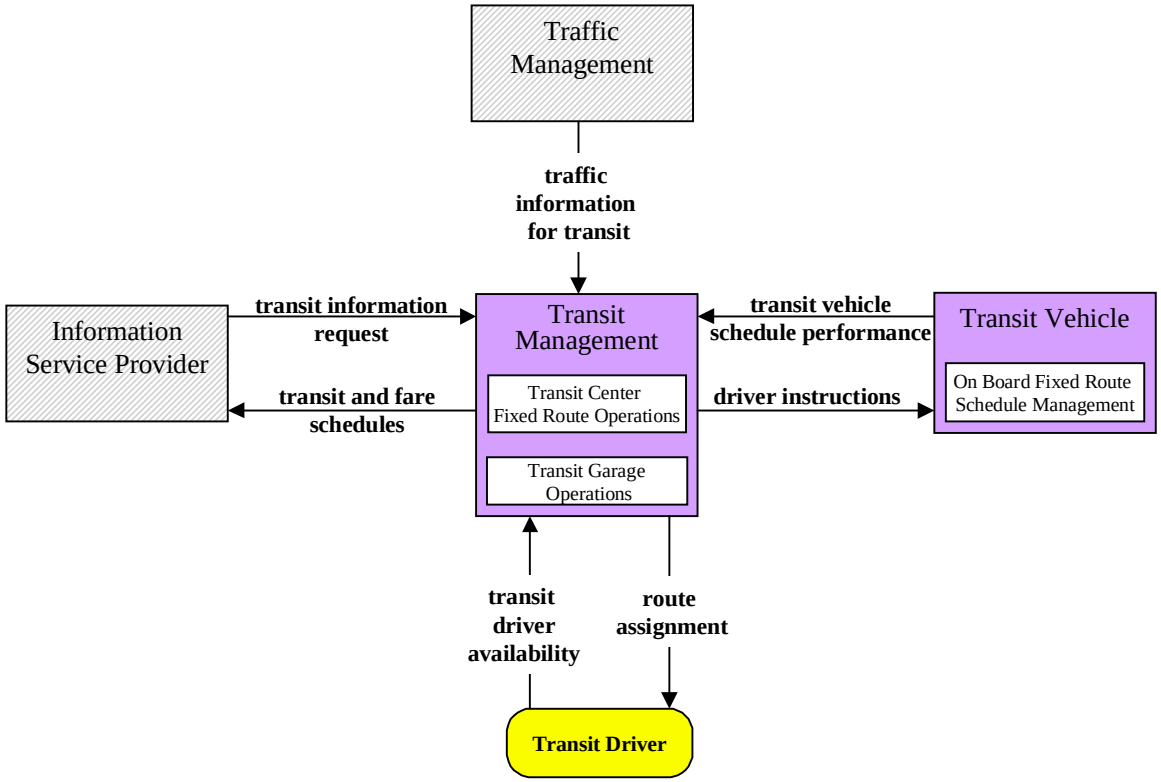
This market package provides for an Automated Vehicle Location System to track the transit vehicle's real time schedule adherence and updates the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. Fixed route transit systems may also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the Information Service Provider Subsystem via a wireline link.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Transit Fixed-Route Operations (APTS2)

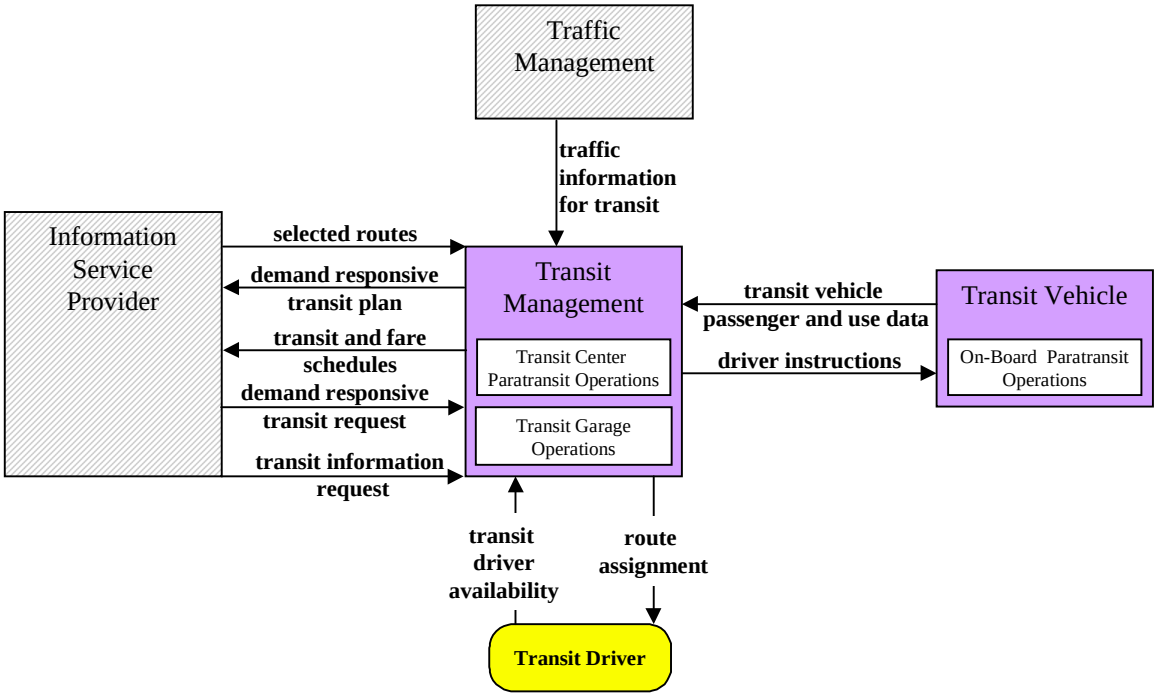
This market package performs automatic driver assignment and monitoring, as well as vehicle routing and scheduling for fixed-route services. This service uses the existing AVL database as a source for current schedule performance data, and is implemented through data processing and information display at the transit management subsystem. This data is exchanged using the existing wireline link to the information service provider where it is integrated with that from other transportation modes (e.g. rail, ferry, air) to provide the public with integrated and personalized dynamic schedules



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Demand Response Transit Operations (APTS3)

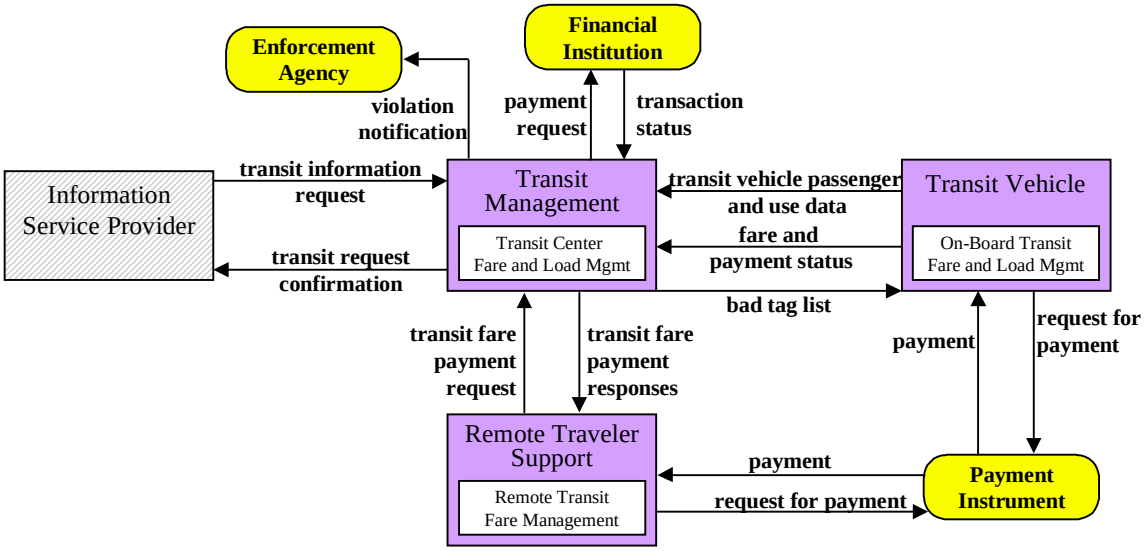
This market package performs automatic driver assignment and monitoring as well as vehicle routing and scheduling for demand response transit services. This package uses the existing AVL database to monitor current status of the transit fleet and supports allocation of these fleet resources to service incoming requests for transit service while also considering traffic conditions. The Transit Management Subsystem provides the necessary data processing and information display to assist the transit operator in making optimal use of the transit fleet. The Information Service Provider Subsystem may be either be operated by transit management center or be independently owned and operated by a separate service provider. In the first scenario, the traveler makes a direct request to a specific paratransit service. In the second scenario, a third party service provider determines the paratransit service is a viable means of satisfying a traveler request and uses wireline communications to make a reservation for the traveler.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Transit Passenger and Fare Management (APTS4)

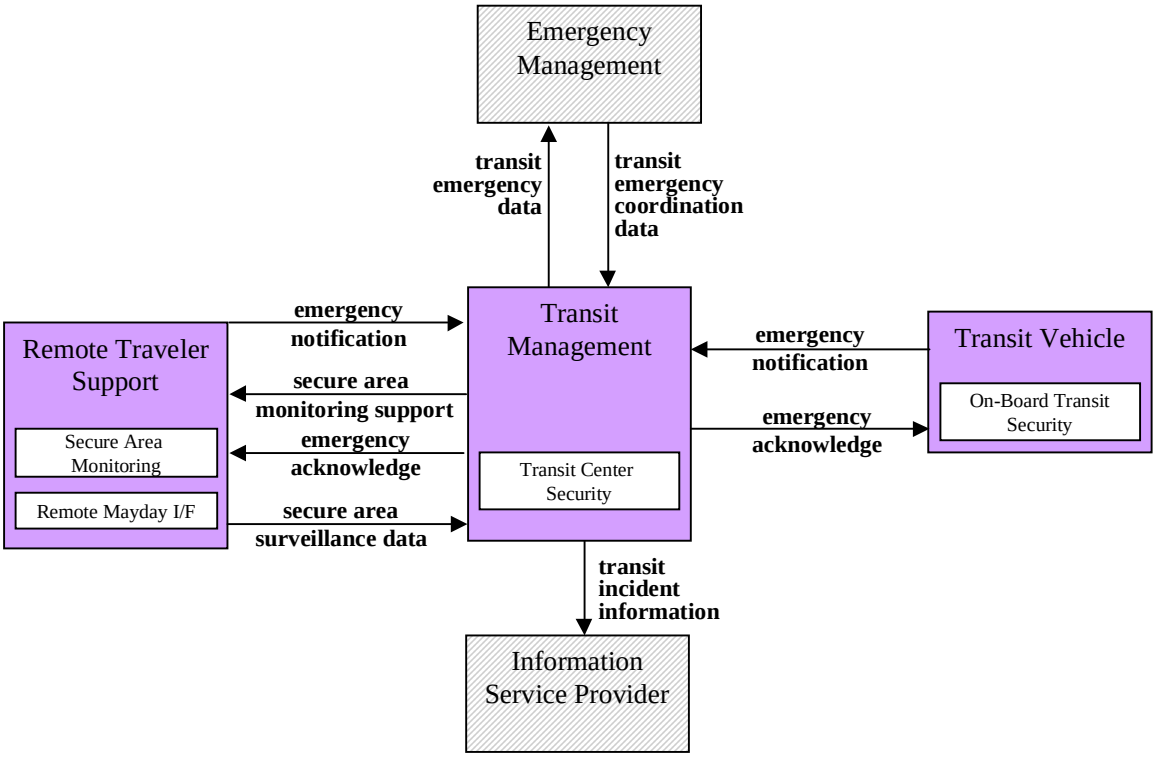
This market package allows for the management of passenger loading and fare payments on-board vehicles using electronic means. The payment instrument may be either a stored value or credit card. This package is implemented with sensors mounted on the vehicle to permit the driver and central operations to determine vehicle loads, and readers located either in the infrastructure or on-board the transit vehicle to allow fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem using existing wireless infrastructure.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Transit Security (APTS5)

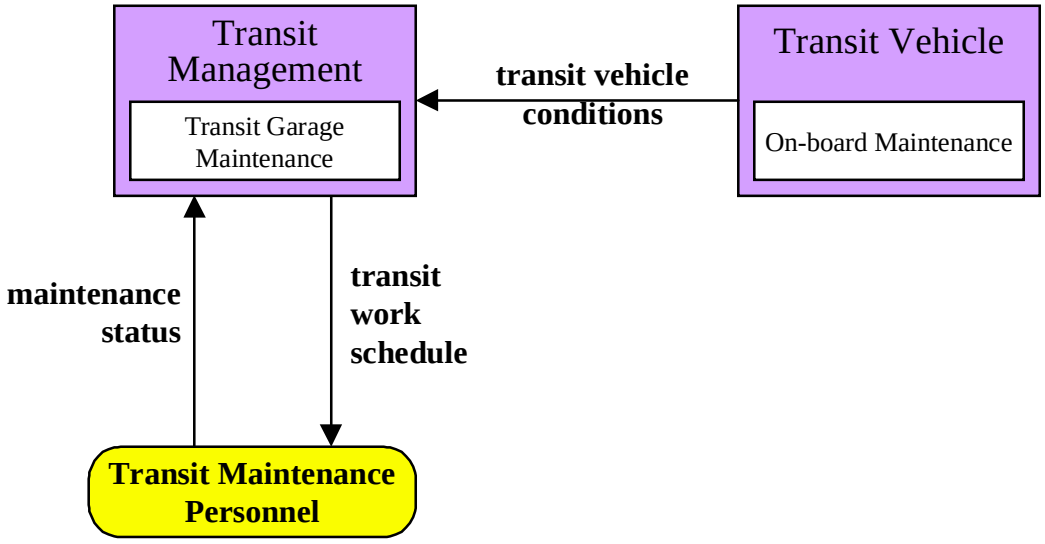
This market package provides for the physical security of transit passengers. An on-board security system is deployed to perform surveillance and warn of potentially hazardous situations. Public areas (e.g. stops, park and ride lots, stations) are also monitored. Information is communicated to the Transit Management Subsystem using the existing or emerging wireless (vehicle to center) or wireline (area to center) infrastructure. Security related information is also transmitted to the Emergency Management Subsystem when an emergency is identified that requires an external response. Incident information is communicated to the Information Service Provider.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Transit Maintenance (APTS6)

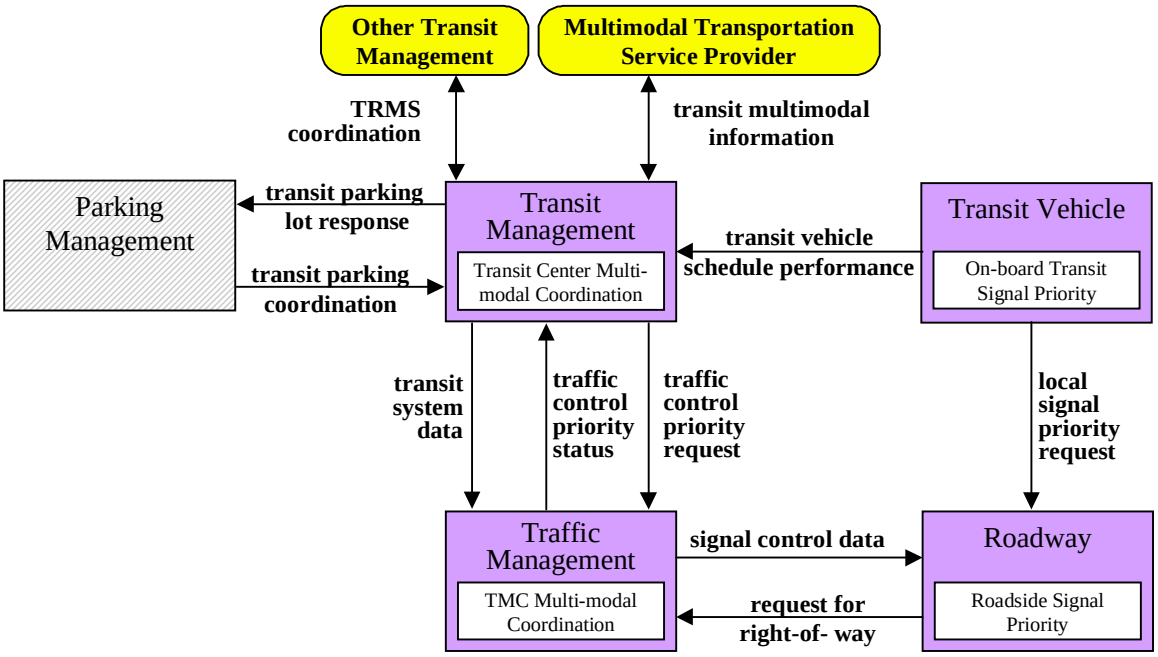
This market package supports automatic maintenance scheduling and monitoring. On-board condition sensors monitor critical system status and transmit critical status information to the Transit Management Subsystem. Hardware and software in the Transit Management Subsystem processes this data and schedules maintenance activities.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

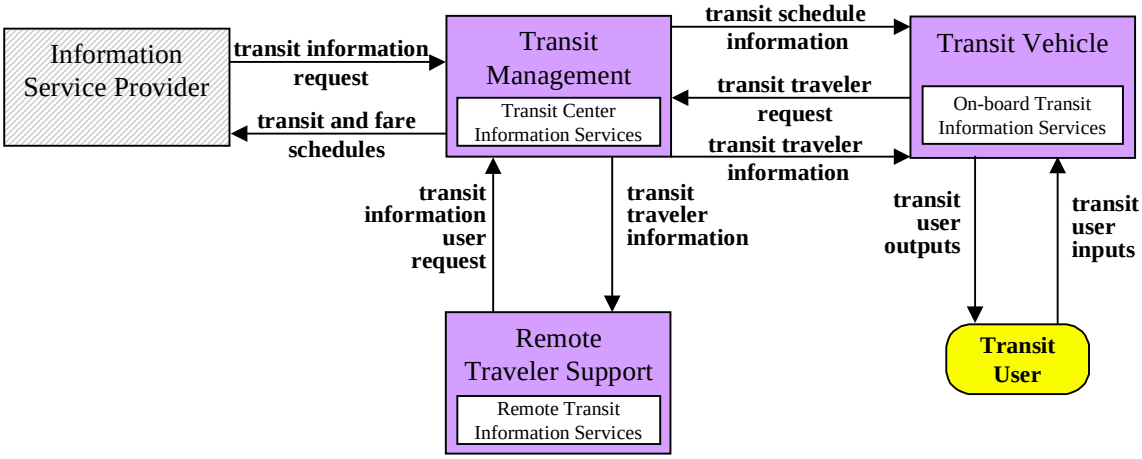
Multi-modal Coordination (APTS7)

This market package establishes two way communications between multiple transit and traffic agencies to improve service coordination. Intermodal coordination between transit agencies can increase traveler convenience at transfer points and also improve operating efficiency. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network. More limited local coordination between the transit vehicle and the individual intersection for signal priority is also supported by this package.



Transit Traveler Information (APTS8)

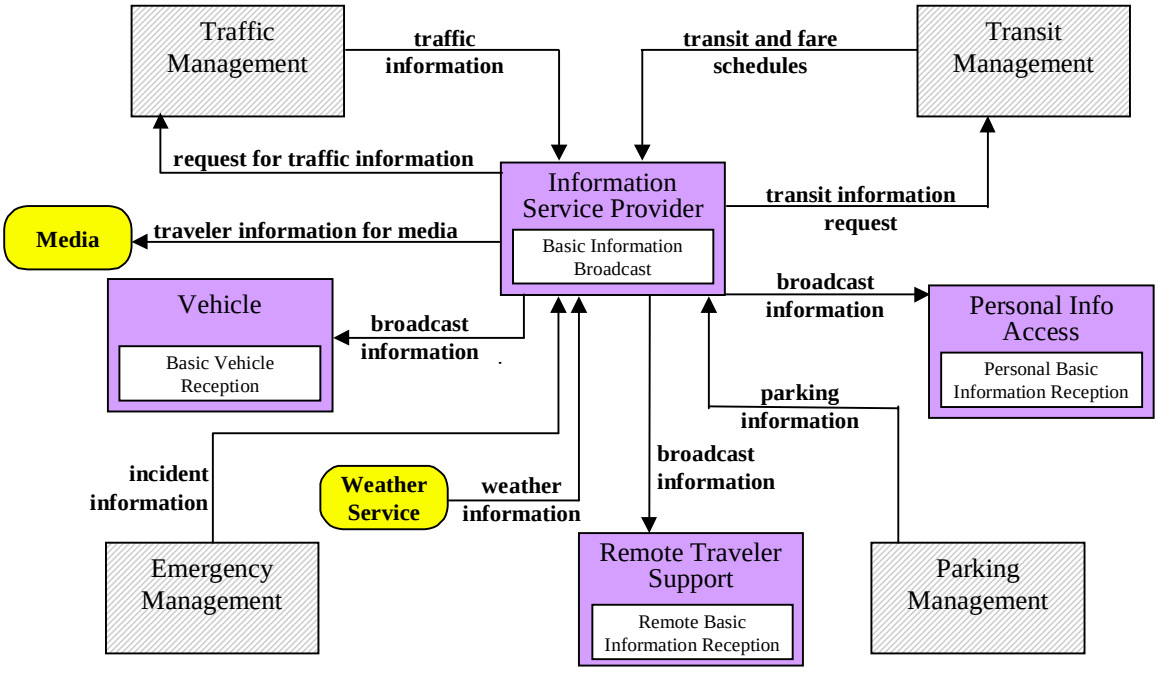
This market package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop annunciation, imminent arrival signs, and real-time transit schedule displays that are of general interest to transit users. Systems that provide custom transit trip itineraries and other tailored transit information services are also represented by this market package.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

2.2.3 Traveler Information Market Packages

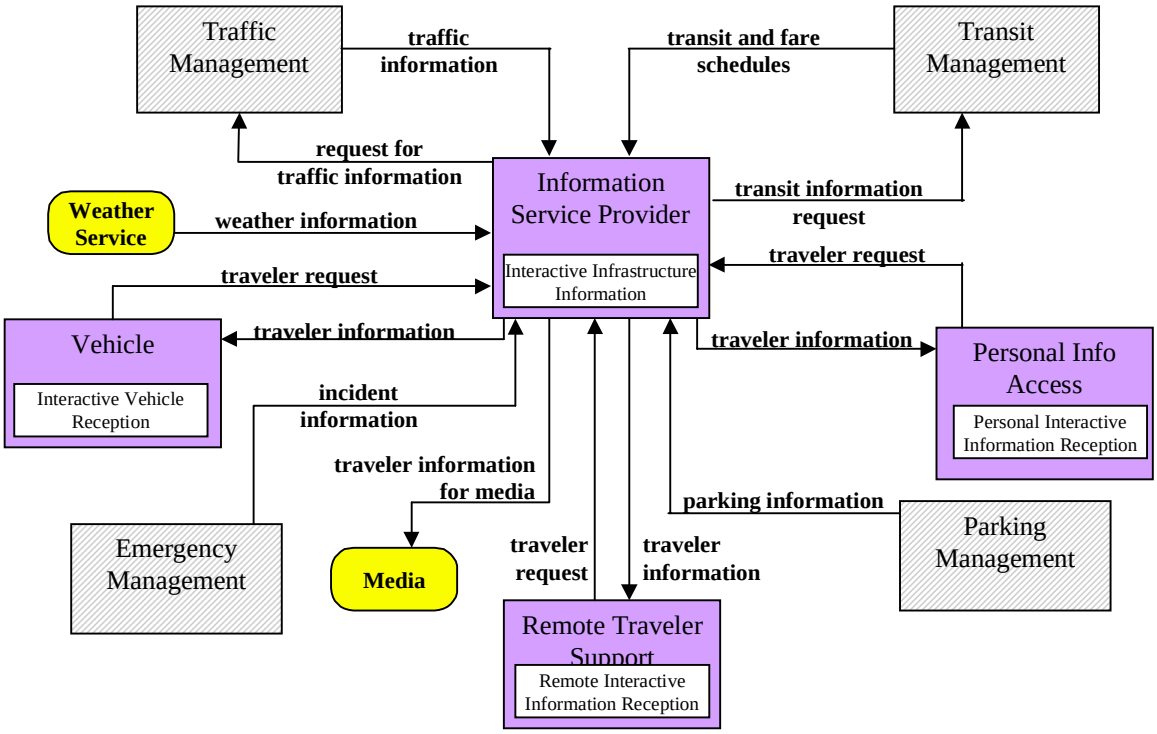
Broadcast Traveler Information (ATIS1)
This market package provides the user with a basic set of ATIS services; its objective is early acceptance. It involves the collection of traffic conditions, advisories, general public transportation, toll and parking information, incident information, air quality and weather information, and the near real time dissemination of this information over a wide area through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). Different from the market package ATMS6--Traffic Information Dissemination--which provides the more basic HAR and DMS information capabilities, ATIS1 provides the more sophisticated digital broadcast service. Successful deployment of this market package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Interactive Traveler Information (ATIS2)

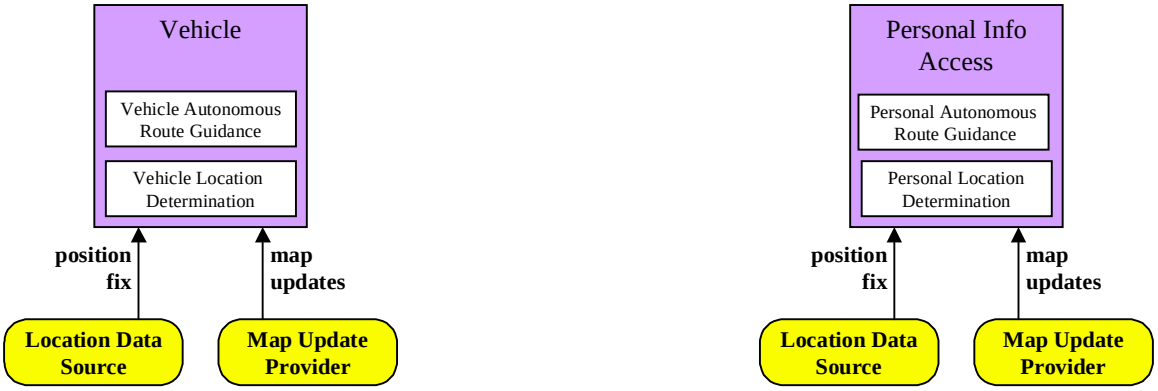
This market package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, transit services, ride share/ride match, parking management, and pricing information. A range of two-way wide-area wireless and wireline communications systems may be used to support the required digital communications between traveler and the information service provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en-route to include phone, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. Successful deployment of this market package relies on availability of real-time transportation data from roadway instrumentation, probe vehicles or other means.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Autonomous Route Guidance (ATIS3)

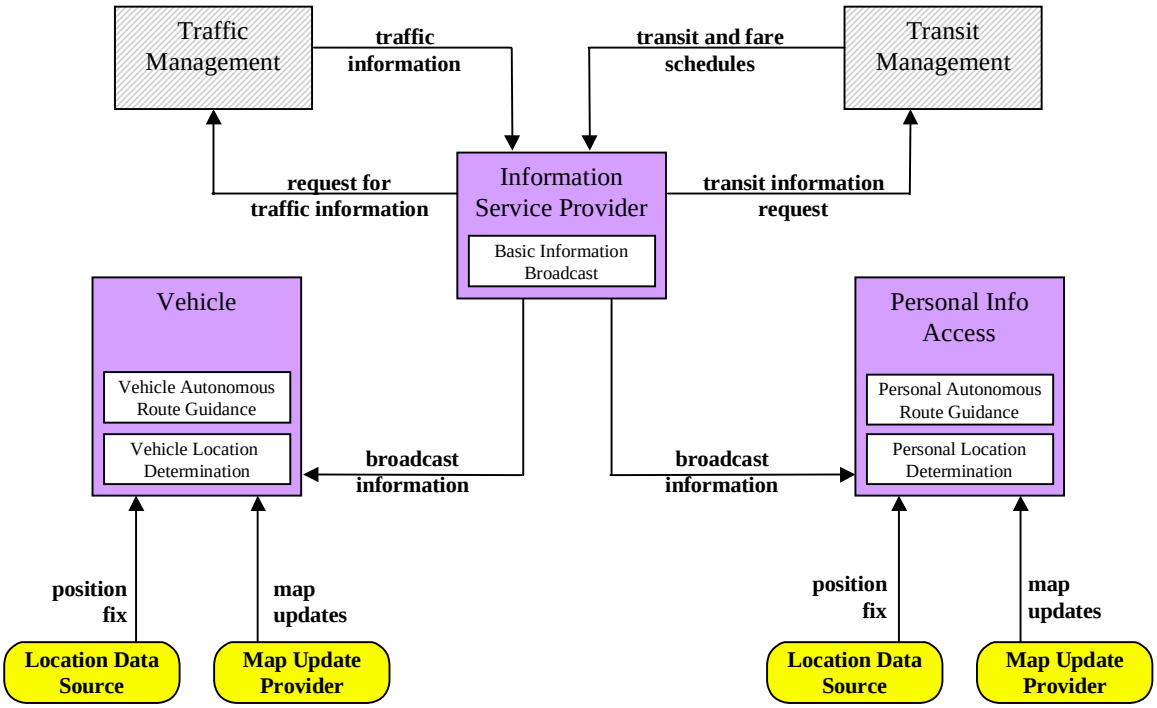
This market package relies on in-vehicle sensory, location determination, computational, map database, and interactive driver interface equipment to enable route planning and detailed route guidance based on static, stored information. No communication with the infrastructure is assumed or required.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



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Dynamic Route Guidance (ATIS4)

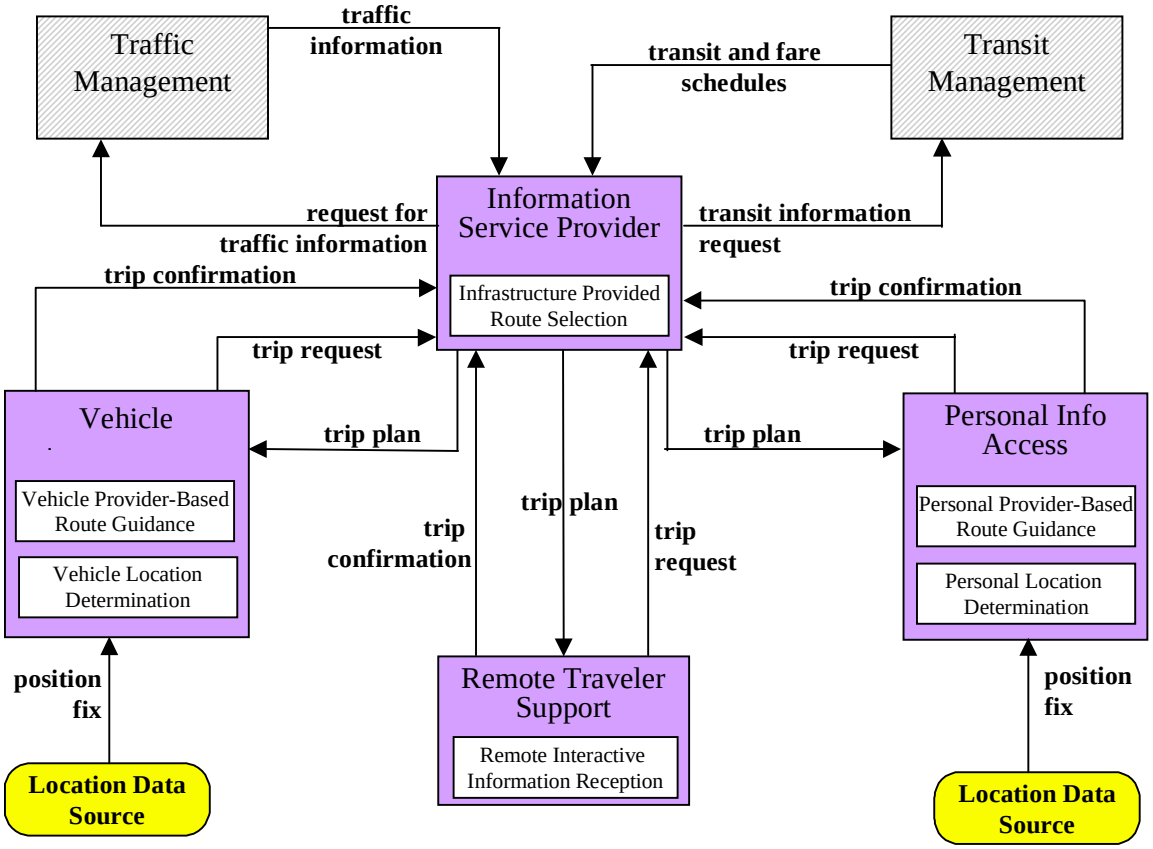
This market package offers the user advanced route planning and guidance which is responsive to current conditions. The package combines the autonomous route guidance user equipment with a digital receiver capable of receiving real-time traffic, transit, and road condition information which is considered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



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

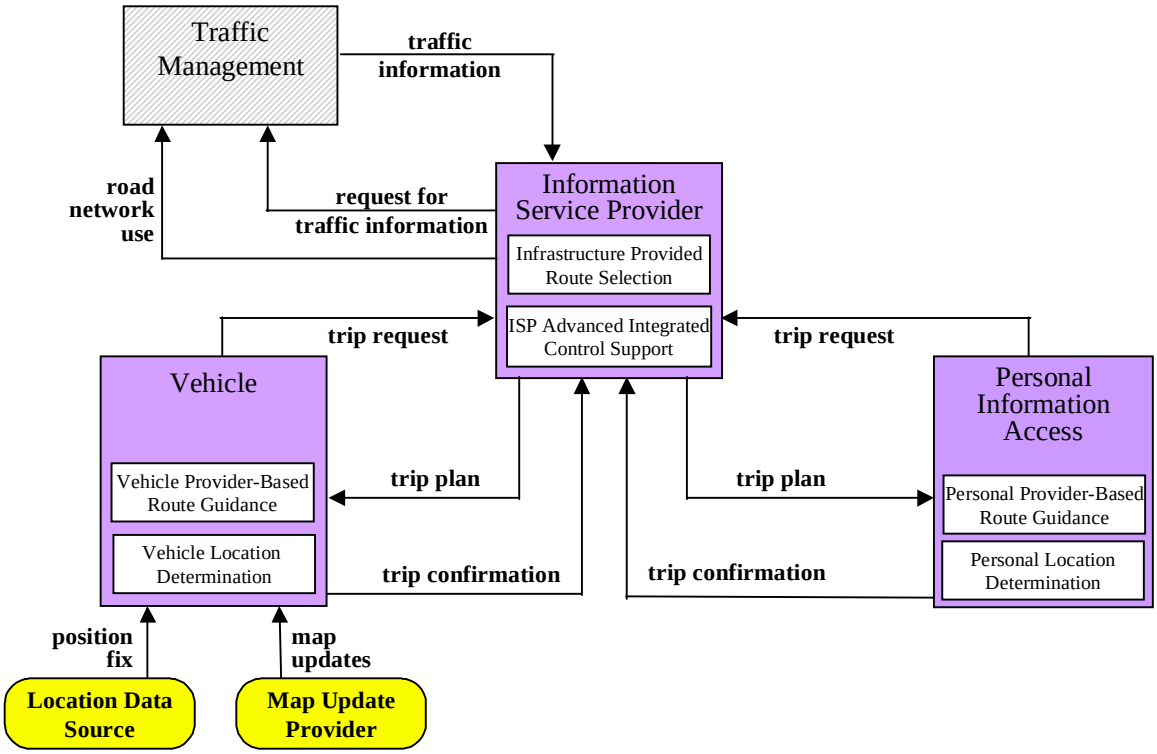
ISP-Based Route Guidance (ATIS5)

This market package offers the user advanced route planning and guidance which is responsive to current conditions. Different than the Dynamic Route Guidance Market Package, this market package moves the route planning function from the user device to the information service provider. This approach simplifies the user equipment requirements and can provide the infrastructure better information on which to predict future traffic and appropriate control strategies to support basic route planning with minimal user equipment. The package includes both turn by turn route guidance as might be used in a vehicle, as well as pre-trip routes. The package includes two way data communications and optionally also equips the vehicle with the databases, location determination capability, and display technology to support turn by turn route guidance.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

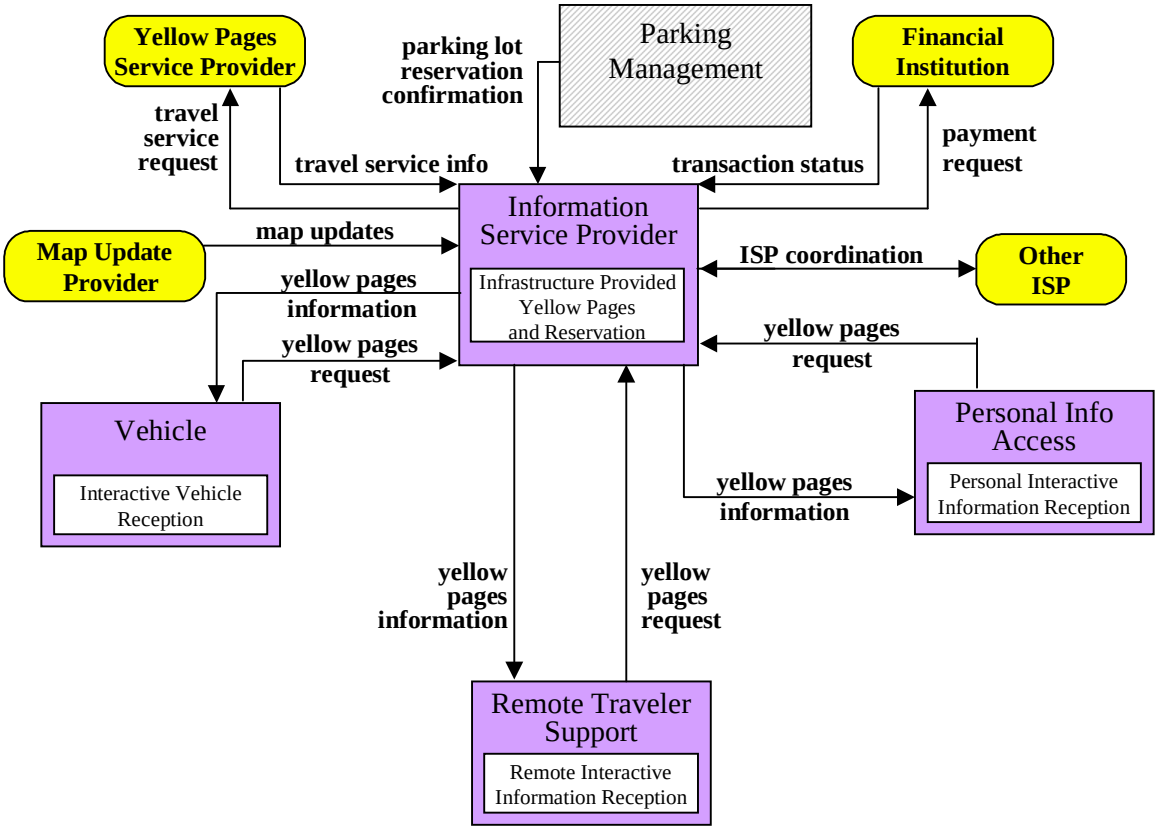
Integrated Transportation Management/Route Guidance (ATIS6)
This market package allows a traffic management center to continuously optimize the traffic control strategy based on near-real time information on intended routes for a proportion of the vehicles within their network while offering the user advanced route planning and guidance which is responsive to current conditions . It would utilize the individual and ISP route planning information to optimize signal timing while at the same time providing updated signal timing information to allow optimized route plans. The use of predictive link times for this market package are possible through utilizing the market package ATMS9--Traffic forecast and Demand Management--at the traffic management center.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Yellow Pages and Reservation (ATIS7)

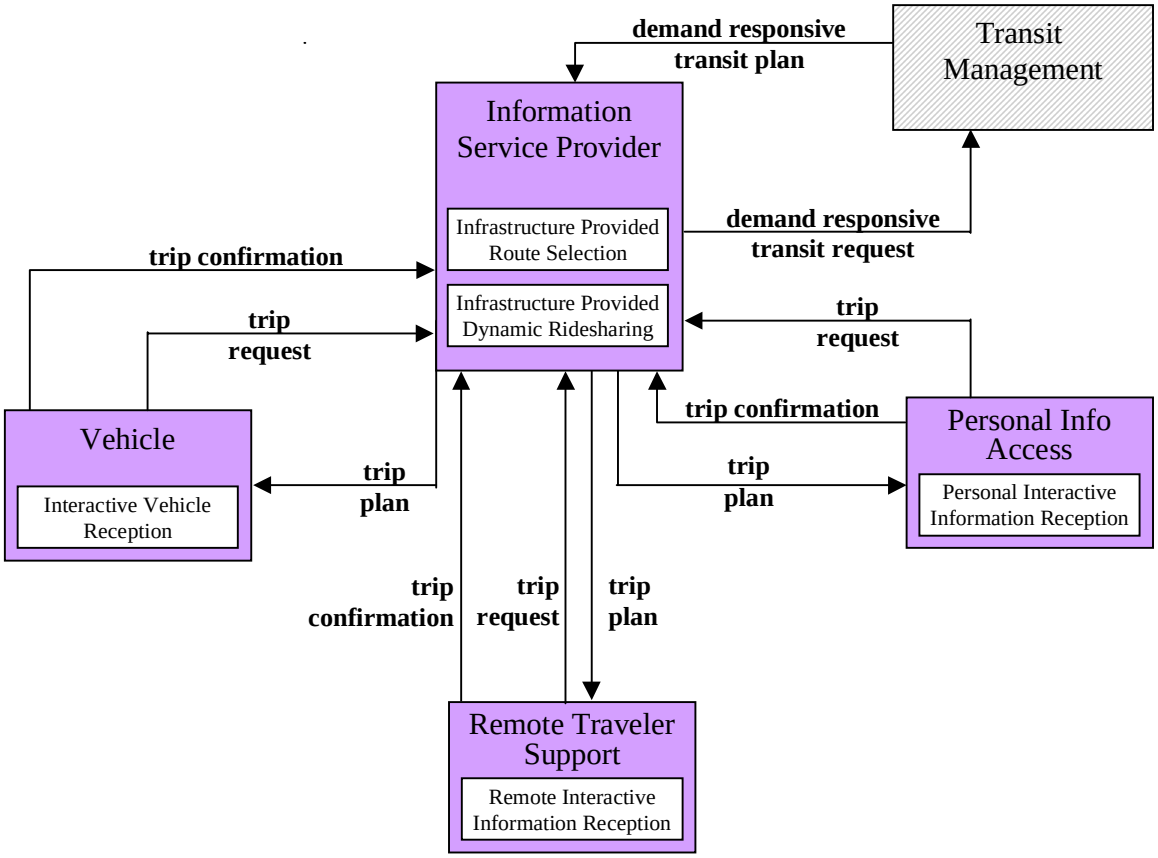
This market package enhances the Interactive Traveler Information package by making infrastructure provided yellow pages and reservation services available to the user. The same basic user equipment is included. This market package provides multiple ways for accessing information either while en-route in a vehicle using wide-area wireless communications or pre-trip via wireline connections.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Dynamic Ridesharing (ATIS8)

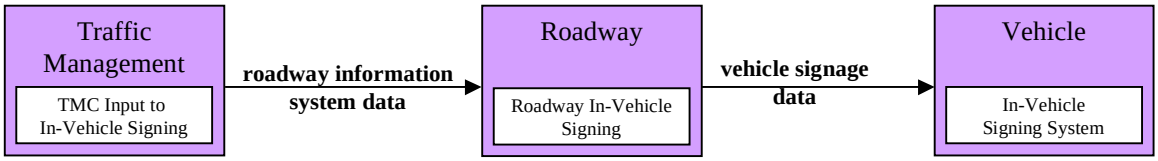
This market package enhances the Interactive Traveler Information package by adding an infrastructure provided dynamic ridesharing/ride matching capability. In terms of equipment requirements, ATIS8 is similar to ATIS7.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

In Vehicle Signing (ATIS9)

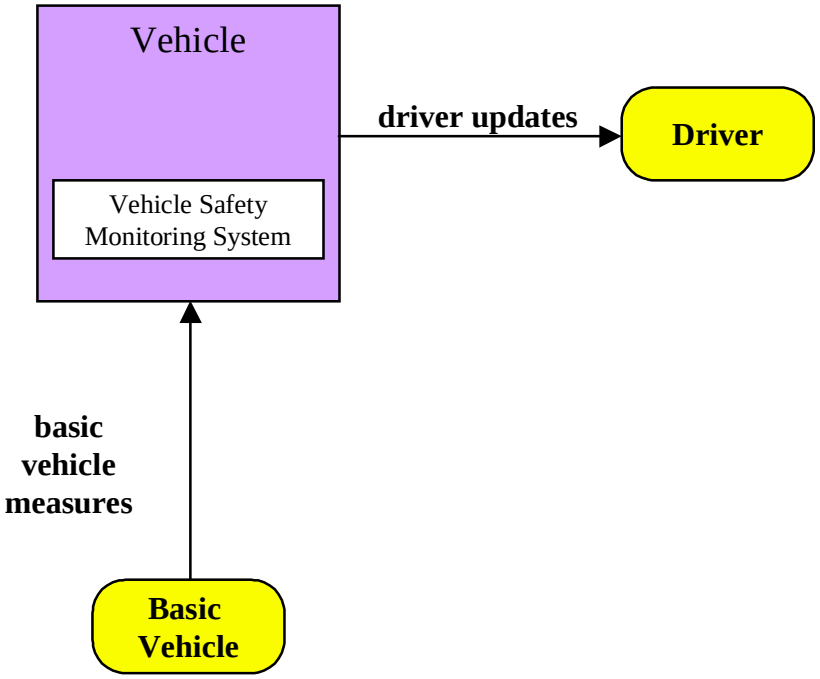
This market package supports distribution of traffic and travel advisory information to drivers through in-vehicle devices. It includes short range communications between roadside equipment and the vehicle and wireline connections to the Traffic Management Subsystem for coordination and control. This market package also informs the driver of both highway-highway and highway-rail intersection status.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

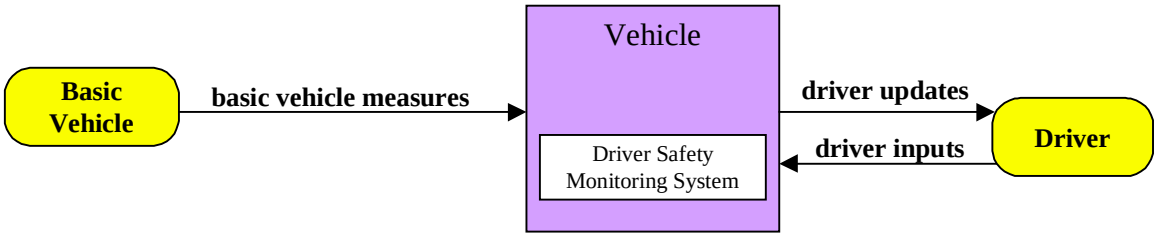
2.2.4 Advanced Vehicle Safety System Market Packages

Vehicle Safety Monitoring (AVSS1)
This market package will diagnose critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition and performance, determine on-board safety data and display information.



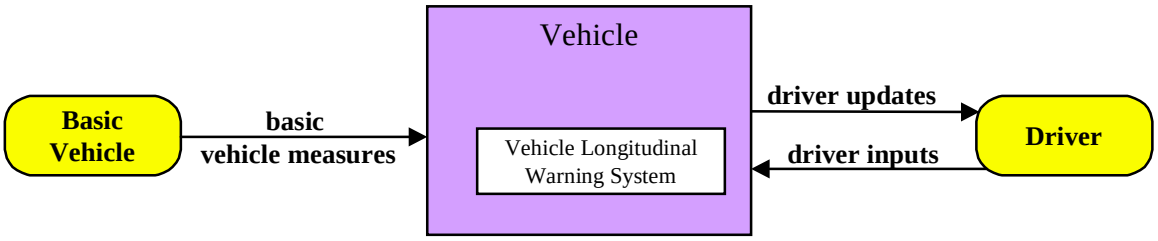
Driver Safety Monitoring (AVSS2)

This market package will determine the driver's condition, and warn the driver of potential dangers. On-board sensors will determine the driver's condition and performance, determine on-board safety data and display information.



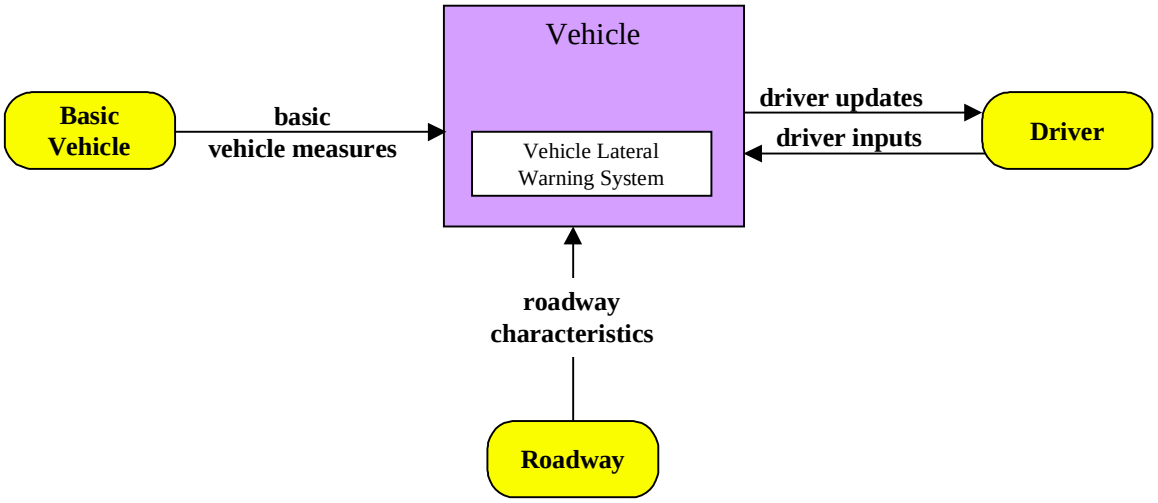
Longitudinal Safety Warning (AVSS3)

This market package allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.

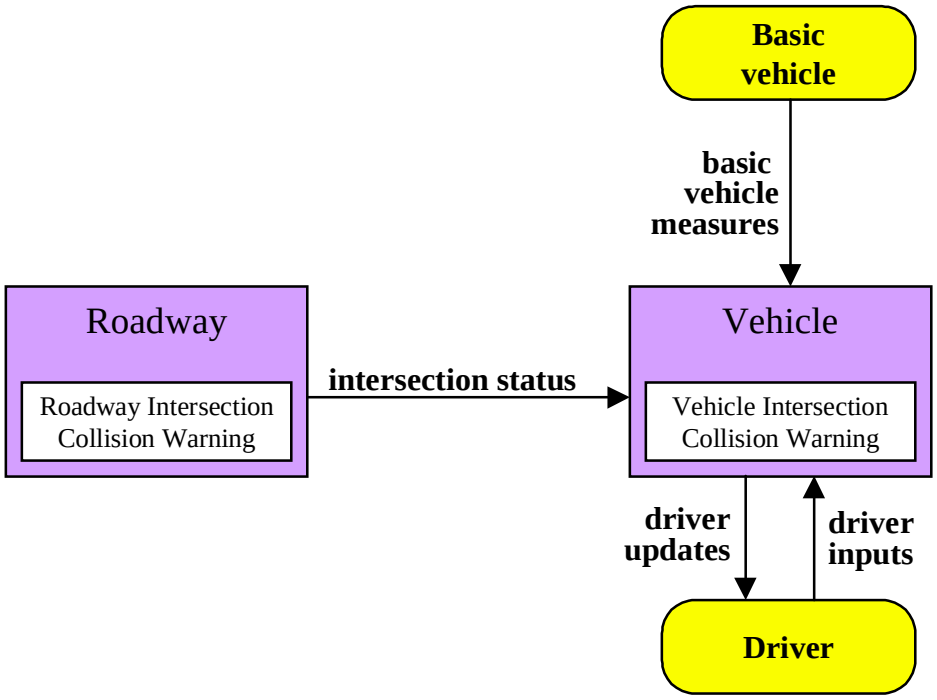


Lateral Safety Warning (AVSS4)

This market package allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.

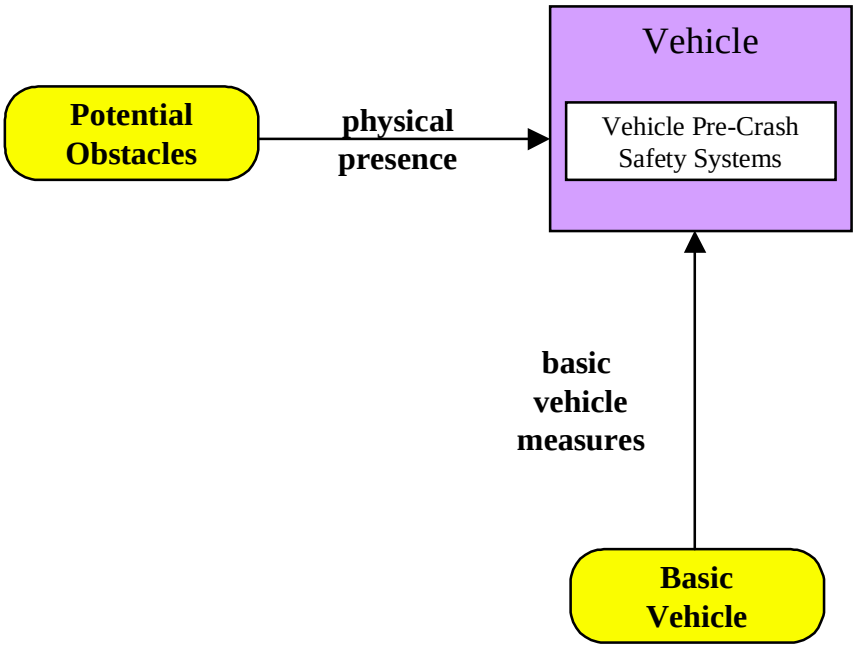


Intersection Safety Warning (AVSS5)
This market package will determine the probability of a collision in an equipped intersection (either highway-highway or highway-rail) and provide timely warnings to drivers in response to hazardous conditions. Monitors in the roadway infrastructure assess vehicle locations and speeds near an intersection. Using this information, a warning is determined and communicated to the approaching vehicle using a short range communications system. Information can be provided to the driver through the market package ATIS9--In-Vehicle Signing.

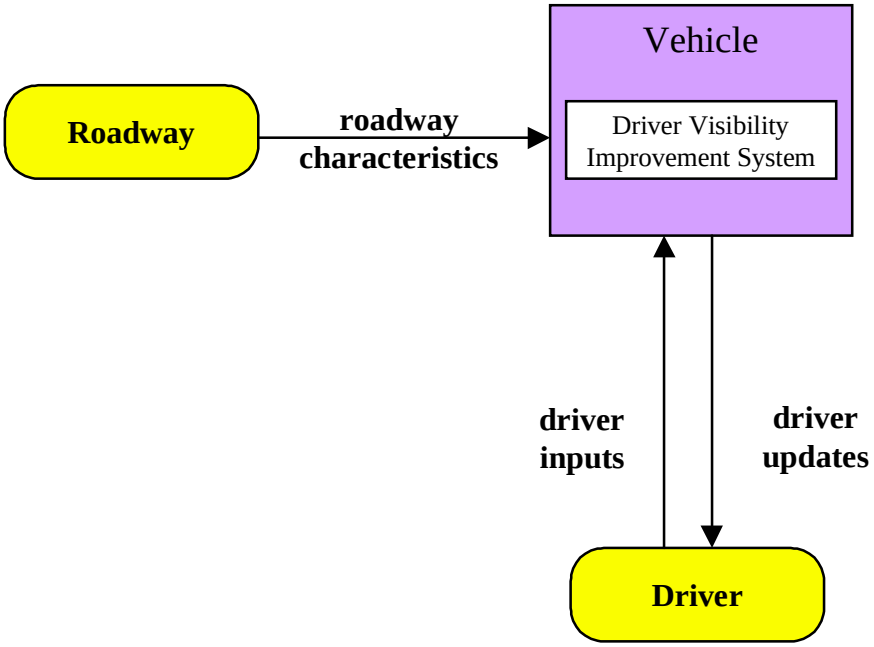


*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Pre-Crash Restraint Deployment (AVSS6)
This market package provides in-vehicle sensors to monitor the vehicle's local environment, determine collision probability and deploy a pre-crash safety system. It will include on-board sensors to measure lateral and longitudinal gaps and together with weather and roadway conditions will determine lateral and longitudinal collision probability. It will have the mechanism to deploy a pre-crash safety system.

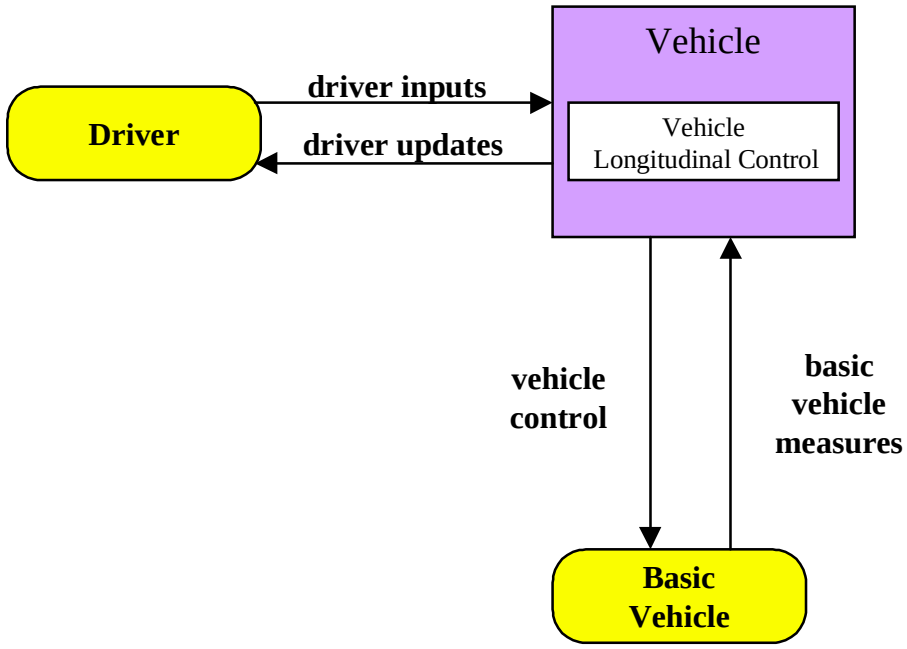


Driver Visibility Improvement (AVSS7)
This market package will enhance driver visibility using an enhanced vision system. On-board display hardware is needed**.**



Advanced Vehicle Longitudinal Control (AVSS8)

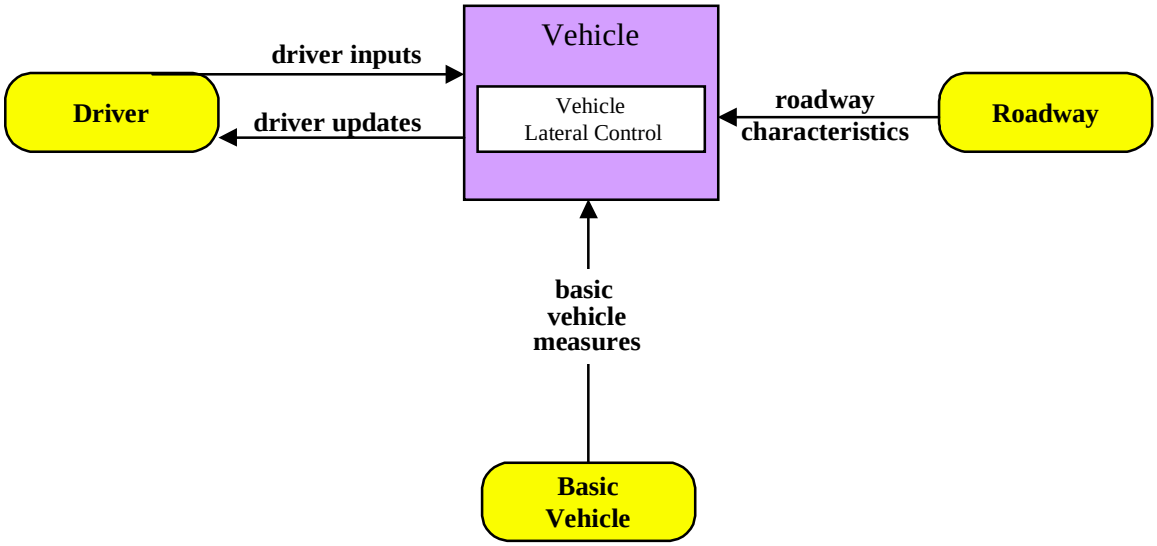
This market package automates the speed and headway control functions on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the throttle and brakes. It requires on-board sensors to measure longitudinal gaps and a processor for controlling the vehicle speed.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Advanced Vehicle Lateral Control (AVSS9)

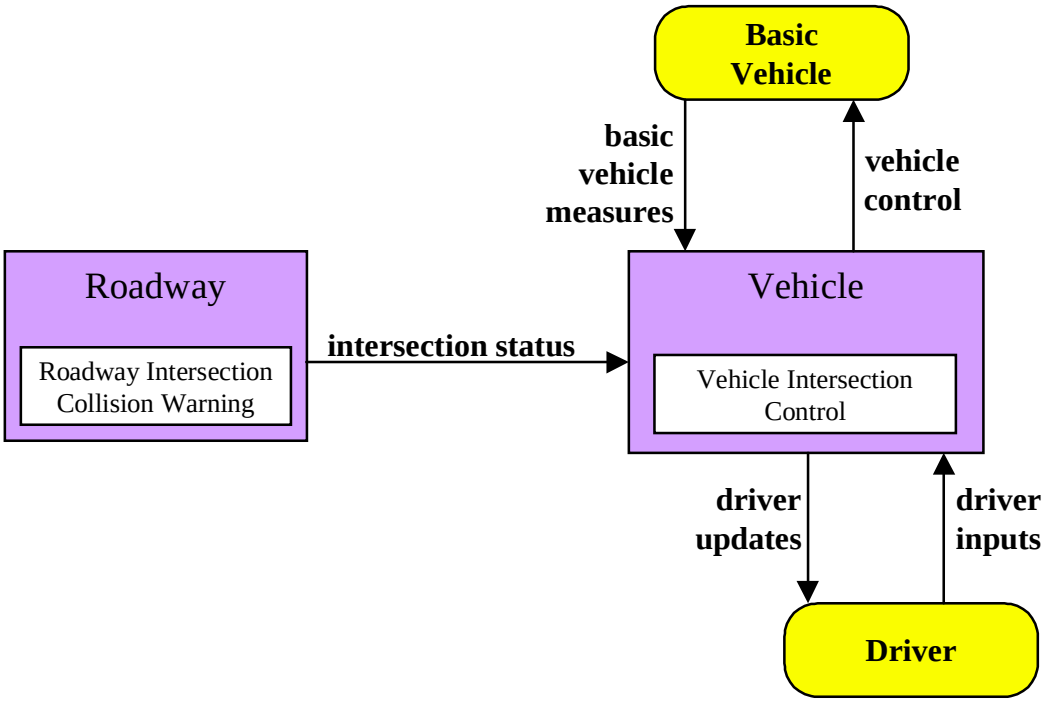
This market package automates the steering control on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the steering. It requires on-board sensors to measure lane position and lateral deviations and a processor for controlling the vehicle steering.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Intersection Collision Avoidance (AVSS10)

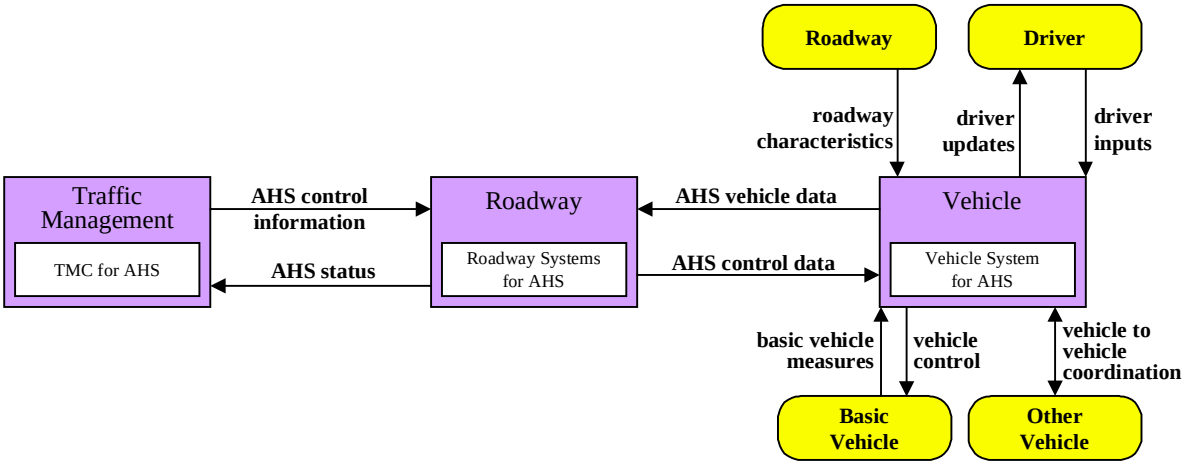
This market package will determine the probability of an intersection collision and provide timely warnings to approaching vehicles so that avoidance actions can be taken. This market package builds on the Intersection Collision Warning infrastructure and in-vehicle equipment and adds equipment in the vehicle that can take control of the vehicle in emergency situations. The same monitors in the roadway infrastructure are needed to assess vehicle locations and speeds near an intersection. This information is determined and communicated to the approaching vehicle using a short range communications system. The vehicle uses this information to develop control actions which alter the vehicle's speed and steering control and potentially activate its pre-crash safety system.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Automated Highway System (AVSS11)

This market package enables "hands-off" operation of the vehicle on the automated portion of the highway system. Implementation requires lateral lane holding, vehicle speed and steering control, and Automated Highway System check-in and checkout. This market package currently supports a balance in intelligence allocation between infrastructure and the vehicle pending selection of a single operational concept by the AHS consortium.

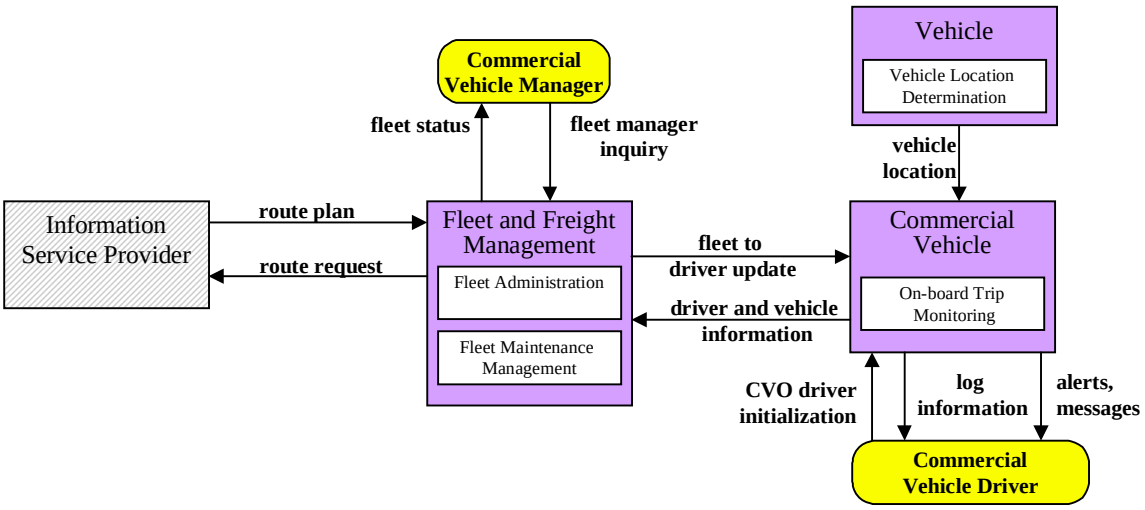


*Note: Graphic shows key market package elements. Some elements are omitted for clarity

2.2.5 Commercial Vehicle Operations Market Packages

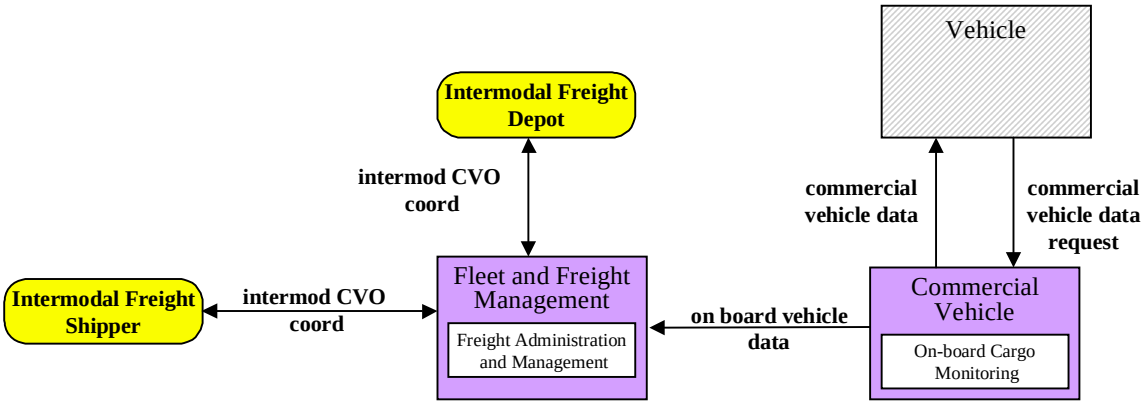
Fleet Administration (CVO1)

This market package keeps track of vehicle location, itineraries, and fuel usage at the Fleet and Freight Management Subsystem using a cell based or satellite data link and the pre-existing wireless infrastructure. The vehicle has a processor to interface to its sensor (e.g., fuel gauge) and to the cellular data link. The Fleet and Freight Management Subsystem can provide the vehicle with dispatch instructions, and can process and respond to requests for assistance and general information from the vehicle via the cellular data link. The market package also provides the Fleet Manager with connectivity to intermodal transportation providers using the existing wireline infrastructure.



Freight Administration (CVO2)

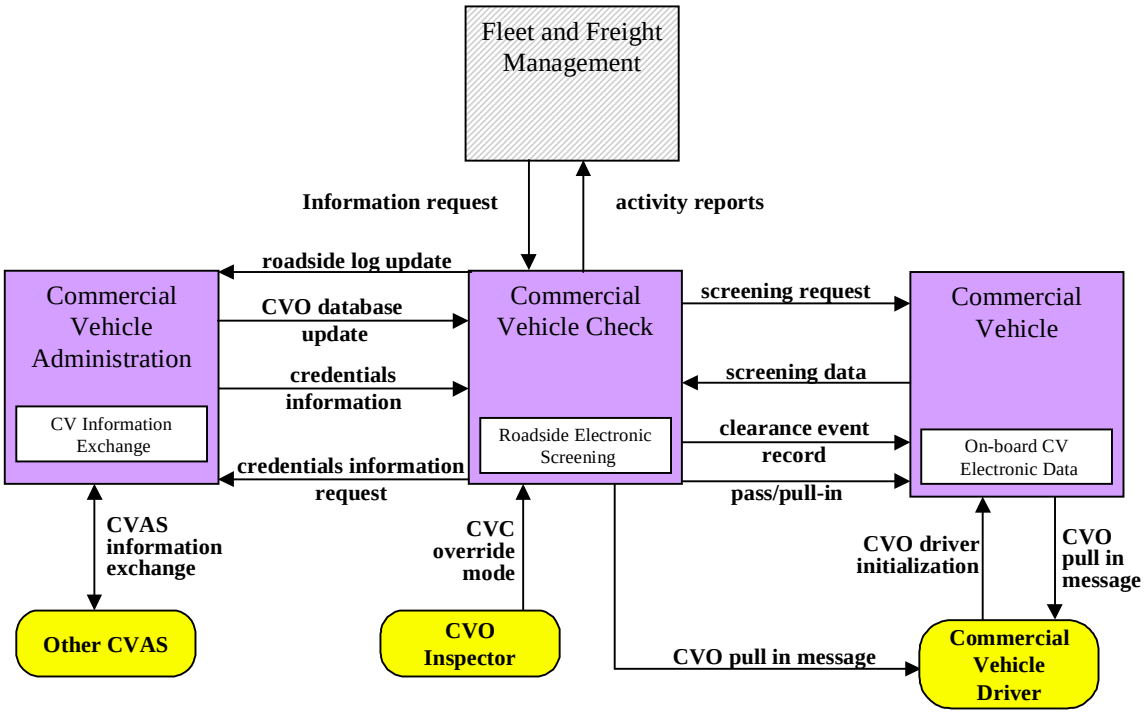
This market package tracks cargo and the cargo condition. This information is communicated with the Fleet and Freight Management Subsystem via the existing wireless infrastructure. Interconnections are provided to intermodal shippers and intermodal freight depots for tracking the cargo from source to destination.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Electronic Clearance (CVO3)

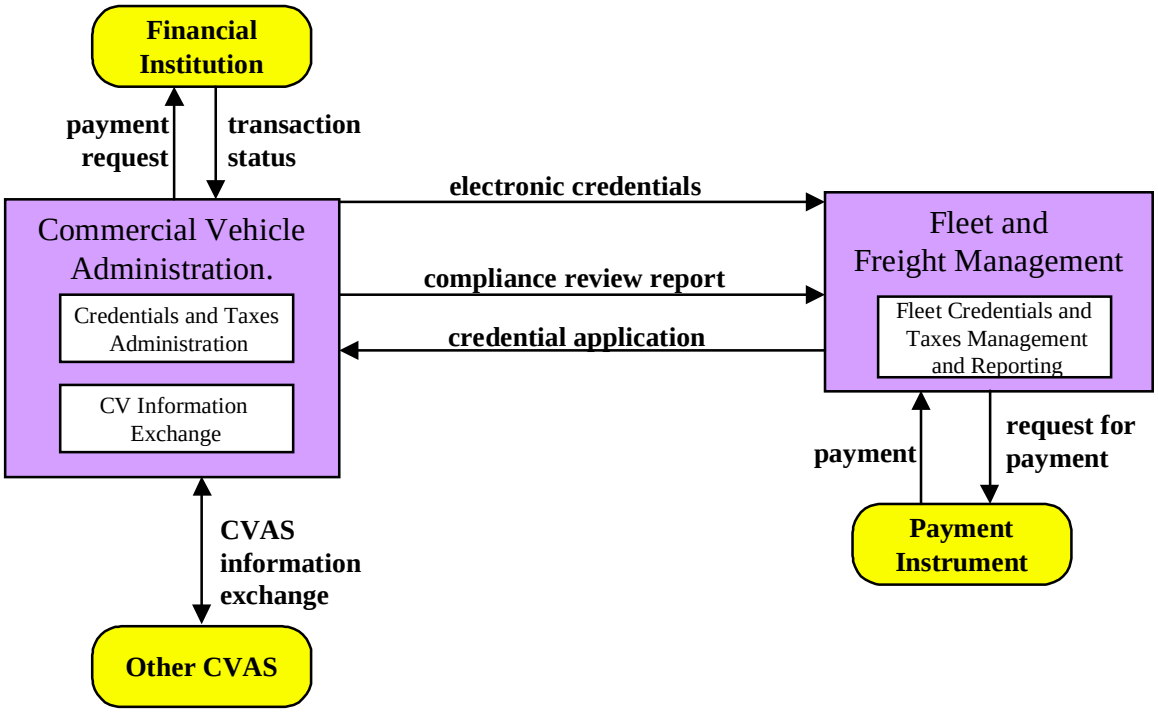
This market package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem over wireline to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This package allows a good driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated short range communications to the roadside. The roadside check facility may be equipped with AVI, weighing sensors, transponder read/write devices, computer workstation processing hardware, software, and databases.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

CV Administrative Processes (CVO04)

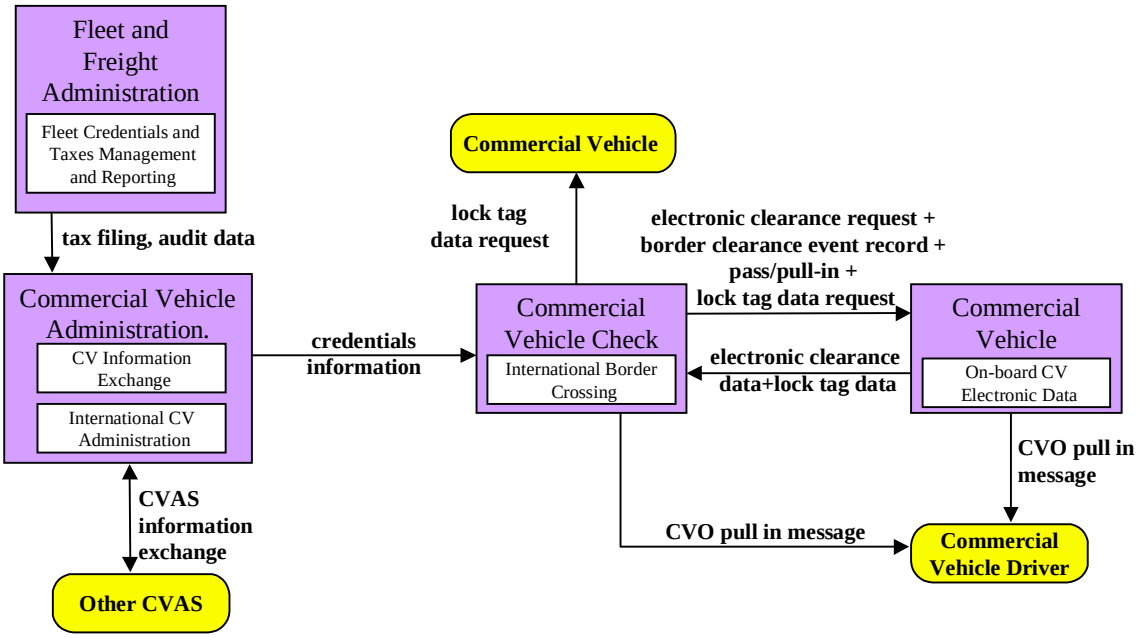
This market package provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in the electronic clearance program provided by a separate market package which allows commercial vehicles to be screened at mainline speeds at commercial vehicle check points. Through this enrollment process, current profile databases are maintained in the Commercial Vehicle Administration Subsystem and snapshots of this database are made available to the commercial vehicle check facilities at the roadside to support the electronic clearance process.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

International Border Electronic Clearance (CVO05)

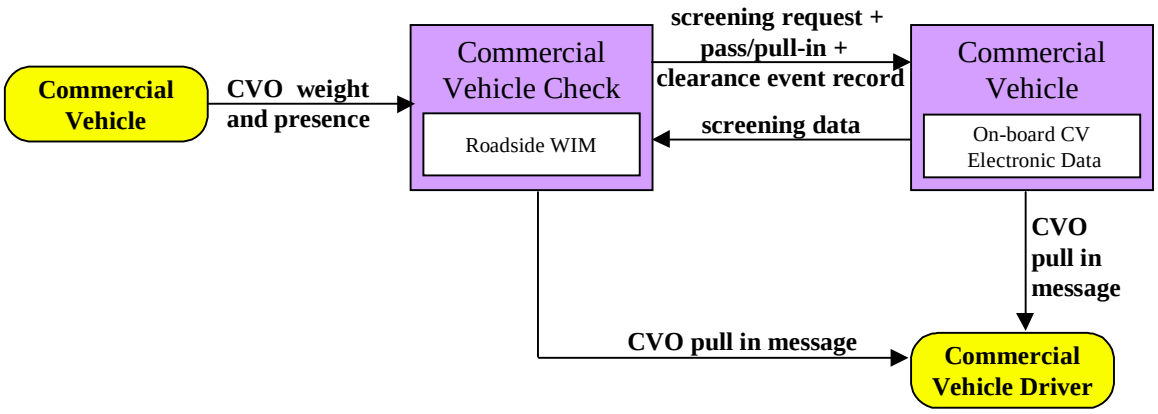
This market package provides for automated clearance specific to international border crossings. This package augments the electronic clearance package by allowing interface with customs related functions and permitting NAFTA required entry and exit from the US to Canada and Mexico.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

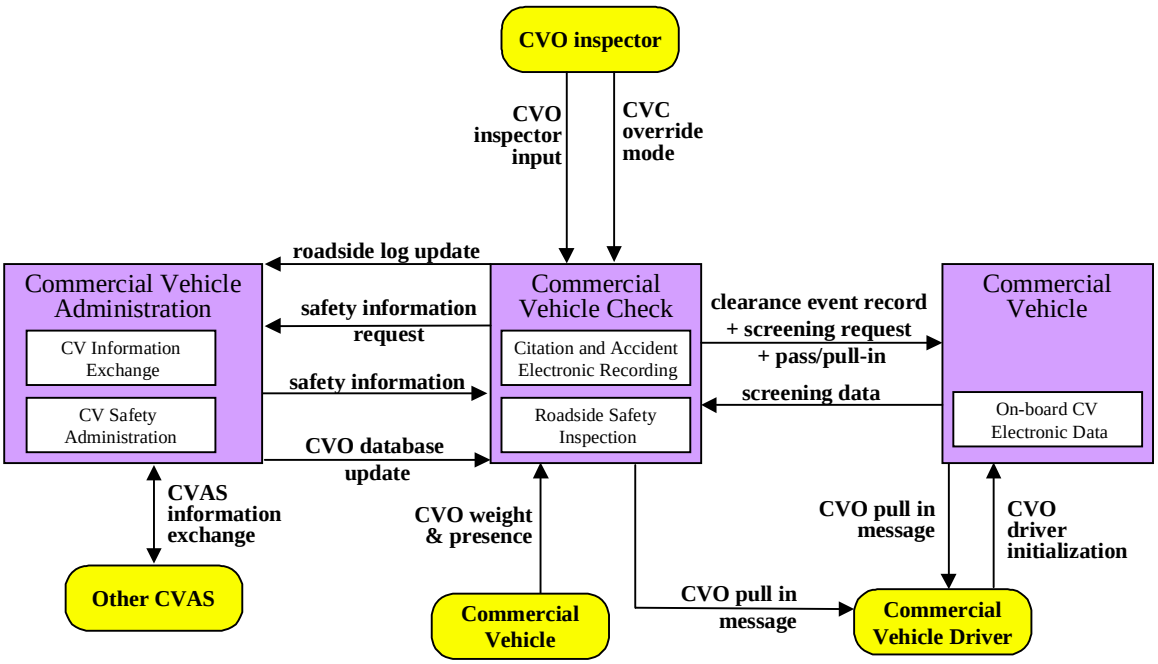
Weigh-In-Motion (CVO06)

This market package provides for high speed weigh-in-motion with or without AVI attachment. Primarily this market package provides the roadside with additional equipment, either fixed or removable. If the equipment is fixed, then it is thought to be an addition to the electronic clearance and would work in conjunction with the AVI and AVC equipment in place.



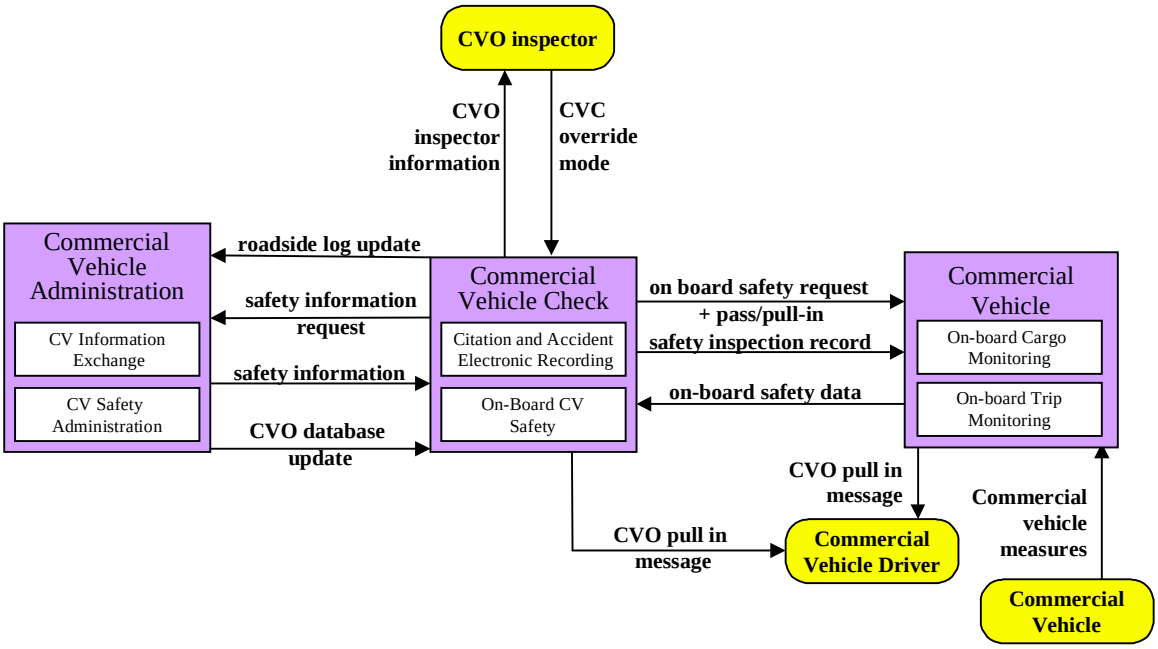
Roadside CVO Safety (CVO07)

This market package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the Commercial Vehicle Check roadside element. The capabilities for performing the safety inspection are shared between this market package and the On-Board CVO Safety Market Package which enables a variety of implementation options. The basic option, directly supported by this market package, facilitates safety inspection of vehicles that have been pulled in, perhaps as a result of the automated screening process provided by the Electronic Clearance Market Package. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-Board CVO Safety market package, utilize additional vehicle safety monitoring and reporting capabilities in the commercial vehicle to augment the roadside safety check.



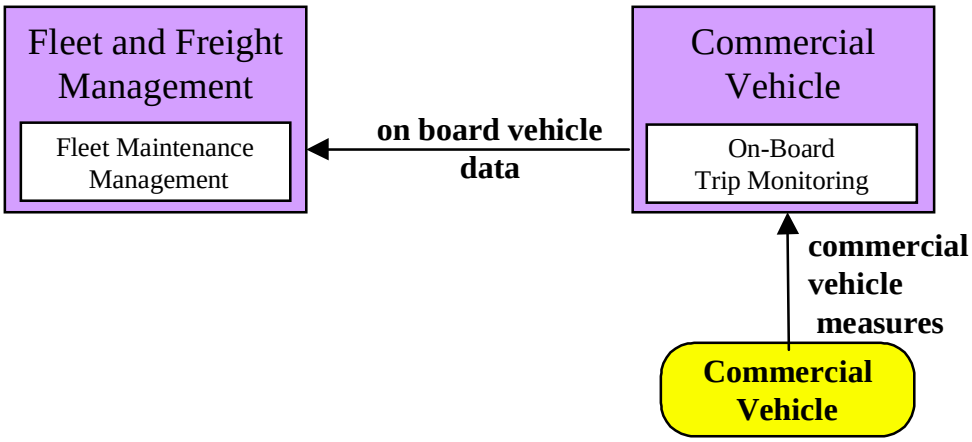
On-board CVO Safety (CVO08)

This market package provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety Market Package and includes roadside support for reading on-board safety data via tags. This market package uses the same communication links as the Roadside CVO Safety Market Package, and provides the commercial vehicle with a wireless link (data and possibly voice) to the Fleet and Freight Management and the Emergency Management Subsystems. Safety warnings are provided to the driver as a priority with secondary requirements to notify the Fleet and Freight Management and Commercial Vehicle Check roadside elements.



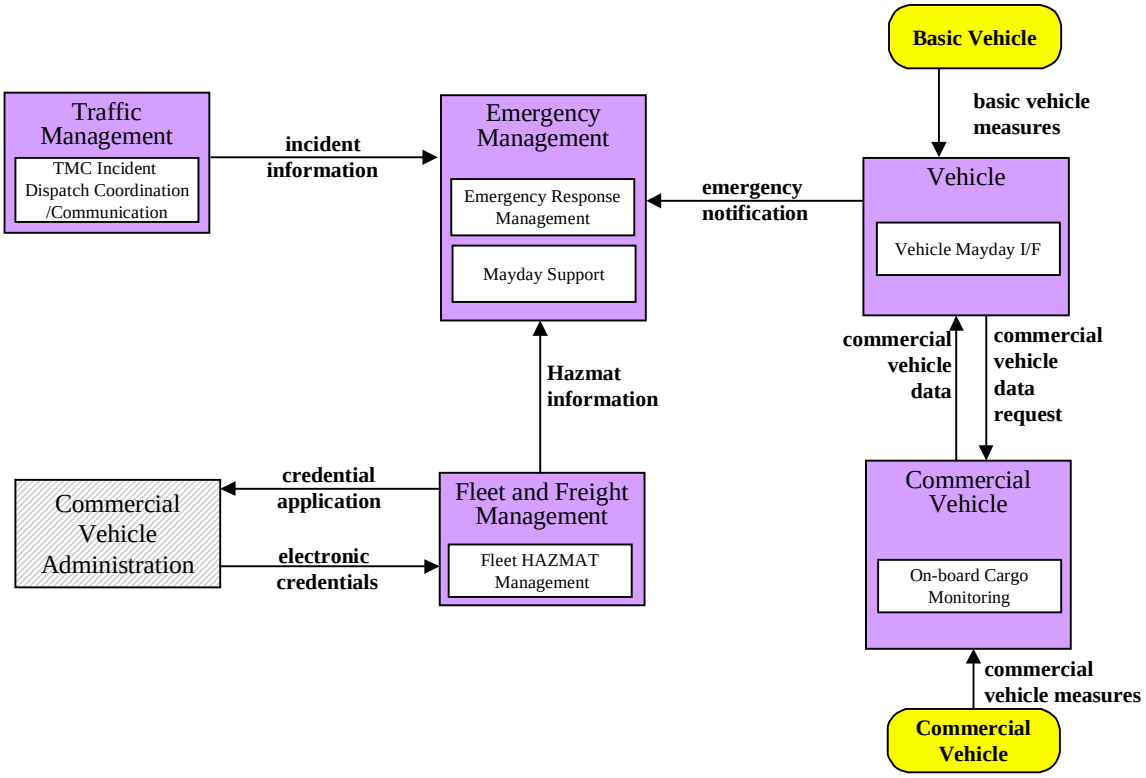
CVO Fleet Maintenance (CVO09)

This market package supports maintenance of CVO fleet vehicles through close interface with on-board monitoring equipment and AVLS capabilities with in the Fleet and Freight Management Subsystem. Records of vehicle mileage, repairs, and safety violations are maintained to assure safe vehicles on the highway.



HAZMAT Management (CVO10)

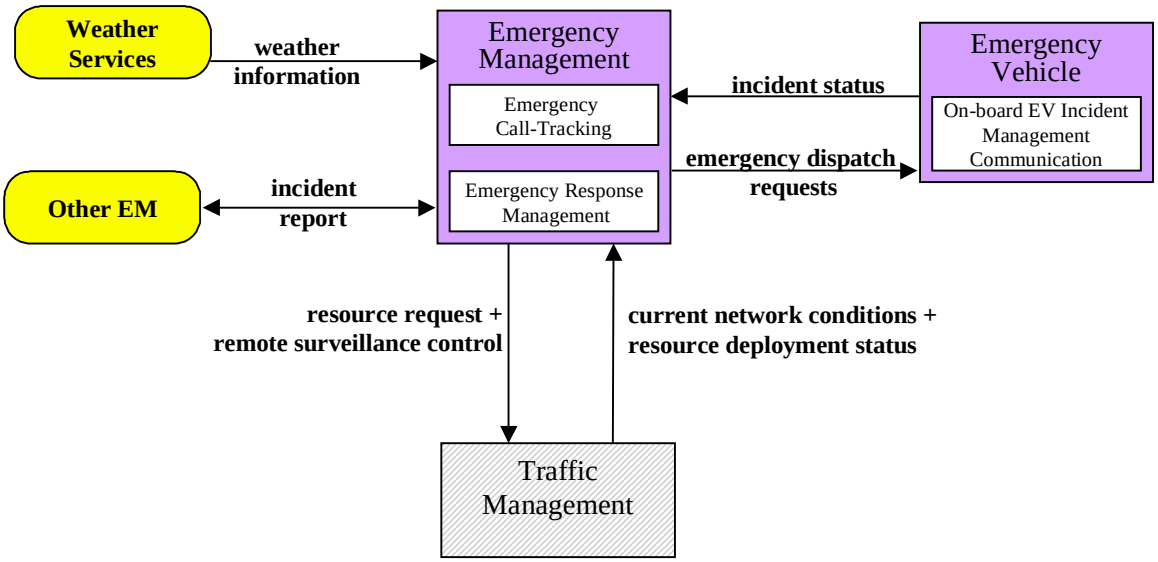
This market package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

2.2.6 Emergency Management Market Packages

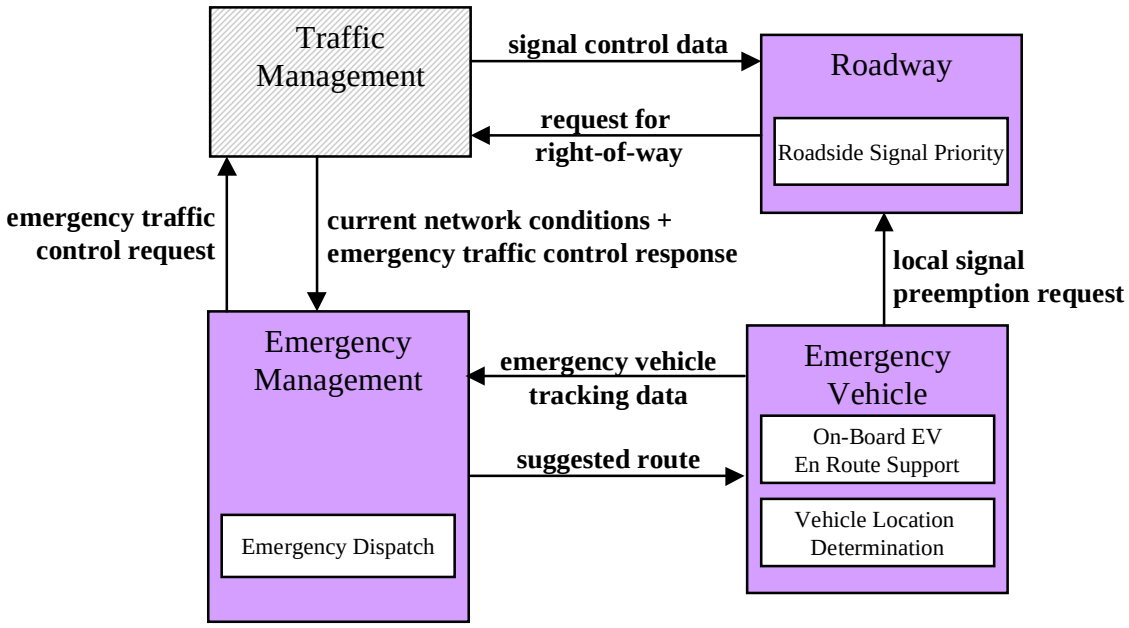
Emergency Response (EM1)
This market package provides the computer-aided dispatch systems, emergency vehicle equipment, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Subsystems supports emergency notification and coordinated response between agencies. Existing wide area wireless communications would be utilized between the Emergency Management Subsystem and an Emergency Vehicle to enable an incident command system to be established and supported at the emergency location. The Emergency Management Subsystem would include hardware and software for tracking the emergency vehicles. Public safety, traffic management, and many other allied agencies may each participate in the coordinated response managed by this package.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Emergency Routing (EM2)

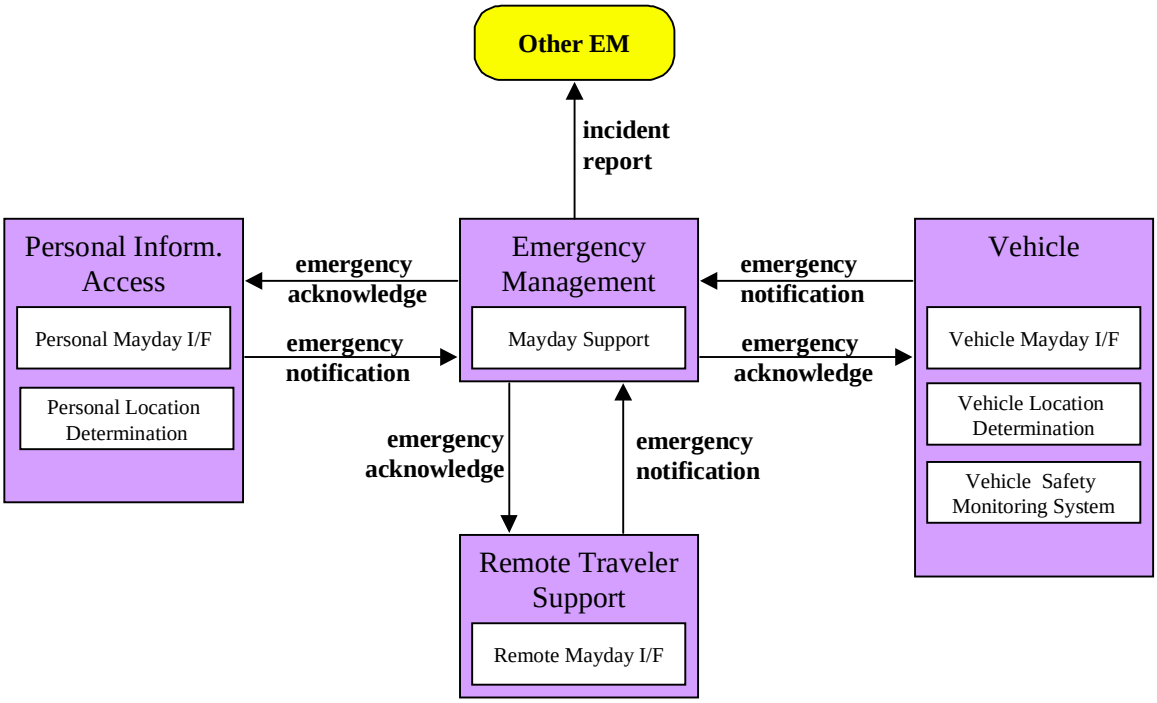
This market package supports dynamic routing of emergency vehicles and coordination with the Traffic Management Subsystem for special priority on the selected route(s). The Information Service Provider Subsystem supports routing for the emergency fleet based on real-time traffic conditions and the emergency routes assigned to other responding vehicles. In this market package, the Information Service Provider Subsystem would typically be integrated with the Emergency Management Subsystem in a public safety communications center. The Emergency Vehicle would also optionally be equipped with dedicated short range communications for local signal preemption.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

Mayday Support (EM3)

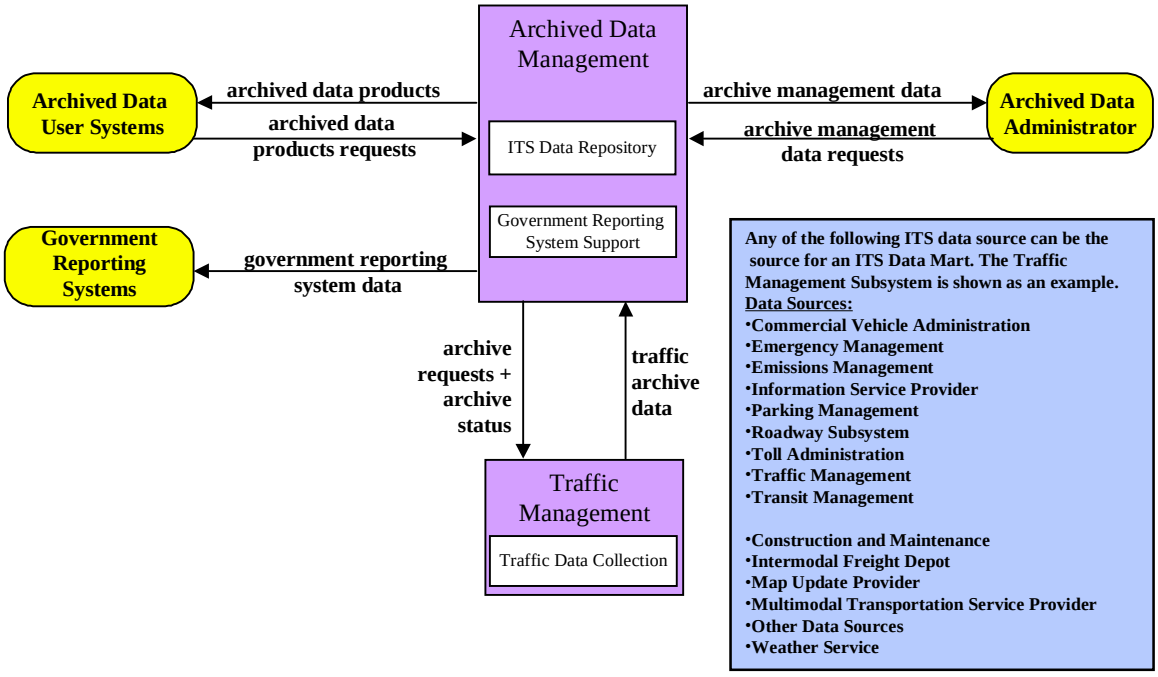
This package allows the user (driver or non-driver) to initiate a request for emergency assistance and enables the Emergency Management Subsystem to locate the user and determine the appropriate response. The Emergency Management Subsystem may be operated by the public sector or by a private sector provider. The request from the traveler needing assistance may be manually initiated or automated and linked to vehicle sensors. The data is sent to the Emergency Management subsystem using wide area wireless communications with voice as an option. Providing user location implies either a location technology within the user device or location determination within the communications infrastructure.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

2.2.7 Archived Data Management Market Packages

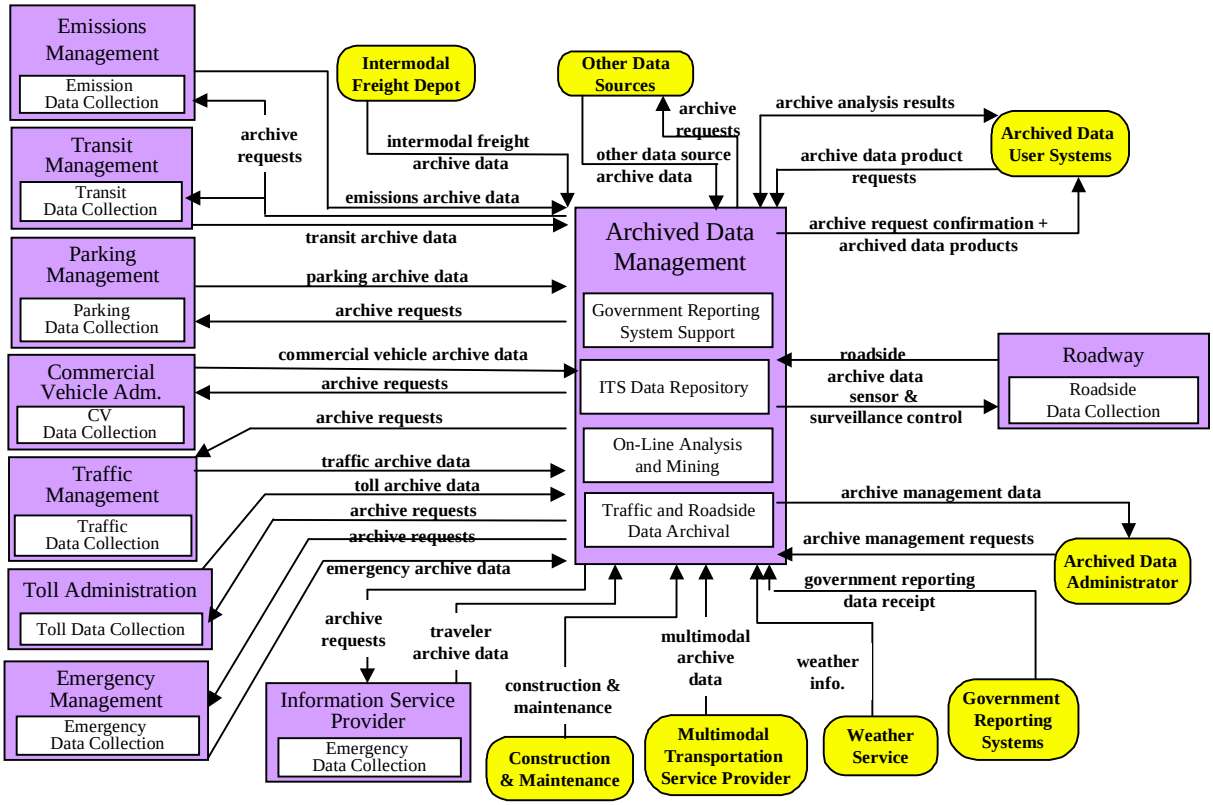
ITS Data Mart (AD1)
This market package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use. It provides the basic data quality, data privacy, and meta data management common to all ITS archives and provides general query and report access to archive data users.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

ITS Data Warehouse (AD2)

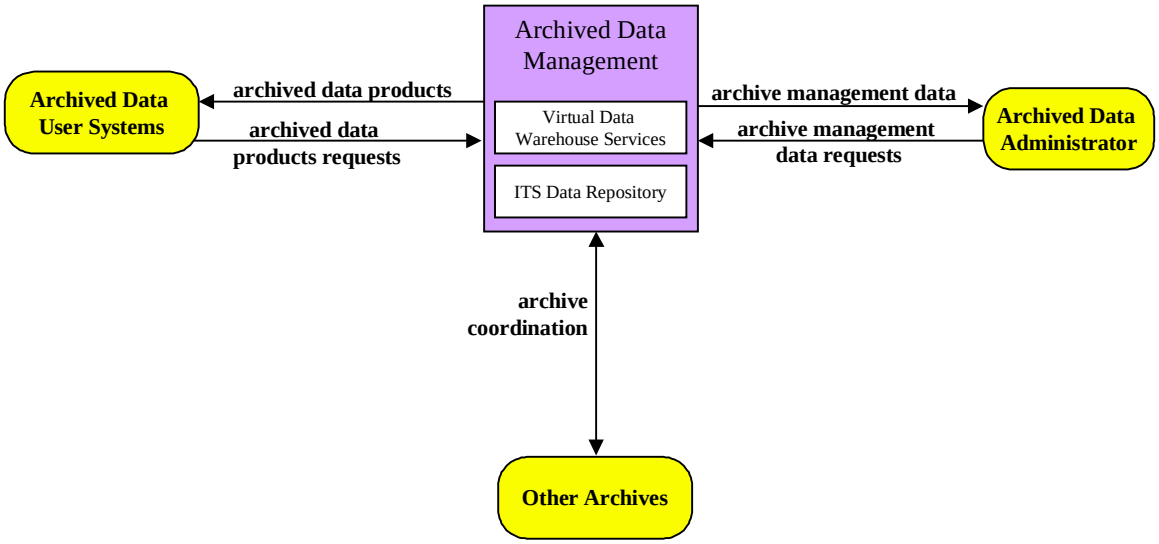
This market package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this market package in addition to the basic query and reporting user access features offered by the ITS Data Mart.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

ITS Virtual Data Warehouse (AD3)

This market package provides the same broad access to multimodal, multidimensional data from varied data sources as in the ITS Data Warehouse Market Package, but provides this access using enhanced interoperability between physically distributed ITS archives that are each locally managed. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse Market Package are parsed by the local archive and dynamically translated to requests to remote archives which relay the data necessary to satisfy the request.



*Note: Graphic shows key market package elements. Some elements are omitted for clarity

3 Market Packages and User Services

The Market Packages are directly traceable to the User Services and often include capabilities that span more than one user service. Conversely, a single User Service sometimes includes a range of incremental capabilities that are segregated into separate Market Packages so that they may be considered separately from a deployment perspective. As a result, there is often a many-to-many relationship between the Market Packages and the User Services.

To illustrate these relationships, consider the following examples:

- The Traffic Control user service requires distinct surveillance, freeway and surface street traffic control, integrated area-wide traffic control, HOV lane control, and traffic information dissemination capabilities. Since each of these capabilities may be deployed individually by a local jurisdiction, they are allocated to distinct Market Packages. The Market Packages also distinguish between different traffic surveillance approaches. Roadside instrumentation (i.e., the Network Surveillance Market Package) and vehicle probes (i.e. the Probe Surveillance Market Package) are separated due to fundamentally different technical and institutional issues for the two approaches. In total, eleven separate Market Packages provide different mechanisms and levels of support for satisfying the Traffic Control User Service Requirements.

- The HOV and Reversible Lane Management Market Package supports both the Traffic Control and Travel Demand Management User Services since both services could include HOV lane management capabilities. This single deployable package satisfies portions of the requirements associated with both of these user services.

The relationship between User Services and Market Packages is presented in Table 3-1. As shown in the table, the identified Market Packages support all required User Services.

Table 3-1: Market Package to User Service Relationships

	Market Packages	1.1 - Pre-Trip Travel Information	1.2 - En-Route Driver Information	1.3 - Route Guidance	1.4 - Ride Matching and Reservation	1.5 - Traveler Service Information	1.6 - Traffic Control	1.7 - Incident Management	1.8 - Travel Demand Management	1.9 Emissions Testing and Mitigation	1.10 - Highway - Rail Intersection	2.1 - Public Transportation Management	2.2 - En-Route Transit Information	2.3 - Personalized Public Transit	2.4 - Public Travel Security	3.1 - Electronic Payment Service	4.1 - Commercial Vehicle Electronic Clearance	4.2 - Automated Roadside Safety Inspection	4.3 - On-Board Safety Monitoring	4.4 - Commercial Vehicle Administrative Process	4.5 - Hazardous Material Incident Response	4.6 - Commercial Fleet Management	5.1 - Emergency Notification And Personal Security	5.2 - Emergency Vehicle Management	6.1 - Longitudinal Collision Avoidance	6.2 - Lateral Collision Avoidance	6.3 - Intersection Collision Avoidance	6.4 - Vision Enhancement For Crash Avoidance	6.5 - Safety Readiness	6.6 - Pre-Crash Restraint Deployment	6.7 - Automated Vehicle Operation	7.1 - Archived Data Function
ATMS	Network Surveillance						◆																									
	Probe Surveillance						◆																									
	Surface Street Control						◆	◆			◆																					
	Freeway Control						◆	◆	◆																							
	HOV Lane Management						◆		◆																							
	Traffic Information Dissemination						◆				◆																					
	Regional Traffic Control						◆																									
	Incident Management System							◆																								
	Traffic Forecast and Demand Management						◆		◆																							
	Electronic Toll Collection								◆							◆																
	Emissions Monitoring and Management									◆																						
	Virtual TMC and Smart Probes		◆				◆	◆																								
	Standard Railroad Grade Crossing										◆																					
	Advanced Railroad Grade Crossing										◆																					
	Railroad Operations Coordination										◆																					
	Parking Facility Management								◆							◆																
	Reversible Lane Management						◆	◆																								
	Road Weather Information System		◆				◆	◆																								
	Regional Parking Management								◆							◆																
APTS	Transit Vehicle Tracking											◆	◆	◆	◆																	
	Transit Fixed-Route Operations											◆	◆																			
	Demand Response Transit Operations											◆	◆	◆																		
	Transit Passenger and Fare Management												◆			◆																
	Transit Security											◆			◆																	
	Transit Maintenance											◆																				
	Multi-modal Coordination						◆		◆			◆																				
	Transit Traveler Information											◆	◆			◆																
ATIS	Broadcast Traveler Information	◆	◆										◆																			
	Interactive Traveler Information	◆	◆		◆	◆							◆	◆		◆																
	Autonomous Route Guidance		◆	◆																												
	Dynamic Route Guidance		◆	◆		◆		◆					◆																			
	ISP Based Route Guidance	◆	◆	◆												◆																
	Integrated Transp. Management/Route Guidance		◆	◆												◆																
	Yellow Pages and Reservation	◆	◆		◆	◆							◆			◆																
	Dynamic Ridesharing	◆	◆	◆	◆				◆				◆	◆		◆																
	In Vehicle Signing		◆				◆				◆																					
AVCSS	Vehicle Safety Monitoring																													◆	◆	
	Driver Safety Monitoring																													◆		
	Longitudinal Safety Warning																									◆				◆		
	Lateral Safety Warning																										◆			◆		
	Intersection Safety Warning										◆																	◆		◆		
	Pre-Crash Restraint Deployment																													◆	◆	
	Driver Visibility Improvement																												◆			
	Advanced Vehicle Longitudinal Control																									◆						
	Advanced Vehicle Lateral Control																										◆					◆
	Intersection Collision Avoidance										◆																	◆				
	Automated Highway System																															◆
CVO	Fleet Administration			◆																		◆										
	Freight Administration																				◆											
	Electronic Clearance																◆			◆												
	CV Administrative Processes																◆			◆												
	International Border Electronic Clearance																◆			◆												
	Weigh-In-Motion																◆															
	Roadside CVO Safety																◆	◆														

	Market Packages	1.1- Pre-Trip Travel Information	1.2 - En-Route Driver Information	1.3 - Route Guidance	1.4 - Ride Matching and Reservation	1.5 - Traveler Service Information	1.6 - Traffic Control	1.7 - Incident Management	1.8 - Travel Demand Management	1.9 Emissions Testing and Mitigation	1.10 - Highway - Rail Intersection	2.1 - Public Transportation Management	2.2 - En-Route Transit Information	2.3 - Personalized Public Transit	2.4 - Public Travel Security	3.1 - Electronic Payment Service	4.1 - Commercial Vehicle Electronic Clearance	4.2 - Automated Roadside Safety Inspection	4.3 - On-Board Safety Monitoring	4.4 - Commercial Vehicle Administrative Process	4.5 - Hazardous Material Incident Response	4.6 - Commercial Fleet Management	5.1 - Emergency Notification And Personal Security	5.2 - Emergency Vehicle Management	6.1 - Longitudinal Collision Avoidance	6.2 - Lateral Collision Awoidance	6.3 - Intersection Collision Avoidance	6.4 - Vision Enhancement For Crash Avoidance	6.5 - Safety Readiness	6.6 - Pre-Crash Restraint Deployment	6.7 - Automated Vehicle Operation	7.1 - Archived Data Function
	On-board CVO Safety																		◆													
	CVO Fleet Maintenance																	◆	◆			◆										
	HAZMAT Management							◆													◆	◆										
EM	Emergency Response																							◆	◆							
EM	Emergency Routing						◆																		◆							
EM	Mayday Support																							◆	◆							
AD	ITS Data Mart																															◆
AD	ITS Data Warehouse																															◆
AD	ITS Virtual Data Warehouse																															◆

Chapter 2 introduced each of the Market Packages and described how they relate to the broader National ITS Architecture technical framework. This chapter discusses the User Services often used to access the Architecture. One of the unique attributes of the National ITS Architecture is the breadth of ITS services that it covers. These inter-relationships, or synergies can be further explored in Section 5.1. The next chapter describes how Market Packages relate to three particular geographical / functional ITS areas that are receiving special attention from US DOT.

4 Relating Market Packages to US DOT ITS Programmatic Focus Areas

To highlight transportation needs and potential ITS solutions in specific settings, US DOT has initiated programs focused on particular segments of the ITS arena. Three program areas which include an Architecture component and can leverage the National ITS Architecture Market Package analyses are: (1) the Metropolitan ITS Infrastructure effort, (2) the rural ITS user needs analyses, and (3) the Commercial Vehicle Information Systems and Networks (CVISN) program. This chapter provides an overview of these programs and their status, identifies key elements of the National ITS Architecture Physical Architecture that relate to these focus areas, and highlights the Market Packages most appropriate to supporting the needs in these areas.

4.1 The Metropolitan ITS Infrastructure (MITI)

In January 1996, Secretary of Transportation Federico Pena set a National goal to build a Metropolitan ITS Infrastructure across the United States. As part of this goal, a target was set for implementing a MITI in the 75 largest metropolitan areas within 10 years.

This section takes a closer look at the elements of the MITI and connects its nine elements with the National ITS Architecture definition and Market Packages that were defined earlier in section 2.2. Through this mapping, the subset of the National Architecture is identified as a national interoperability framework within which an MITI may be deployed.

The relationship between the Metropolitan ITS Infrastructure and the National ITS Architecture is a complementary one that allows for introductory conceptualizations through the infrastructure with more detailed planning and execution by using the National ITS Architecture as a tool for local decisions.

4.1.1 Components of the MITI

The U.S. DOT has defined nine components within the MITI:

1. *Regional Multimodal Traveler Information System.* These systems serve as a repository for current, comprehensive and accurate roadway and transit performance data. They directly receive data from a variety of public and private sector sources, combines and packages this data, and provides the resulting information to travelers and other customers via a variety of distribution channels. The system may be a single physical facility or an inter-connected set of facilities.

2. *Arterial Management Systems.* These systems are used to manage traffic and the control of arterial roadways. They include arterial traffic management systems that provide surveillance and signal control, and systems that provide travelers with information on arterial street travel conditions through audio or visual displays.

3. *Freeway Management Systems.* These systems monitor traffic conditions on the freeway system, identify recurring and non-recurring flow impediments, implement appropriate control and management strategies (such as ramp metering or lane control), and provide critical information to travelers using dissemination methods such as variable message signs and highway advisory radio and In-Vehicle Signing.

4. *Transit Management Systems.* These systems provide reliable and timely bus position information to the dispatcher. The dispatcher or a central computer compares the actual location with the scheduled location, enabling positive action to improve schedule adherence and expanded information to the Traveler Information System component. In addition, on-board sensors automatically monitor data such as vehicle passenger loading, fare collection, drive line operating conditions, etc., providing for real-time management response. In the event of an on-board emergency, the dispatcher can inform the police and direct them to the vehicle's exact location.

5. *Incident Management Programs.* Incident management provides an organized and functioning system for quickly identifying and clearing crashes, disabled vehicles, debris, and other non-recurring flow impediments from area freeways and major arterials. The objectives are to coordinate incident identification, response, and clearance activities across regional boundaries, to use traffic management capabilities to improve response times, and to reduce traveler delays due to incidents.

6. *Electronic Fare Payment Systems*. These systems include hardware and software for roadside, in-vehicle, and in-station electronic payment of transit fares, parking fees, etc. Both debit and credit systems would possibly be included. The system eliminates the need for travelers to carry exact fare amounts and facilitates the subsequent implementation of a single fare payment medium.

7. *Electronic Toll Collection Systems.* These systems include hardware and software for roadside and in-vehicle use that will allow drivers to pay tolls without stopping. It includes driver payment cards or tags, financial and card accounting system(s), roadside systems at mainline plazas or toll road entry and exit points, and a communications system between vehicles and the roadside. The system performs automated vehicle identification, automatic determination of tolls for differing classes of vehicles, automated enforcement of violations, and flexibility in financial arrangement.

8. *Highway-Rail Intersection Systems:* These systems coordinate rail movements with the traffic control signal systems, and provide travelers with advanced warning of crossing closures. This system also improves and automates warnings at highway-rail intersections. The Highway-Rail Intersection component involves electronic surveillance of grade crossings to detect vehicles within the crossing area, either through video or other means such as loop detectors.

9. *Emergency Management Services:* These systems support coordination of emergency services across jurisdictional boundaries, make emergency fleet management more efficient through application of AVL and dispatch-support systems, provide coordination with traffic management systems to further reduce emergency response times, and improve HAZMAT material tracking and HAZMAT incident response through provision of timely and accurate information to emergency personnel

4.1.2 Relating MITI to the National ITS Architecture and Market Packages

This section provides a direct technical mapping between the elements defined by Metropolitan ITS Infrastructure and the equivalent elements defined by the National ITS Architecture.

As described in section 2.1, the National ITS Architecture consists of nineteen interconnected Subsystems. Each Subsystem is, in turn, made up of at least one Equipment Package. Market Packages provide another perspective of the Architecture that groups Equipment Packages that must be deployed together to provide a service. To define a "Metropolitan Intelligent Transportation System Infrastructure Architecture", the subset of these National ITS Architecture elements that is necessary to support the MITI must be identified.

The nine MITI elements neatly correspond with a subset of the physical Subsystems defined by the National ITS Architecture as presented in table 4.1.2-1. A more detailed view of the applicable National ITS Architecture requirements is developed by mapping the functional description for each MITI element to the National ITS Architecture Market Packages. To accomplish this, the table lists the major functions identified for each of the MITI elements and selects the Market Packages that provide supporting capabilities.

Table 4.1.2-1: Relating Metropolitan ITS Infrastructure to National ITS Architecture

Metropolitan ITS Infrastructure		National ITS Architecture	
Element	**Identified Functions**	**Applicable Market Packages**	**Subsystems**
Regional Multimodal Traveler Information	Real-time Multi-Modal Data Repository Broadcast Information Distribution	• Broadcast Traveler Information	Information Service Provider, Remote Traveler Support, Personal Info Access, Vehicle
	Interactive Information Distribution	• Interactive Traveler Information	

Metropolitan ITS Infrastructure		National ITS Architecture	
Element	**Identified Functions**	**Applicable Market Packages**	**Subsystems**
	Central or Distributed Facilities		
Arterial Management Systems	Monitors Arterial Network Traffic	• Network Surveillance	Traffic Management, Roadway
	Range of Adaptive Control Strategies	• Surface Street Control	
	Area-wide Signal Coordination	• Regional Traffic Control	
	Integration with Freeway Management		
Freeway Management System	Monitors Freeway Conditions Identifies Flow Impediments	• Network Surveillance • Probe Surveillance	Traffic Management, Roadway
	Ramp Metering/Lane Controls	• Freeway Control	
		• HOV and Reversible Lane Management	
Transit Management System	HARs/VMSs	• Traffic Information Dissemination	Transit Management, Transit Vehicle, Information Service Provider
	Monitors Transit Vehicle Position	• Transit Vehicle Tracking	
	Disseminates Real-Time Schedules		
	Computer-Aided Dispatch	• Transit Fixed Route Operations • Demand Response Transit Operations	
	Vehicle Passenger Loading	• Transit Passenger and Fare Management	
	Fare Management		
	Vehicle Condition Monitoring	• Transit Maintenance	
	On-Board Safety Monitoring	• Transit Security	
	Coordination with Traffic Management	• Multi-modal Coordination	
Incident Management Program	Policy and Operations Agreement	• No Market Package. Policy separate from Architecture	Traffic Management
	Incident Detection/Verification	• Incident Management System	
	Incident Response/Clearance		
Electronic Fare Payment Systems	Credit or Debit Card Support	• Transit Passenger and Fare Management	Transit Management, Transit Vehicle, Remote Traveler Support
	Payment at Station/Stop or In-Vehicle		
Electronic Toll Collection Systems	Short Range Communications	• Electronic Toll Collection	Toll Administration, Toll Collection, Vehicle
	Automated Vehicle Identification		
	Vehicle Class Differentiation		
	Automated Enforcement		
	Credit/Debit Flexibility		
Highway-Rail Intersection system	Improve and automate HRI warnings	• Standard Railroad Grade Crossing	Traffic Management, Roadway
	Provide advanced warning of closures	• Rail Operations Coordination	
	Coordinate signal control with rail movements	• Rail Operations Coordination	
Emergency Management Services	Coordinate Regional Response AVL and Fleet Management Support Coordination with Traffic Management	• Emergency Response • Emergency Routing • Emergency Routing	Emergency Management, Emergency Vehicle

Based on the mappings presented in the previous table, the following list of Market Packages most strongly support the Metropolitan ITS Infrastructure:

- Network Surveillance
- Probe Surveillance
- Surface Street Control
- Freeway Control
- Incident Management System
- Regional Traffic Control
- Traffic Information Dissemination
- HOV and Reversible Lane Management
- Dynamic Toll/Parking Fee Management
- Standard Railroad Grade Crossing
- Railroad Operations Coordination
- Broadcast Traveler Information
- Interactive Traveler Information
- Transit Vehicle Tracking
- Transit Fixed Route Operations
- Transit Demand Response Operations
- Transit Passenger and Fare Management
- Transit Maintenance
- Transit Security
- Multi-modal Coordination
- Emergency Response
- Emergency Routing

Note that many of the Metropolitan ITS Infrastructure Market Packages include a mix of equipment; not all of which would normally be considered as "public infrastructure" and included in Metropolitan ITS Infrastructure under a strict definition. For instance, two traveler information Market Packages are required to support Metropolitan ITS Infrastructure; however, these Market Packages include vehicle and personal information access (e.g., personal computer) equipment that would not be classified as infrastructure and would not normally be eligible for public funds. Figure 4.1.2-1 presents all of the Subsystems and interconnections necessary to support the Market Packages associated with Metropolitan ITS Infrastructure. This yields an inclusive view of ITS which includes elements that are not public infrastructure but are required for the Metropolitan ITS Infrastructure to provide a service to end-users.

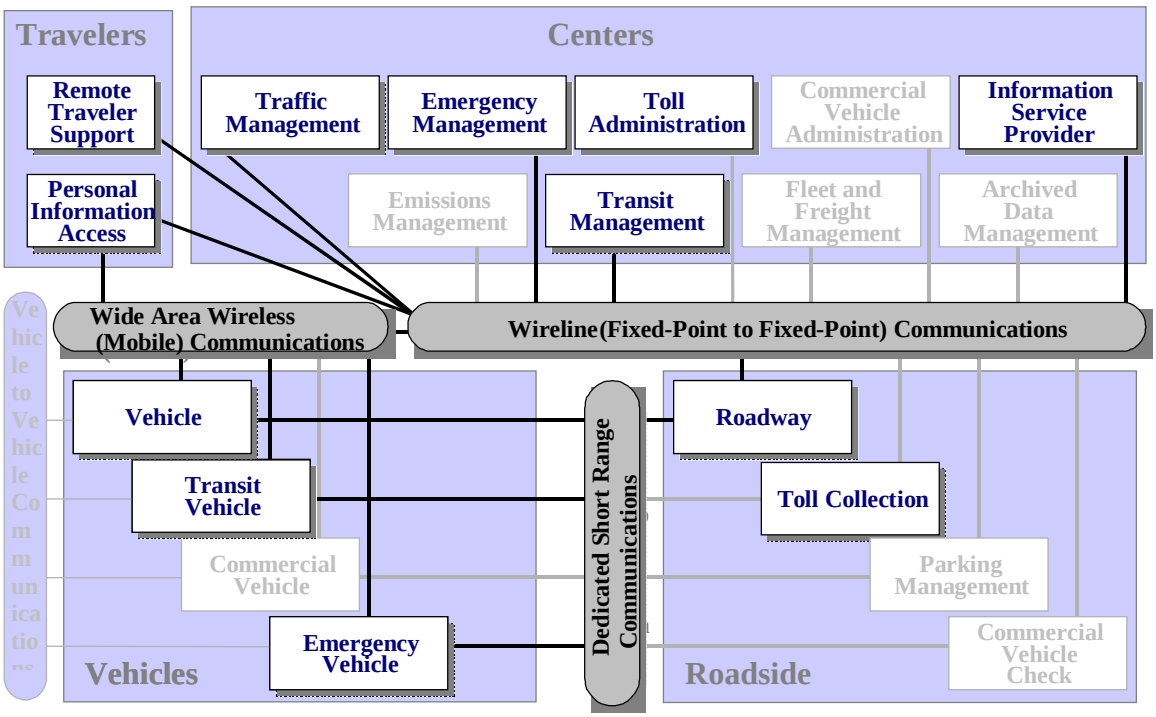


Figure 4.1.2-1. National ITS Architecture Sausage Diagram for Metropolitan ITS Infrastructure

4.2 Market Packages and National ITS Architecture Support of Rural Needs

This section will address Market Package support in version 3.0 of the National ITS Architecture for rural transportation needs. In general, the needs of rural stakeholders are not substantially different from those of urban ones. However, different needs assume different priorities in the rural environment. The geography of rural areas also poses specific deployment challenges due to the variability and the large distances involved. The net of these considerations is that the applicability of the National ITS Architecture in general, and more specifically the Market Packages, warrants specific analysis for the rural case.

4.2.1 Introduction

The FHWA Rural ITS program has gathered information through workshops and individual stakeholder interaction, to better define the needs of rural users. These needs are described in the document "*Rural ITS User Needs*"[1]. The "Rural ITS User Needs" document divides the rural needs into seven categories (called "rural development tracks"). These development tracks are listed below:

- Emergency Services
- Tourism and Travel
- Traffic Management
- Rural Transit and Mobility
- Crash Prevention and Security
- Operations and Maintenance
- Surface Transportation and Weather

Within this section, we will offer a discussion of each rural development track, followed by a table mapping the existing Market Packages to the development track, with an assessment of the applicability of the Market Package to the development track. The following three rating codes are used for this mapping:

● = highly applicable to rural user needs and suitable for the rural environment *(this indicates a strong match between the Market Package and a select set of the rural user needs)*

◗ = applicable to a significant number of rural user needs, may require some augmentation for the rural environment *(this indicates a good match for the Market Package, but it may require modifications to enhance applicability)*

❍ = applicable to rural user needs, but has limitations for the rural environment *(indicates the Market Package partially addresses one or*

[1] Final version dated June 8th, 1999, and provided to the Federal Highway Administration by Science Applications International Corp. This document can be obtained from the FHWA Electronic Document Library (http://www.its.fhwa.dot.gov/cyberdocs/welcome.htm) as document number 10063.

more rural user needs, but may not be appropriate as currently defined for rural application or may not fully address any need)

The way a Market Package is assigned to one of these three classifications in a given rural development track is somewhat subjective, but the following rules were applied:

1. A perfect Market Package mapping to even a small number of rural user needs (example: rural highway-rail intersections) led to selection of the ● class.
2. A Market Package that mapped to a significant percentage of the rural user needs in a development track (more than 10%) would lead to an ● or ◗ classification.
3. If there was a known technological limitation for current implementation of a Market Package in rural areas (example: wide-area interactive communications with vehicles), then the classification mapping was downgraded.
4. Market Packages that are infrastructure intensive were generally downgraded in their classification. This may not be a reasonable approach, since much of ITS is inherently dependent on deployed infrastructure, but it is intended to recognize the sensitivity of many rural areas to the deployment and maintenance costs of field equipment.
5. In general, most Market Packages that received a "❍" classification, and were not subject to issues 3 and 4 above, were simply a weak match to the rural user needs. In these cases, future versions of the National ITS Architecture will include either modifications to the Market Package or a new Market Package that better satisfy the rural user needs.

Following the classification table for the existing Market Packages, is a brief discussion of the main areas in the development track that are either not covered or weakly covered by the National ITS Architecture. These areas are generally either (1) implementation requirements, which are not usually addressed by the National ITS Architecture, (2) elements that will receive enhancement following some additional analysis to fully identify the requirements, or (3) needs that are sufficiently far outside the current scope of the National ITS Architecture to require development of a new User Service. In this last case, the National ITS Architecture will be updated once the consensus User Service development process has defined the new User Service.

Appendix A briefly describes each of the rural development tracks and some of the sub-areas under each track, followed by the Market Package applicability analysis for each track. The descriptive text is drawn directly from the previously cited "Rural ITS User Needs" document.

4.2.2 Summary of the Rural Applicability of Market Packages

Based on the analyses for the seven rural development tracks, there are some generalizations that can be made about the applicability of the existing Market

Packages in a rural context. This section will examine those that are judged consistently applicable for rural deployment. We will also examine Market Packages that are applicable, given that the communications or transportation infrastructure elements are present with sufficient coverage to meaningfully deploy the service.

At this point, it is important to caveat the analysis in this section. This is intended to be a starting point for rural analysis and architecture development. However, the term “rural” covers a tremendously broad spectrum of regions and situations. For every case where a “generalization” that is offered here about Market Package applicability is valid, there will be ten real-world situations where it is not. So, again, use these analyses as a starting point, but realize that ultimately the full set of Market Packages should be examined and that not all "highly applicable" Market Packages may be useful in a given rural situation.

4.2.2.1 The Most Rural-Applicable Market Packages

There are nineteen Market Packages shown in Table 4.2.9.1-1 that should be widely deployable in rural situations and which satisfy significant rural user needs. The classifications of these Market Packages are summarized across the rural development tracks. These tracks are referred to by number; the actual track names are summarized below the table. The Market Packages that appear in this table are the ones that have received a ● ("highly applicable") in one or more rural development tracks.

Not all of these Market Packages in Table 4.2.9.1-1 can be implemented with currently available technology. In these cases, it is expected that in the future, technology will be available to support the desired functionality. “Smart probes”, as an example, are very suitable for rural applications, but there is currently no demonstrable implementation of this technology. Some of the others are technologically feasible, but have implementation issues. “Autonomous route guidance” systems, for example, are relatively commonplace. However, the issue of rural addressing and the ability to provide navigational instructions to rural locations may be an issue for the implementers of these systems.

Table 4.2.9.1-1: Market Packages that are Highly Applicable to the Rural Development Tracks

Market Package	Market Package Name	Rural Development Tracks						
		1	2	3	4	5	6	7
APTS1	Transit Vehicle Tracing		●		●			
APTS2	Transit Fixed-Route Operations		●	●	◗			
APTS3	Demand Response Transit Operations		❍		●	❍		
APTS8	Transit Traveler Information		●	●	●			
ATIS3	Autonomous Route Guidance	●	●	◗	●	●		
ATIS7	Yellow Pages and Reservation	❍	●		❍			
ATIS9	In Vehicle Signing		◗	●		●		❍
ATMS12	Virtual TMC and Smart Probe Data	❍	●			●		
ATMS13	Standard Railroad Grade Crossing					●		

Market Package	Market Package Name	Rural Development Tracks						
		1	2	3	4	5	6	7
ATMS14	Advanced Railroad Grade Crossing					●		
ATMS15	Railroad Operations Coordination					●		
ATMS18	Road Weather Information System					◗		●
AVSS02	Driver Safety Monitoring					●		
AVSS03	Longitudinal Safety Warning					●		
AVSS04	Lateral Safety Warning					●		
AVSS06	Pre-Crash Restraint Deployment					●		
AVSS09	Advanced Vehicle Lateral Control					●		
EM1	Emergency Response	●	◗	◗				
EM3	Mayday Support	●	◗	◗				

Key:

❍ = applicable to rural user needs, but has limitations for the rural environment

◗ = applicable to a significant number of rural user needs, may require some augmentation for the rural environment

● = highly applicable to rural user needs and suitable for the rural environment

Rural Development Tracks:
1. Emergency Services
2. Tourism and Travel
3. Traffic Management
4. Rural Transit and Mobility
5. Crash Prevention and Security
6. Operations and Maintenance
7. Surface Transportation and Weather

The following is a brief explanation of how the Market Packages identified in Table 4.2.9.1-1 address the needs of the broad rural development tacks (RDT).

APTS1 Transit Vehicle Tracking

Tourism and Travel — Allows transit agencies to locate their vehicles in real-time to determine if their buses are on schedule and to ensure that the tourism community is receiving quality service. Also applicable for paratransit vehicles.

Rural Transit and Mobility — Allows transit agencies to locate their vehicles in real-time to determine if their buses are meeting their schedules. This service allows transit agencies to improve their trip reliability by sharing their information with the local information service provider.

APTS2 Transit Fixed-Route Operations

Tourism and Travel — Allows agencies to manage their buses to maintain schedule and to ensure that the tourism community is kept informed.

Traffic Management — Information that is collected will allow agencies to determine if route changes are required for buses to avoid congestion.

Rural Transit and Mobility	Provides transit agencies with the ability to improve schedule adherence. Congestion level information can also be obtained from traffic management agencies and local information service providers.

APTS3 Demand Response Transit Operations

Tourism and Travel	Services that provide driver assignment and vehicle routing for paratransit vehicles (e.g., dial-a-ride) while considering traffic conditions.
Rural Transit and Mobility	Systems that provide automatic scheduling and provide support for dynamic vehicle routing. The transit agency or a local information service provider can provide vehicle routing directions. System also aids in schedule and route adherence.
Crash Prevention and Security	Allow transit agencies to receive traffic information (e.g., congestion levels, accidents) to allow them to make route changes to mitigate the potential for secondary incidents.

APTS8 Transit Traveler Information

Tourism and Travel	Systems that provide custom transit trip itineraries and other tailored transit information services that can be used by the tourism community. System also allows for real-time schedule displays at transit stops.
Traffic Management	Systems that provide custom transit trip itineraries and other tailored transit information services that will reduce VMT (emissions).
Rural Transit and Mobility	Systems that provide real-time information about estimated time of arrival and real-time arrivals and departures at transit stops or on-board transit vehicles. Also the ability to exchange information between the transit agency and the local information service provider.

ATIS3 Autonomous Route Guidance

Emergency Services	Provides en-route navigation services information to emergency vehicle drivers (based on static, stored information in the vehicle). Medical facility and shelter information is not explicitly supported. Functionality to determine vehicle position must exist within the vehicle.
Tourism and Travel	Systems that provide route guidance (based on static, stored information) to tourists that may be unfamiliar with the area. Travelers can obtain information through

	equipment located in their vehicles or through portable devices.
Traffic Management	Systems that provide en-route directions to drivers (based on static, stored information) that can be used to find alternate routes if a congested area is encountered.
Rural Transit and Mobility	Systems that provide en-route directions to transit drivers (based on static, stored information) that can be used to find rural locations or determine alternate routes.
Crash Prevention and Security	Systems that provide route guidance based warnings to drivers (using static, stored information) about roadway hazards such as geometry. Can reduce driver uncertainty as an accident risk. Can be used to find alternate routes if a congested area is encountered and thereby reduce secondary accidents.

ATIS7 Yellow Pages and Reservation

Emergency Services	Systems that provide en-route advisory and facility availability information to emergency vehicle drivers. However, hospital, medical, and shelter availability information not explicitly supported.
Tourism and Travel	Systems that provide information to the tourism community regarding the available traveler services within an area (e.g., service stations and restaurants). Information about and guidance to emergency shelters are not explicitly supported.
Rural Transit and Mobility	Systems that support multi-modal trip planning and reservations.

ATIS9 In-Vehicle Signing

Tourism and Travel	Systems that provide traffic advisories to travelers using in-vehicle devices.
Traffic Management	Provide drivers with dynamic and static warnings and control information from roadside beacons.
Crash Prevention and Security	Provide in vehicle warnings to motorist regarding roadway geometrics or other hazards that affect driving safety. Also provides drivers with congestion, weather related information, and approaching train advisories at rail-roadway intersections.
Surface Transportation	Systems that provide weather warning and terrain hazard

and Weather	advisories to motorists who have in-vehicle devices.

ATMS12 Virtual TMC and Smart Probe Data

Emergency Services	Futuristic option for low-infrastructure areas. Emergency fleet vehicles could be the first smart probes that are capable of measuring road conditions and providing this information to the roadway equipment for relay to the traffic management center.
Tourism and Travel	Futuristic option for low-infrastructure areas. Traveler vehicles acting as smart probes can relay road conditions to the traffic management personnel.
Crash Prevention and Security	Allows the use of vehicles to gather data and in-vehicle signing is used to inform drivers of detected road conditions.

ATMS13 Standard Railroad Grade Crossing

Crash Prevention and Security	Systems that manage highway rail intersections by warning vehicle operators of train proximity and providing traffic control through barriers to prevent vehicle from entering rail/roadway to prevent accidents from occurring. Data from the intersection is shared with the local traffic management agency.

ATMS14 Advanced Railroad Grade Crossing

Crash Prevention and Security	Systems that manage highway rail intersections by warning vehicle operators of train proximity and providing traffic control through barriers to prevent vehicle from entering rail/roadway to prevent accidents from occurring. System provides additional safety features to mitigate the risk associated with higher rail speeds. Data from the intersection is shared with the local traffic management agency.

ATMS15 Railroad Operations Coordination

Crash Prevention and Security	Provides strategic coordination between rail operations and traffic management centers to enhance the quality of traveler information.

ATMS18 Road Weather Information System

Crash Prevention and Security	Systems that support the forecasting of road conditions based on environmental factors (e.g., X inches of rain on this slope produces a given probability of mudslides.) System includes elements to monitor and detect weather conditions that affect driver safety.

Surface Transportation and Weather	Systems that monitors current and forecast road and weather conditions using a combination of weather service information and data collected from environmental sensors deployed on and about the roadway. Provides information regarding surface conditions that can affect travel conditions.

AVSS02 Driver Safety Monitoring

Crash Prevention and Security	Systems that will monitor a driver's condition and performance. Based on the information obtained, the system will warn the driver of potential dangers.

AVSS03 Longitudinal Safety Warning

Crash Prevention and Security	System designed to alert drivers of potential hazard (e.g., vehicles, pedestrians, obstacles in road, etc.) situations based on on-board sensors to monitor the areas in front of and behind the vehicle.

AVSS04 Lateral Safety Warning

Crash Prevention and Security	System designed to present warnings to the driver about potential hazards based on on-board sensors to monitor the areas to the sides of the vehicle.

AVSS06 Pre-Crash Restraint Deployment

Crash Prevention and Security	System that uses on-board sensors to detect an impending collision and deploy a pre-crash safety system.

AVSS09 Advanced Vehicle Lateral Control

Crash Prevention and Security	System uses on-board sensors to monitor the areas to the sides of the vehicle and then uses automates the steering control to avoid an unsafe condition. Specifically would address "run off road" crashes.

EM1 Emergency Response

Emergency Services	Systems that determine the location of emergency vehicles to enable safe and rapid deployment of appropriate resources to an emergency.
Tourism and Travel	Provides for improved incident response times to aid travelers and tourists in distress.
Traffic Management	Allows the coordination among emergency services agencies and traffic management, to provide incident status and severity information.

EM3 Mayday Support

Emergency Services	Allows the user of the system (driver or non-driver) to initiate a request for emergency assistance and enables the emergency management center to locate the user and determine the appropriate response.
Tourism and Travel	Provides the ability to automatically transmit Mayday information from traveler personal device or vehicle. For vehicle crashes, can include vehicle location and extent of crash damage.
Traffic Management	Allows agencies to automatically know the location of a vehicle calling in an incident, as travelers/users don't always know where they are. This type of service will further be enhanced as efforts in the E911 community continue.

It is expected that many of the Market Packages in Table 4.2.9.1-1 will receive additions or modification in future National ITS Architecture releases, to increase their suitability for rural application. For example, "Yellow Pages and Reservation" provides an excellent match for many needs in the "Tourism and Travel" development track. However, this same market package currently has weak support for information about trauma centers or shelters for disaster situations. Improving this coverage will also substantially improve this Market Package's applicability for the "Emergency Services" development track.

Based on the Market Packages that are deemed most rural-applicable, it is possible to construct an architecture sausage diagram that highlights both the types of communications and the subsystems that are involved in these Market packages. This is shown in Figure 4.2.9.1-1. This should not be construed as the "rural architecture"; rather, it highlights the subsystems and communications links that are most likely to be a part of near-term rural deployments. However, all of the National ITS Architecture subsystems will invariably show up in some (possibly specialized) contexts.

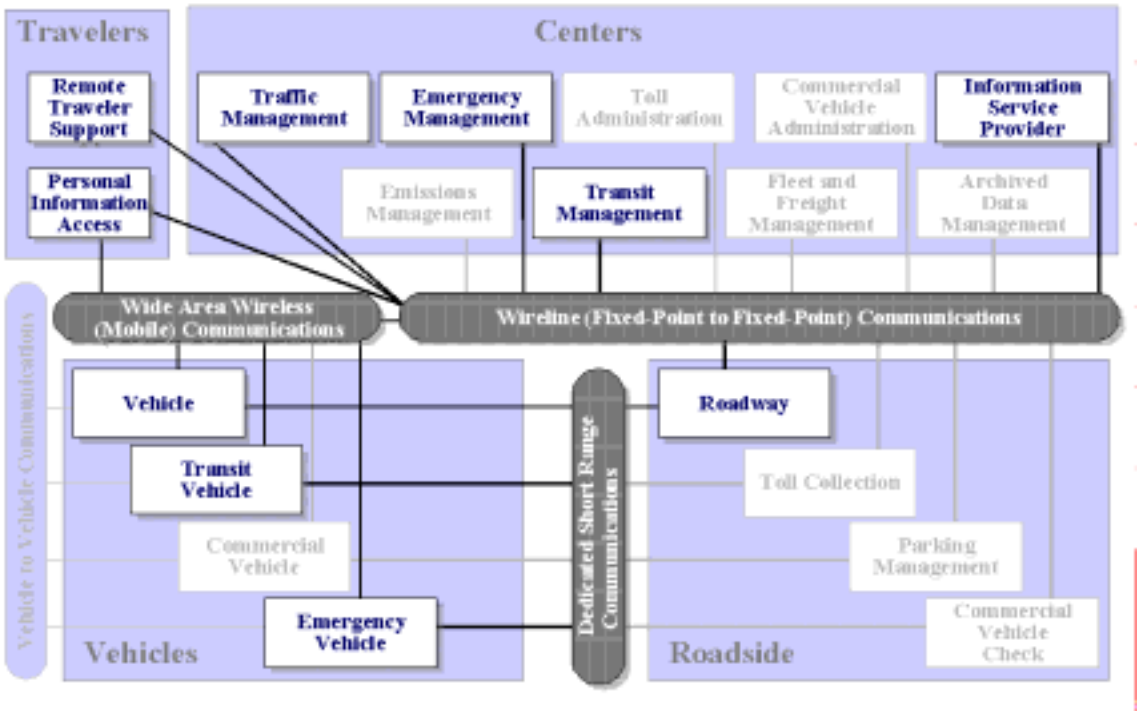


Figure 4.2.9.1-1: National ITS Architecture Sausage Diagram for the Rural User Needs

4.2.2.2 Market Packages with Communications or Infrastructure Implications for Rural Deployments

There are a few Market Packages that map very well functionally the rural user needs, but that are predicated on significant communications (particularly wireless to vehicles) or a significant infrastructure base (particularly sensors) to operate as described. In many rural contexts these issues will not be a problem, and these Market Packages can be considered to be in the same category as the highly applicable Market Packages described in the previous section. But in some rural situations, the required communications or infrastructure may be unaffordable or even undeployable due to terrain, weather, or other considerations. For this reason, these Market Packages are presented here.

Table 4.2.9.2-1 shows six Market Packages that potential communications or infrastructure requirements issues for rural deployments. All of these Market Packages represent fundamental ITS capabilities, so even limited scale applicability in a given rural situation may still justify deployment. Hopefully the widespread deployment of ITS products, coupled with the proliferation of communications options, will bring down costs and increase the availability of the necessary elements to allow universal deployment of these services.

Table 4.2.9.2.-1: Market Packages with Significant Communications or Infrastructure Requirements that apply to the Rural Development Tracks

Market Package	Market Package Name	Issue for Rural
ATIS1	Broadcast Traveler Information	Broadcast wireless communication (e.g. FM subcarrier data)
ATIS2	Interactive Traveler Information	Interactive wireless communications (e.g. AMPS, PDA, or satellite)
ATMS01	Network Surveillance	Surveillance detector devices and communications to a central system for network-wide traffic measurements
ATMS02	Probe Surveillance	Tag reader infrastructure (and sufficient vehicle traffic with toll or other electronic tags) or, alternatively, interactive wireless communications
ATMS06	Traffic Information Dissemination	Dynamic Message Sign and/or Highway Advisory Radio systems
ATMS08	Incident Management System	Communications to disseminate incident information to travelers and for interagency coordination

4.2.3 Rural Market Packages: Status and Next Steps

This section has presented the results of correlating an in-depth study on the needs of rural users with the Market Packages in version 3.0 of the National ITS Architecture. This establishes a baseline for the National ITS Architecture support of rural users. Since “rural” is not a well-defined term, the validity of this analysis will vary with the specific situation. But the analyses in this section should provide a starting point for rural users looking to apply the National ITS Architecture in their regions.

Of the 63 Market Packages in version 3.0 of the National ITS Architecture, 49 apply at least to some degree to addressing the rural user needs. Nineteen of these 49 Market Packages were evaluated to be very appropriate for general rural application. Many of the remainder will be highly appropriate for specific situations.

Subsequent to version 3.0, the National ITS Architecture will be enhanced to improve coverage of the rural user needs. This will include everything from minor updates of the definitions of data exchanges to the incorporation of complete, new user services. This activity is important, as it will then help drive standards activities and regional architectures, both critical aspects of maximizing the benefits from each ITS dollar invested.

4.3 Commercial Vehicle Information Systems and Networks (CVISN)

The CVISN program is intended to develop a means for existing commercial vehicle operations information systems to electronically exchange information through the use of standards and commercially available communications infrastructure. It is intended to include information systems owned and operated by state and local governments. States participating in the CVISN program strive

to make advancements in three areas of business that primarily involve the exchange of information:

- Electronic Screening of Truck Traffic
- Roadside Safety Assurance
- Electronic Credentialing

The CVISN Deployment Strategy is divided into four major steps. The first step was to develop the management plans and technical architecture frameworks necessary to coordinate the subsequent phases. Phase 1 is complete. Phase 2 is to prototype the technology in a live environment, using the states of Maryland and Virginia, to demonstrate the operational concepts. This phase is currently in progress. Phase 3 is to "pilot" the approach developed during the prototype phase in a select number of states. A national evaluation of this phase will be conducted and will serve as key input into the eventual nationwide deployment of the program. This phase is also in progress. Phase 4 of the CVISN program allows for full deployment of CVISN to all interested states.

4.3.1 CVISN Infrastructure

The CVISN Core infrastructure is a selected group of key commercial vehicle operations (CVO) information systems that provide a mechanism for exchange of safety information, registration, fuel tax, HAZMAT, and commercial driver license information among states. The CVISN Core Infrastructure consists of several information systems that support multiple states.

Some elements of the CVISN Core Infrastructure are authoritative sources of information. For example, the Motor Carrier Management Information System (MCMIS) holds safety records for all interstate carriers. Other CVISN Core Infrastructure elements route queries to authoritative sources. For example, the Commercial Drivers License Information System (CDLIS) routes commercial driver license queries to the appropriate state(s). The Safety and Fitness Electronic Record (SAFER) system is an example of an indirect source that maintains copies of selected data from authoritative sources. SAFER packages safety and credentials information for quick access by a variety of users. The information is provided to SAFER by the authoritative sources proactively upon change or interactively upon request. The clearinghouses (International Registration Program (IRP), International Fuel Tax Agreement (IFTA), Oversize/Overweight (OS/OW), and Hazardous Materials (HAZMAT) will support the information exchange associated with financial reconciliation for multi-state credentials. So, the CVISN Core Infrastructure provides directories for routing queries and can provide a repository (database) of, pointer to, or indirect sources for commonly required information.

4.3.2 Relating CVISN to the National ITS Architecture and Market Packages

This section provides a direct technical mapping between the elements defined by CVISN Infrastructure and the equivalent elements defined by the National ITS Architecture. The CVISN Architecture consists of the ITS/CVO information systems portion of the National ITS Architecture along with additional operational detail necessary to facilitate information (safety, credentials, and screening) exchange between carriers and public sector agencies responsible for commercial vehicle administration.

The ITS/CVO element includes the ITS technologies which uniquely support Commercial Vehicle Operations (CVO). The scope of CVO in the National ITS Architecture includes the operations associated with moving goods and passengers via commercial vehicles over the North American highway system and the activities necessary to regulate these operations. It includes activities related to safety assurance, commercial vehicle credentials and tax administration, roadside operations, freight & fleet management, and vehicle operation.

National ITS Architecture consists of four Subsystems unique to CVO as follows:

- Commercial Vehicle Administration
- Commercial Vehicle Check
- Fleet and Freight Management
- Commercial Vehicle.

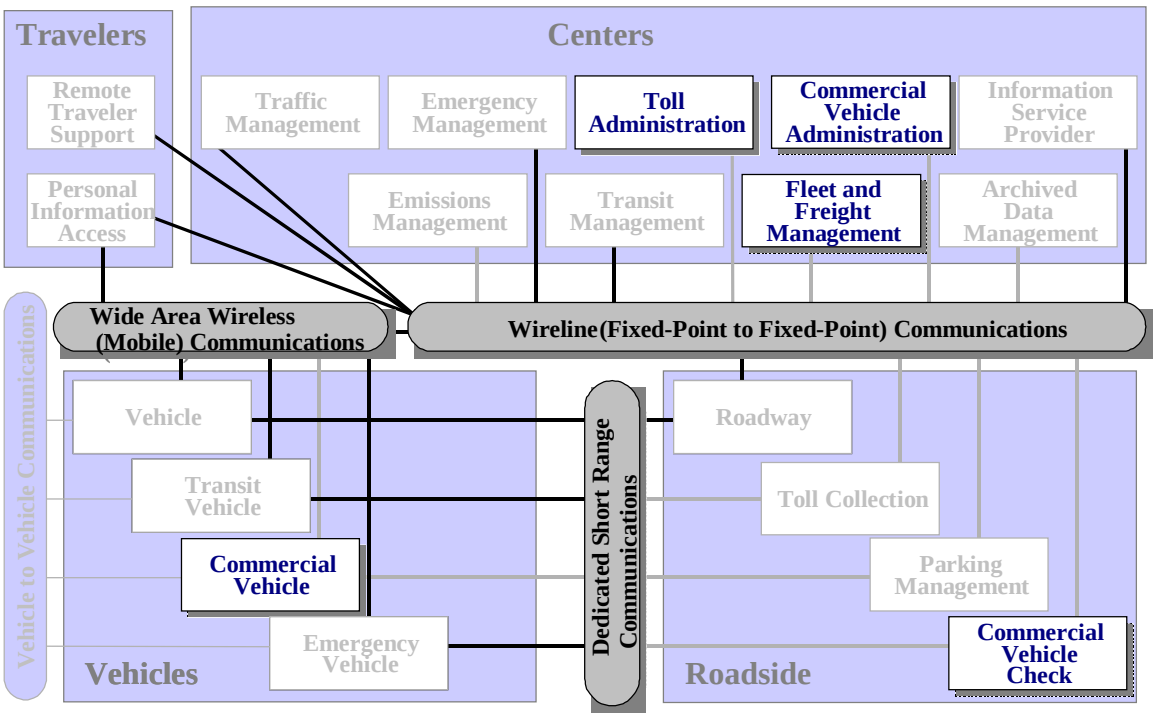


Figure 4.3.2-1 National ITS Architecture Sausage Diagram for CVISN

The CVISN Architecture also identifies the National ITS Architecture Subsystem capabilities, or Equipment Packages that support the goals of the program. Figure 4.3.2-2 shows the Equipment Packages in the four subsystems noted above that are supported by the National ITS Architecture. All Equipment Packages except the four that are shaded are also included in CVISN.

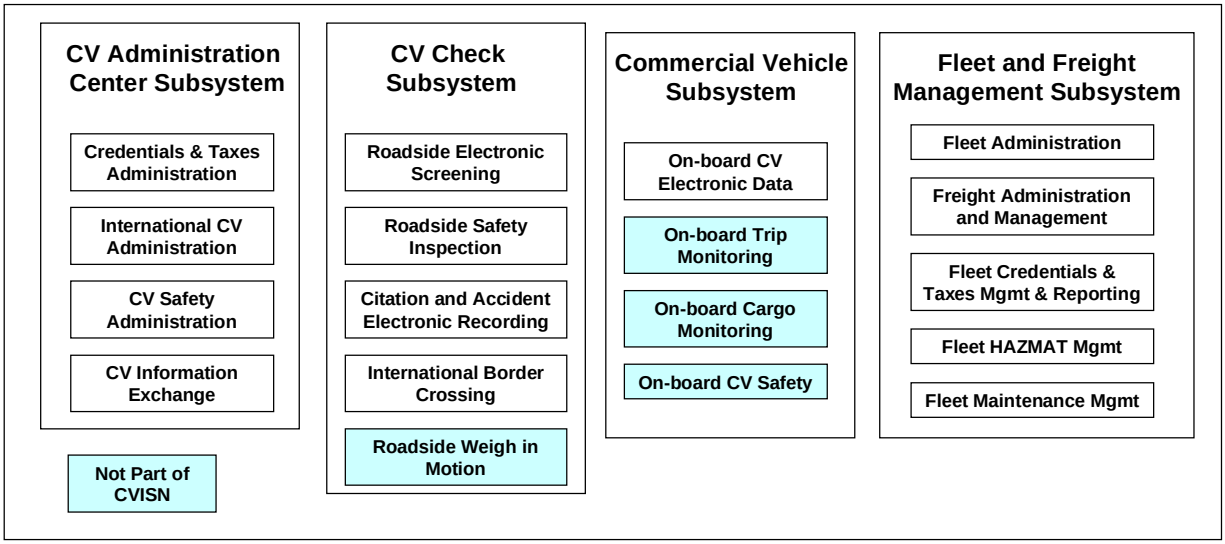


Figure 4.3.2-2 National ITS Architecture CVO Equipment Packages Participating in CVISN

Based on the CVISN emphasis areas and the applicable Equipment Packages identified above, the following National ITS Architecture Market Packages most closely support the goals of CVISN.

- Electronic Clearance
- CV Administrative Processes
- International Border Electronic Clearance
- Roadside CVO Safety

5 Market Package Analysis

The Market Packages that are defined in section 2 are inter-related and are also dependent on external factors such as technology advancement, policy change, and development of common interface standards. Moreover, each Market Package provides different benefits, lends itself to different cost recovery mechanisms, and is subject to different levels of market influence. It is through the interplay of these influences that ITS deployments will occur over time. This chapter provides some insight into these influences by analyzing and evaluating the Market Packages from these different perspectives.

The Market Packages were the basic unit of analysis for the various institutional, performance, benefits, cost, and risk analyses that were performed as part of the National ITS Architecture development effort. These analyses are documented in the Implementation Strategy document. As identified in figure 5-1, a subset of this analysis, updated to reflect recent ITS activities and the current set of Market Packages, is made available in this Chapter. The original Architecture documentation may be consulted for more information on the analyses that have not been updated and included in this section.

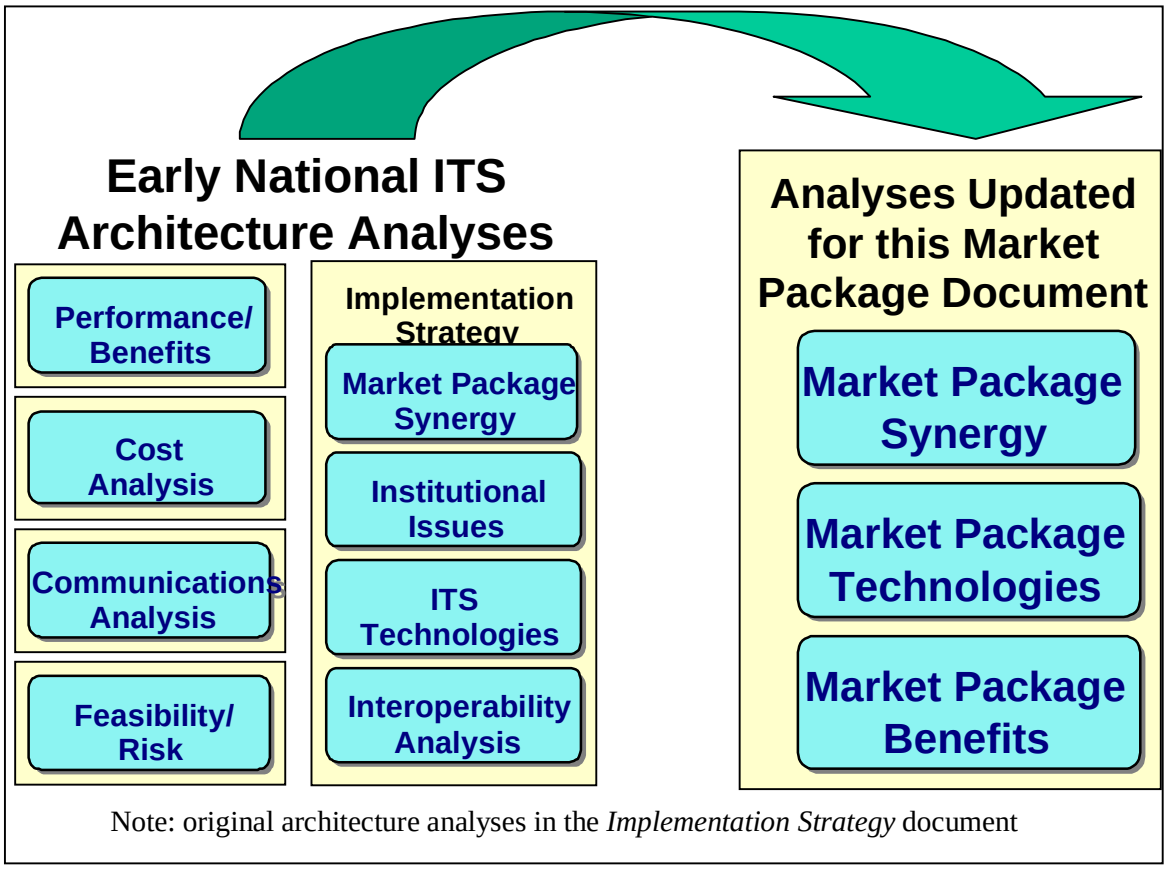


Figure 5-1: Factors Affecting Market Package Deployment

5.1 Market Package Synergy

One of the unique attributes of the National ITS Architecture is the breadth of ITS services that it covers. This scope allows each potential service to be considered in context with all other ITS services, identifying common features and shared functionality. Questions such as: "Once I implement electronic toll collection in my region, what other services can I implement by extending the beacon infrastructure?" and "What sorts of efficiencies are possible when advanced traveler information and traffic management systems are implemented in the same region?" are readily answered through the National Architecture. These inter-relationships, or synergies, are presented for each of the defined Market Packages in this section.

Consideration for these Market Package synergies can result in more efficient deployment of ITS services over time. The Architecture can only identify the potential synergies. Developing an integration strategy that capitalizes on these efficiencies is the responsibility of the local transportation planners and.

Synergies have been identified and analyzed for each Equipment Package and then aggregated and presented in this section at the Market Package level. A large number of synergies can be derived from the Architecture definition by examining the Equipment Packages and Architecture Flows that are shared between Market Packages. Only the most significant synergies are brought forward and discussed in this section.

Several different types of synergies have been identified, from most restrictive to least restrictive as follows.

> Interdependent: Interdependent Equipment Packages are the most closely coupled. Two Equipment Packages are interdependent if both must be deployed to achieve an ITS service. If interdependent Equipment Packages are not deployed at the same time in the same region, the resulting service will be marginal or non-existent. All interdependent Equipment Packages have been allocated to the same Market Package to reflect this required association. Since interdependent Equipment Packages are not allocated to different Market Packages, there are no interdependent relationships between Market Packages.
>
> Common Functions: Equipment Packages which reside in the same subsystem can share common functions to more efficiently implement the required services. This type of synergy reflects the potential sharing of hardware and/or software to perform a function that is required by both Equipment Packages. The shared functions are included in only one of the Equipment Packages and synergy is noted between the Equipment Package which includes the common equipment and the remaining

Equipment Package(s) which utilize it. Many Equipment Packages rely on equipment included in more basic Equipment Packages to support more advanced capabilities. Such "incremental" Equipment Packages allow efficient deployment over time by building on existing equipment capabilities. In other cases, Equipment Packages that share functionality are of the same relative sophistication. In such cases, the dependent Equipment Packages may be implemented in either order based on the needs (and preferences) of the end user. The common equipment is purchased with the first Equipment Package to be deployed.

Shared Information: Some Equipment Packages rely on information provided by a Equipment Package in a separate subsystem. In many cases, if the Equipment Package which supplies the information is not deployed, the Equipment Package which relies on the information will still provide degraded capabilities but not satisfy all user service requirements allocated to it. Typically, this “shared information” synergy reflects information that is shared between an information collection/provider Equipment Package in the infrastructure and an information user Equipment Package which is part of a second infrastructure subsystem or a mobile subsystem.

Complementary: Even when Equipment Packages may be independently deployed and operated to achieve the required user services (i.e., the Equipment Packages are not part of the same Market Package, do not share equipment, and are not required to share information), there may still be synergy between the provided services which should be considered in an implementation strategy. Complementary Equipment Packages provide compatible services which, taken together, enhance net system performance. In most cases, this relationship reflects the sharing of optional information between Equipment Packages within the Architecture definition. In such cases, the information generated by one Equipment Package, if available, enhances the service provided by a second Equipment Package. In contrast, a shared information dependency, if not satisfied, prevents the associated Equipment Packages from meeting all of the user service requirements.

A series of five diagrams and accompanying discussion describe the principal synergies identified for the Market Packages. In each diagram, the connections represent the synergies between the Market Packages. Tracing the diagrams along the flows provides various efficient deployment sequences that leverage the incremental nature of the Market Packages.

The connections are coded to represent the types of synergies between Market Packages. When Market Packages are related in more than one way, the most restrictive dependency type is shown. (e.g., If two Market Packages share common functions and share information, the flow connecting the two Market

Packages would reflect a "Common Functions" synergy.). Note that the "Interdependent" relationship is not represented in the figure since this synergy exists only between Equipment Packages within the same Market Package.

Each of the diagrams illustrate the Market Package synergies for a particular stakeholder area (e.g., Traffic Management, Traveler Information, etc.) Often, synergies will cross stakeholder boundaries (e.g., Traveler Information Market Packages are often reliant on information from Traffic Management Market Packages). These synergies are documented by “off-page references” which indicate the stakeholder area in an oval along with the associated Market Package. The diagrams also identify Market Packages containing "enabling" functions. Implementing these Market Packages allow more advanced capabilities to be selectively implemented over time to meet local needs. The text accompanying each diagram briefly describes, and justifies, the major synergies.

5.1.1 Advanced Traffic Management Systems Market Package Synergy

The most significant common feature of the Traffic Management Market Packages is the shared need for traffic information. Each of these packages are supported by the basic surveillance infrastructure that is implemented through the two surveillance Market Packages. The information provided by this equipment (e.g., traffic counts and speeds) can be used for many purposes, including control and management of the traffic signals, incident management, emissions management, and traveler information. The surveillance data can also be saved as historical data for planning purposes or for evaluating the effectiveness of previous system enhancements. Each of the synergies that have been identified between the Traffic Management Market Packages in Figure 5.1-1are elaborated in the following descriptions.

Network Surveillance Market Package

> This Market Package implements the basic roadside sensors, controllers, and communications infrastructure equipment which is leveraged by most of the other ATMS Market Packages. In addition to providing the information necessary to support more advanced traffic management implementations, this package also shares traffic information with the ATIS Market Packages.

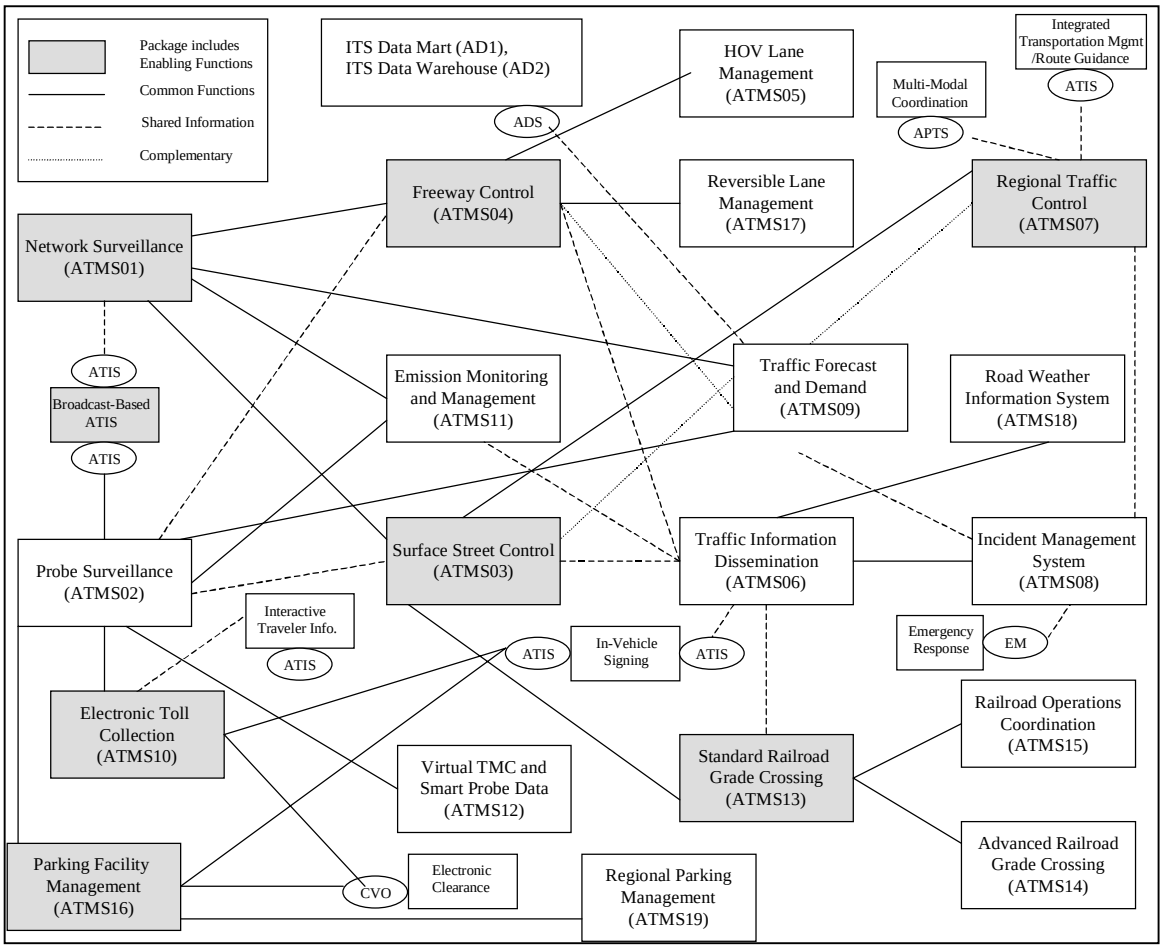


Figure 5.1-1. Advanced Traffic Management Systems Market Package Synergies.

Probe Surveillance Market Package

This Market Package provides an alternative approach to surveillance that provides many of the same fundamental benefits as the network surveillance Market Package. The dependency to the Surface Street and Freeway control Market Packages is denoted as data sharing since this package does not require implementation of the extensive distributed roadside infrastructure that may be directly utilized by the other ATMS packages. Dedicated Short Range Communications and AVI technologies may be shared between this package and the Dynamic Toll/Parking Management package. The Virtual TMC and Smart Probe Data Market Package adds additional “smart probe” capabilities such as road condition monitoring to the basic probe capabilities offered by this package.

Electronic Toll Collection Market Package

This Market Package shares common functionality with the Electronic Clearance, In-Vehicle Signing, and Probe Surveillance Market Packages. Each of these Market Packages are additional potential applications for the dedicated short range communications, AVI, and rudimentary driver interface capabilities offered by this Electronic Toll Market Package.

Freeway Control Market Package

The infrastructure implemented to support this Market Package facilitates implementation of the HOV and Reversible Lane Management Market Package. HOV management should be able to utilize much of the same wireline communications, surveillance, and control infrastructure provided by this Market Package. Several more advanced traffic management Market Packages build on the fundamental infrastructure and control strategies supported by this package by increasing the level of coordination and/or increasing the sophistication of the control strategies.

Surface Street Control Market Package

This Market Package provides a basic surface street control building block, analogous to the Freeway Control Market Package above. The highway-highway intersection management capabilities provided by this Market Package are closely related to the highway-rail intersection capabilities provided by the Market Packages that support grade crossings.

Standard Railroad Grade Crossing Market Package

This Market Package manages traffic at highway-rail intersections using equipment that has potential commonality with equipment used for surface street control. The active warning systems and ancillary supporting equipment included in this Market Package provide the basic equipment that is augmented with additional features in the Advanced Railroad Grade Crossing Market Package. In the same way, the basic communications between Traffic Management and Rail Operations that is established in this Market Package is expanded and leveraged in the Rail Operations Coordination Market Package. The basic intersection status provided to the driver by this Market Package may be expanded and also provided through the Traffic Information Dissemination Market Package (e.g., variable message sign displays) and the In-Vehicle Signing Market Package. The communication of intersection status to the vehicle provided by the In-Vehicle Signing Market Package can be further extended and applied to intersection safety warning and intersection collision avoidance as will be seen in the analysis of the ATIS and AVSS Market Packages.

Advanced Railroad Grade Crossing Market Package

This Market Package adds additional surveillance, physical barriers, and enhanced driver information systems to the core equipment included in the Standard Railroad Grade Crossing. The surveillance capabilities can enable real-time detection and reporting of collisions which can speed Emergency Response.

Railroad Operations Coordination Market Package

This Market Package provides additional coordination between railroad operations and traffic operations by building on the same interface established for the Railroad Grade Crossing Market Packages. This Market Package provides area-wide, accurate forecasts of grade crossing closures that can be factored into regional control strategies provided by the Regional Traffic Control Market Package.

Emissions Monitoring and Management

This Market Package provides emissions information to the Traffic Information Dissemination Market Package. It may be interconnected with the basic surveillance infrastructure deployed at the roadside for cost-effective implementation.

Traffic Information Dissemination Market Package

This Market Package provides basic roadside information dissemination infrastructure that is applicable to a wide variety of traffic management Market Packages. The basic infrastructure which provides an information dissemination interface located at the roadside which is controlled by the traffic management subsystem may be extended to provide in-vehicle signing capabilities in more advanced applications.

Incident Management System Market Package

This Market Package utilizes the traffic information dissemination and traffic control capabilities deployed through other Market Packages to adapt traveler information and traffic control strategies to account for incidents. The communications infrastructure and working relationships established to support Incident Management can also be used to support the coordination required for the regional traffic control Market Package. This Market Package shares information with the Emergency Response Market Package to enable coordination between traffic management and emergency management subsystems in incidents and other emergencies impacting traffic management strategies.

Regional Traffic Control Market Package

This Market Package enhances the coordination between traffic management systems within a region. It directly leverages the existing traffic control systems (freeway and arterial) already implemented in the region through improved coordination between traffic management systems in the region. It also benefits from the same coordination between agencies within the region that is established in the Incident Management System Market Package. The regional scope of this Market Package provides the opportunity to fully realize the benefits of enhanced coordination with the transit systems and railroads operating in the region.

HOV Lane Management

This Market Package utilizes freeway lane use monitoring and freeway output control processes included in the Freeway Management Market Package.

Traffic Forecast and Demand Management

This Market Package utilizes the traffic statistics generated by the Surface Street Control and Freeway Control Market Packages to estimate future system use and, if necessary, initiate travel demand strategies.

Virtual TMC and Smart Probe Data

This Market Packages utilizes probe beacon infrastructure, deployed for traffic surveillance purposes, to collect road condition information from vehicles and to disseminate the information to passing vehicles.

Parking Facility Management

This Market Package utilizes the vehicle and infrastructure equipment included in the Probe Surveillance Market Package to monitor parking facility utilization and support electronic parking payment. The information generated by this Market Package could then be made available to vehicles via the In Vehicle Signing Market Package.

Reversible Lane Management

This Market Package utilizes freeway lane use monitoring and freeway output control processes included in the Freeway Management Market Package.

Road Weather Information System

This Market Package adds weather information to the traffic information provided by a TMC to the ISP in the Traffic Information Dissemination Market Package.

Regional Parking Management

This Market Package allows coordinates multiple instances of the Parking Facility Management Market Package.

5.1.2 Advanced Traveler Information Systems Market Package Synergy

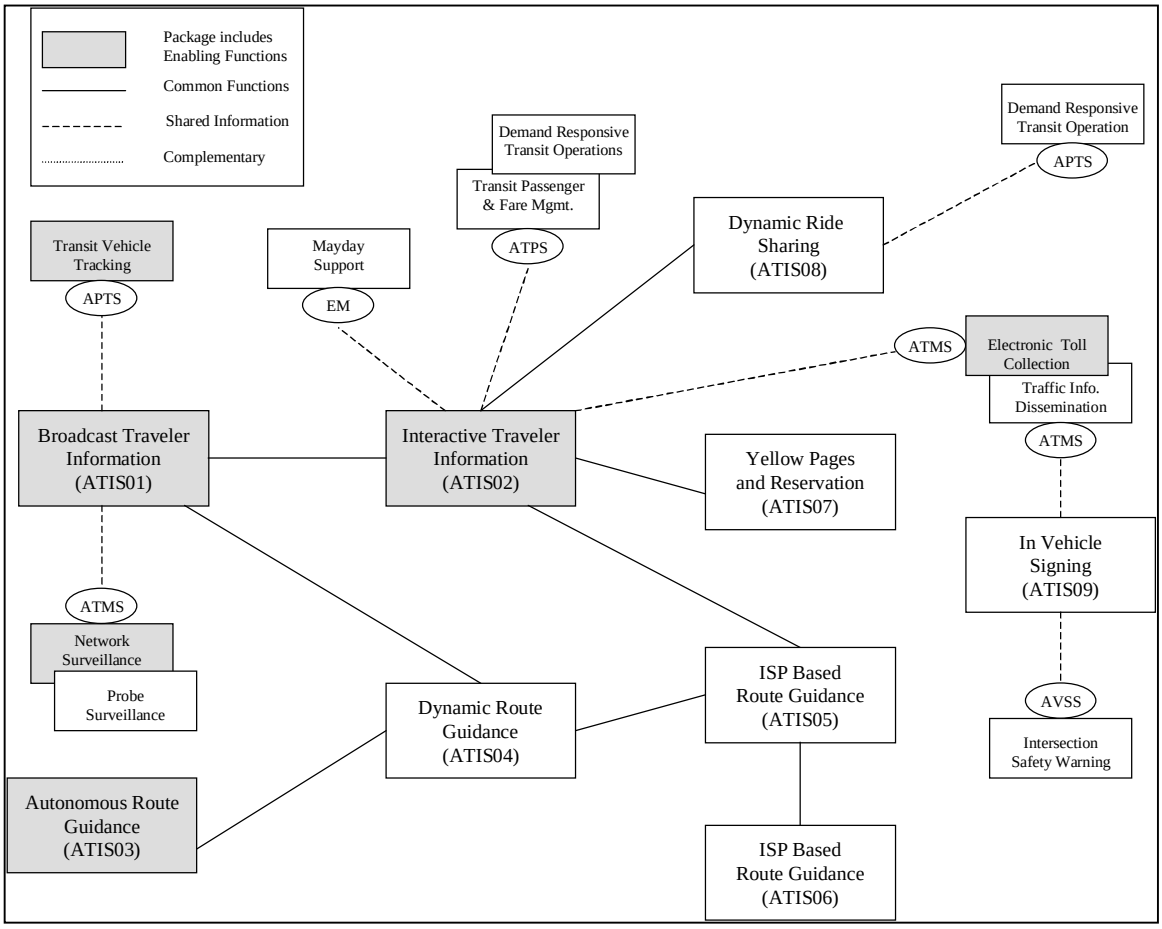


Figure 5.1-2. Advanced Traveler Information Services Market Package Synergies.

Broadcast Traveler Information Market Package

This Market Package shares many of the basic transportation data collection and management functions with more advanced interactive traveler information packages. This Market Package and its interactive counterparts each collect traffic, transit and other traveler information for processing and disseminating. In addition to providing advisories and other basic traffic information, this Market Package can be extended to provide real-time traffic information in a format supporting dynamic route guidance.

Interactive Traveler Information Market Package

This Market Package shares the basic traveler information collection and management and interactive communications capabilities with more advanced or specialized traveler information Market Packages. The basic interactive traveler information service can be extended to support centralized route planning services offered by the ISP-Based Route Guidance Market Package. The interactive capabilities of this Market Package allow it to better use information provided by the Transit Passenger and Fare Management and the Dynamic Toll/Parking Fee Management Market Packages for transit, toll, and parking fees and transit schedules and parking occupancy and reservation.

Autonomous Route Guidance Market Package

This Market Package provides a rich set of in-vehicle functions that can be utilized by enhanced route guidance services that require interaction with the infrastructure. Each of the more advanced route guidance Market Packages provide successive enhancements to the infrastructures role in supporting the autonomous vehicle equipment included in this Market Package.

In-Vehicle Signing Market Package

This Market Package communicates between the vehicle and roadside using the same dedicated short-range communications used by the Dynamic Toll/Parking Fee Management Market Package. The infrastructure in the Traffic Information Dissemination Market Package which provides dynamic driver advisories to roadside variable message signs may be extended to support provision of information to the vehicle for in-vehicle display. The communications of road status to the vehicle for in-vehicle display provides a incremental step towards more advanced intersection safety warning and collision avoidance implementations.

5.1.3 Advanced Public Transit Systems Market Package Synergy

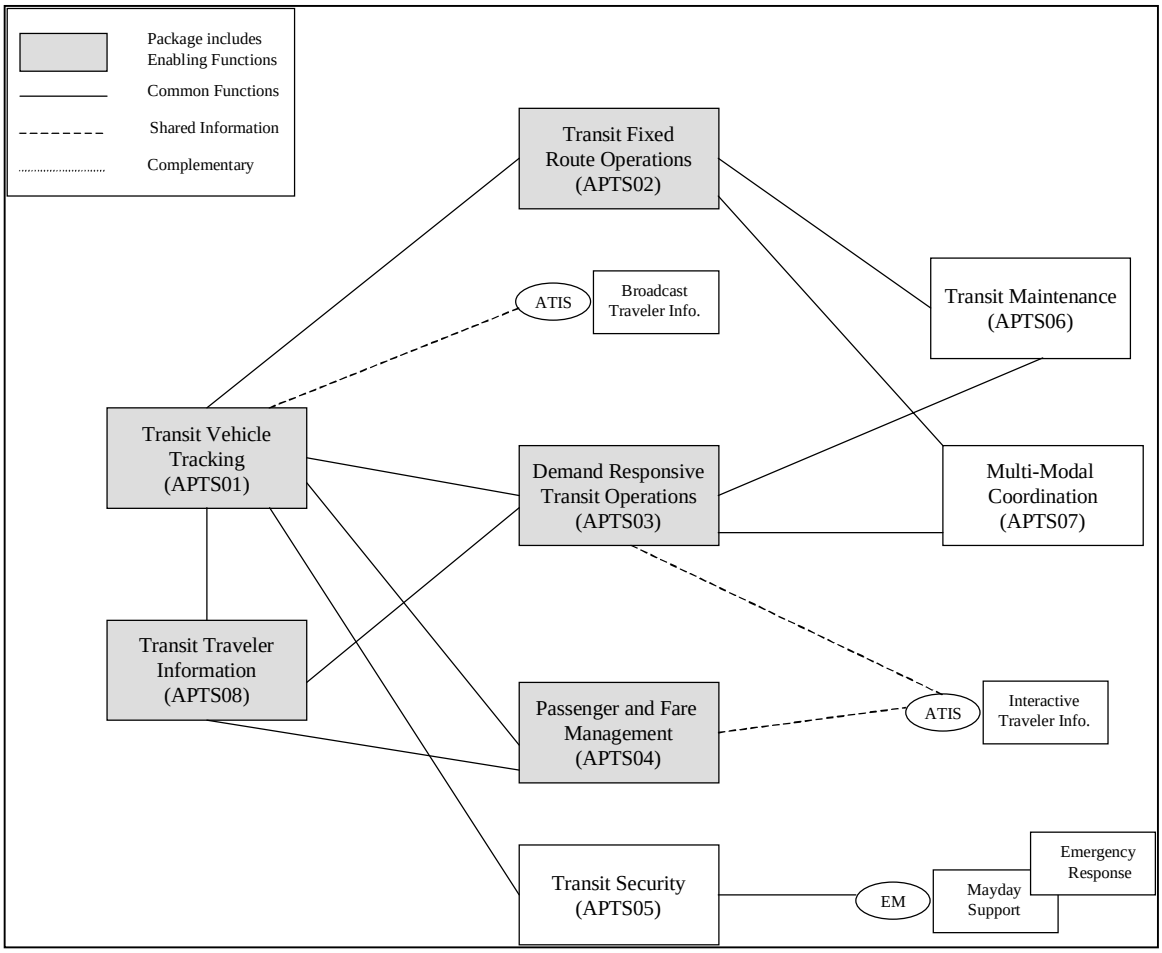


Figure 5.1-3. Advanced Public Transit Systems Market Package Synergies.

Transit Vehicle Tracking Market Package

This Market Package provides a fundamental vehicle location service that is required by many of the other APTS related Market Packages since accurate and current knowledge of transit vehicle position is key to many other services. The automated vehicle location and tracking capability provided by this Market Package is necessary to support the advanced operations packages, passenger and fare management, and transit security. Current transit schedule information, derived through this package, also supports the traveler information Market Packages.

Transit Fixed Route and Demand Response Transit Operations Market Packages

These two Market Packages support operations and dispatch and provide key database management functions which are utilized to support more specialized Transit Maintenance and Multi-Modal Coordination Market Packages. The Demand Response Transit service is only well supported by the more advanced interactive traveler information services which enable a convenient, real-time request/response interface to travelers seeking transit.

Transit Security Market Package

This Market Package shares emergency notification and status information with the Emergency Response Market Package. It provides many of the same safety features that are provided by the Mayday Support Market Package which is oriented towards individual subscribers rather than a transit provider.

Passenger and Fare Management Market Package

This Market Package shares information with the Interactive ATIS Driver and Traveler Information Market Package for providing real-time fare information to prospective transit passengers.

Multi-Modal Coordination Market Package

This Market Package shares transit signal request information with the Regional Traffic Control Market Package.

Transit Traveler Information

This Market Package uses the Transit Fixed Route Operations and Demand Responsive Transit Operations Market Packages to supply transit schedule, routing, and service information to passengers. To the extent that passengers use an Information Service Provider or Remote Traveler Support device to request information, the equipment provided for the Passenger and Fare Management Market Package may be leveraged.

5.1.4 Commercial Vehicle Operations Market Package Synergy

Fleet Administration Market Package

This Market Package shares common tracking, management, and dispatch capabilities with the Freight Administration, CVO Fleet Maintenance, and HAZMAT Management Market Packages.

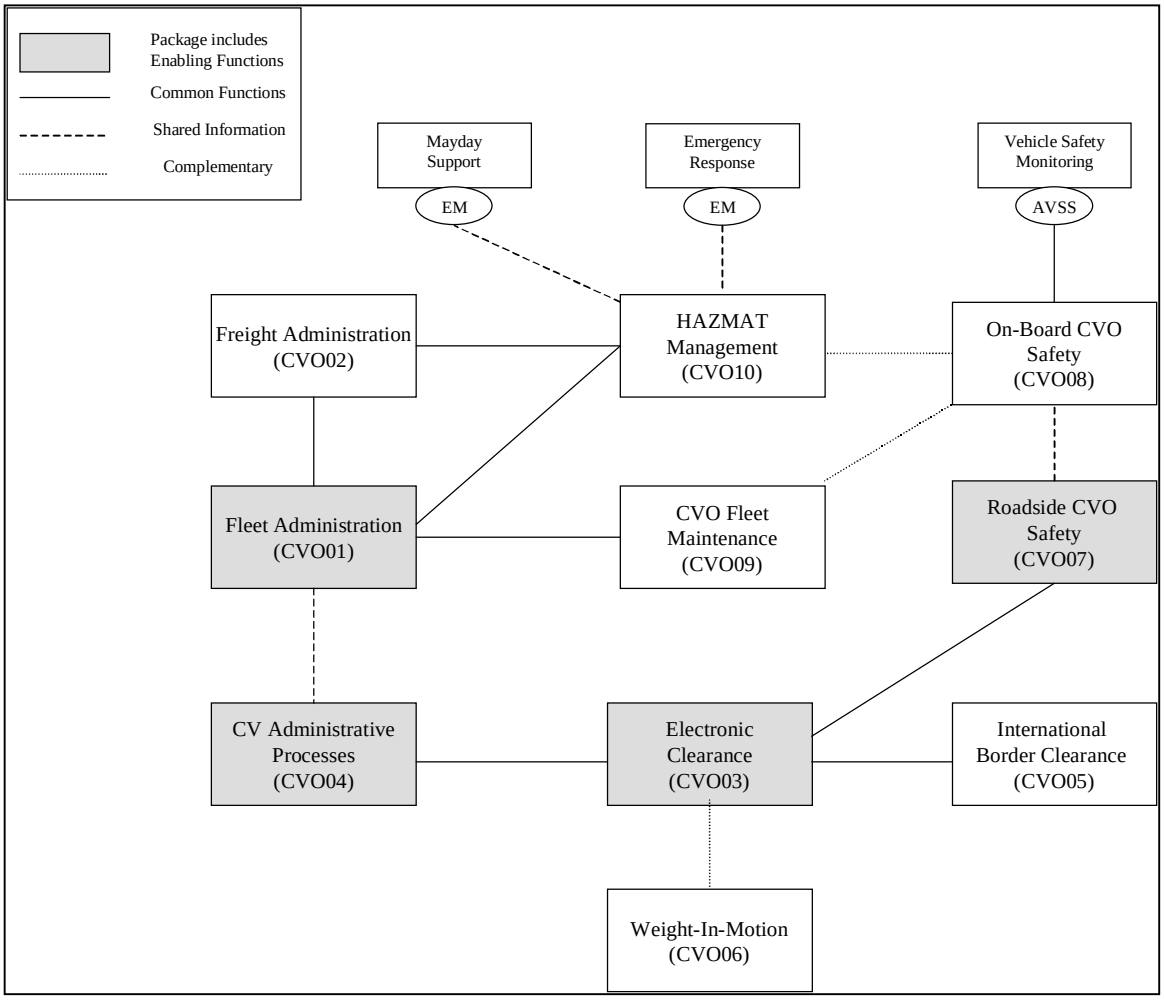


Figure 5.1-4. Commercial Vehicle Operations Market Package Synergies.

Freight Administration Market Package

This Market Package adds more specific freight monitoring capabilities to the basic tracking capabilities provided by fleet administration. These more advanced cargo tracking capabilities also support the HAZMAT Management Market Package.

CV Administrative Processes

This Market Package enables the Electronic Clearance Market Package since participants must both enroll (through this package) and be cleared electronically (through the Electronic Clearance Market Package) before a service is actually provided to participating carriers. As well, this Market Package supports various one-stop shopping applications which facilitate and expedite the administration of commercial vehicles.

Electronic Clearance

The International Clearance Market Package extends the basic clearance functions provided by the Electronic Clearance package by adding an interface to customs and permitting to support entry and exit from Canada and Mexico. The Weigh-In-Motion Market Package provides a logical enhancement to the AVI and commercial vehicle screening capabilities offered by this package. The Roadside CVO Safety Market Package provides another potential enhancement that enlists the basic AVI functions established for Electronic Clearance.

Roadside and On-Board CVO Safety Market Packages

This On-Board CVO Safety Market Package provides advanced sensory and diagnostic capabilities on-board the vehicle that complements the services provided by the HAZMAT Management, CVO Fleet Maintenance, and Roadside CVO Safety Market Packages by making additional diagnostic data. The roadside checking and verification against database entries and safety standards provided by the Roadside Market Package will be enhanced by the on-board safety verification provided by the CVO On-Board Safety Market Package.

HAZMAT Management Market Package

This Market Package provides HAZMAT spill notification information to the Emergency Response Market Package.

5.1.5 Emergency Management Market Package Synergy

Mayday Support

The Mayday Support Market Package requires a portable traveler interface and interactive, wide area wireless communications between the traveler and the infrastructure. This same portable traveler interface and interactive communications capabilities can be leveraged to support other traveler information capabilities addressed by the Interactive Traveler Information Market Package. This progression reflects a likely scenario in which the consumer is motivated by the potential for enhanced safety, installs the equipment, and then becomes part of a larger market for more advanced interactive information services.

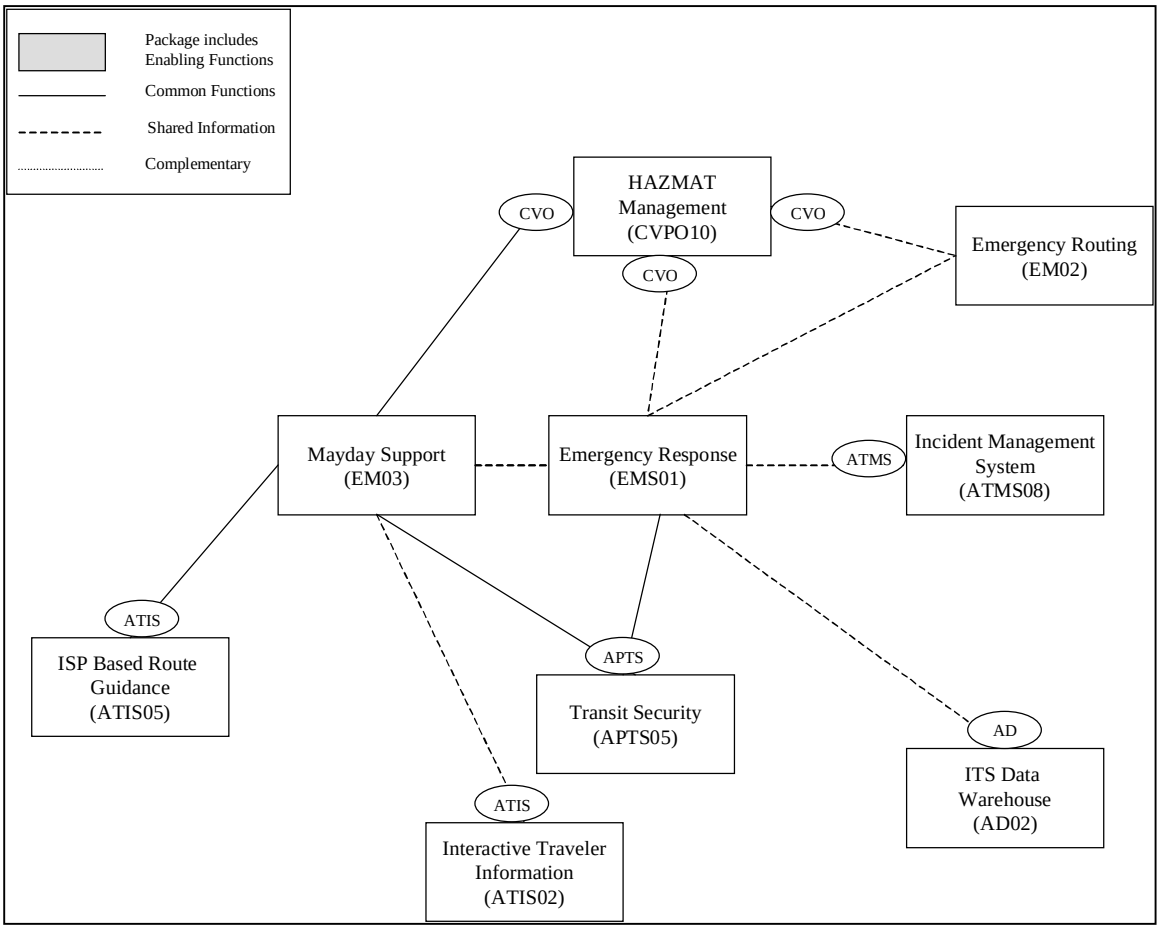


Figure 5.1-5 Emergency Management Market Package Synergies

Emergency Response Market Package

The Emergency Response Market Package enables a rapid response to the emergency notifications provided by the Mayday Support, Transit Security, and Incident Management System Market Packages. The Emergency Routing Market Package provides the basic dispatcher support capabilities which may be extended and integrated to support the required multi-agency coordination supported by the Emergency Response Market Package.

Emergency Routing Market Package

The emergency routing capabilities supported by this Market Package are a special application of similar route selection algorithms and processing capabilities provided by the traveler-oriented ISP Based Route Guidance Market Package.

5.1.6 Advanced Vehicle Safety Systems Market Package Synergy

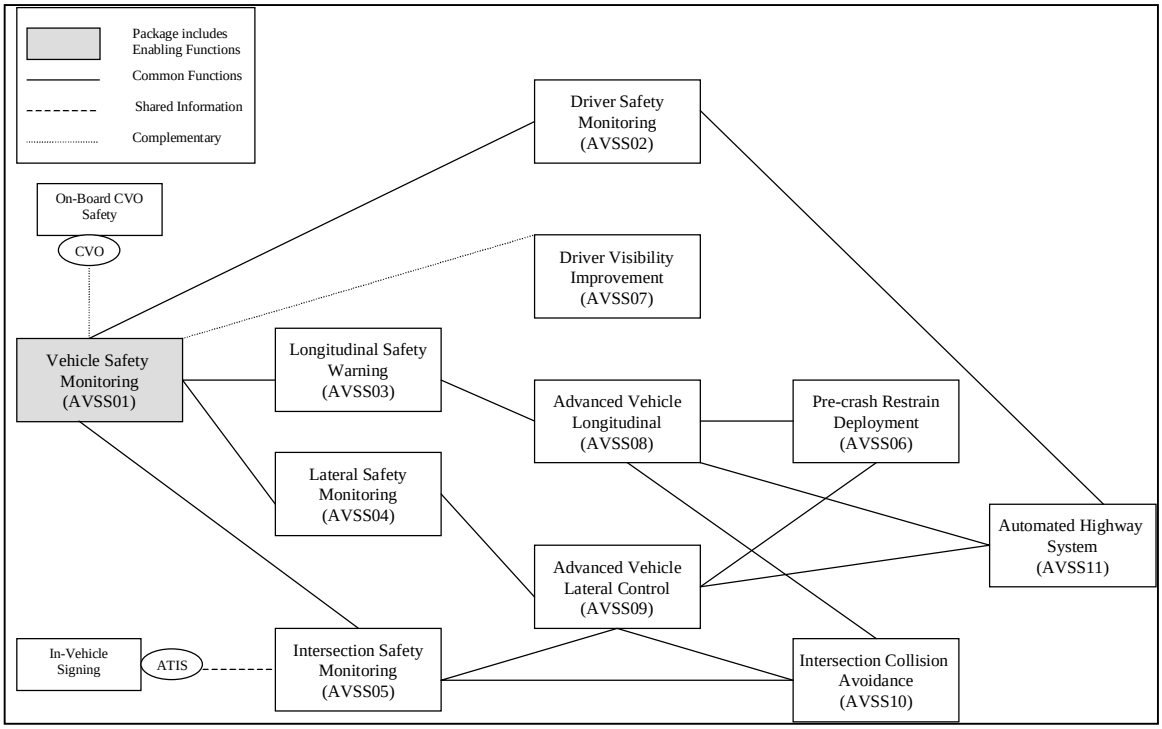


Figure 5.1-6. Advanced Vehicle Safety Systems Market Package Synergies.

Vehicle Safety Monitoring Market Package

This Market Package shares common functions with the Driver Safety Monitoring, Longitudinal Safety Warning, Lateral Safety Warning and Intersection Safety Warning Market Packages since each of these packages includes common sensory, processing, and driver interface capabilities. Each of these safety-related Market Packages may include separate sensing devices, however similar processing algorithms as well as the same or similar processors can be expected. The status and warning displays can be expected to be similar as well.

Longitudinal Safety Warning Market Package

This Market Package shares common sensory functions with the Advanced Vehicle Longitudinal Control Market Package. The sensing and detecting of obstacles in the longitudinal direction performed in this Market Package is directly applicable to the Advanced Vehicle Longitudinal Control Market Package.

Lateral Safety Warning Market Package

This Market Package shares common functions with the Advanced Vehicle Lateral Control Market Package. The proximity sensing and lane following functions performed in this Market Package may be applied to the Advanced Vehicle Lateral Control Market Package.

Intersection Safety Warning Market Package

This Market Package has common functions with the Intersection Collision Avoidance Market Package. The sensing and detecting of obstacles and conditions in the vicinity of an intersection and communicating this information to on-coming vehicles performed in this Market Package is directly applicable to its successor, the Intersection Collision Avoidance Market Package. The provision of basic intersection status to the vehicle supports intersection safety warning and is a logical extension of the in-vehicle signing function provided by a separate Market Package.

Advanced Vehicle Longitudinal and Lateral Control Market Packages

These two Market Packages share common functions with the Pre-Crash Restraint Deployment and Automated Highway System Market Packages. The capability to sense, detect, and act based upon longitudinal and lateral detection is a requirement for the Pre-Crash Restraint Deployment Market Package. This Market Package provides these functionalities that would be integral to the Pre-Crash Restraint Deployment Market Package. Complete automated control of the vehicle is an extension to these predecessor packages.

5.1.7 Archived Data Management Market Package Synergy

All of the Archived Data Management Market Packages shown in Figure 5.1-7 share the capability to collect data and data catalogues, perform data quality checks, and provide general query and report access to archive data users

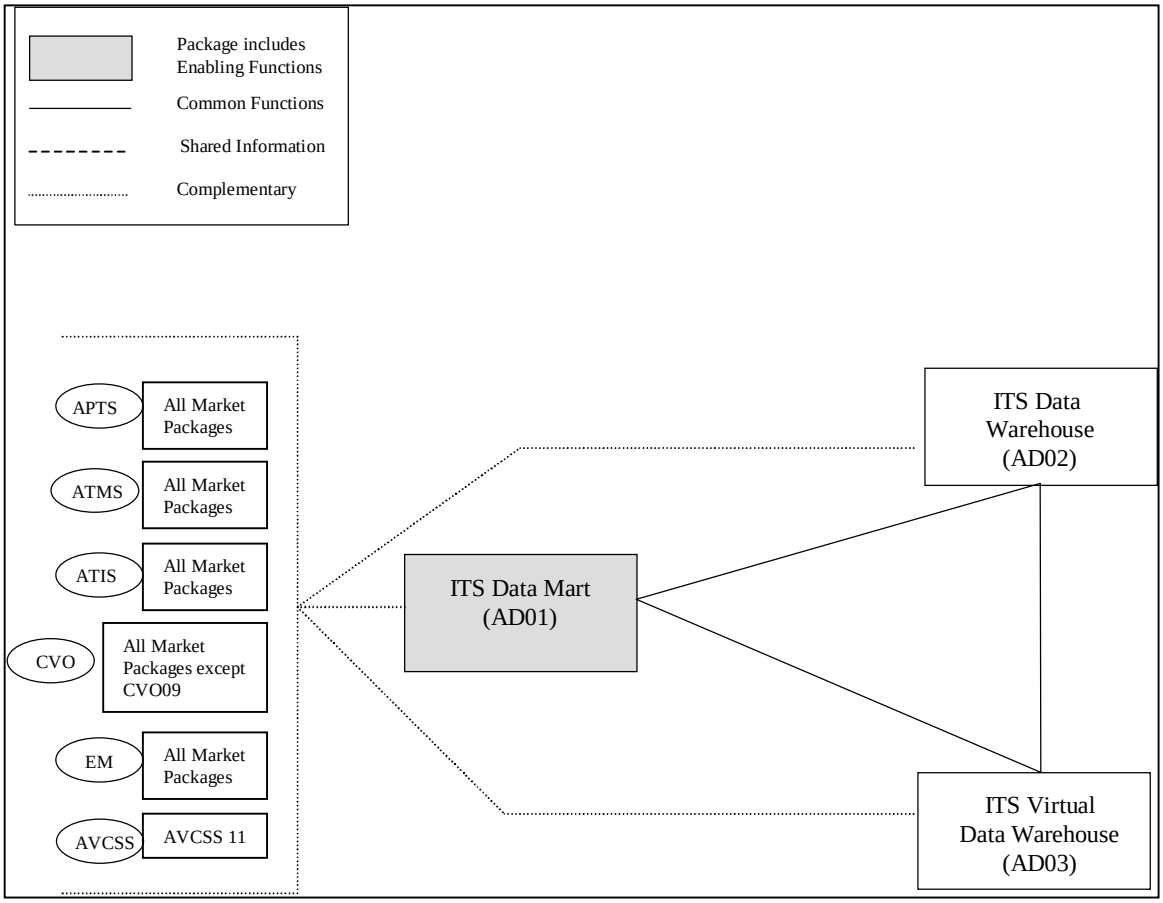


Figure 5.1-7 Archive Data Management Systems Market Package Synergies

ITS Data Mart and ITS Data Warehouse

These Market Packages share many of the same data management functions associated with collecting data delivered by an operational center, field device, or other data source, checking and storing data in a centralized physical repository. The ITS Data Warehouse builds upon the capabilities of the ITS Data Mart by adding data transformation and metadata management features necessary for integrating data from disparate sources and also includes more advanced data analysis capabilities.

ITS Data Warehouse and ITS Virtual Data Warehouse

These Market Packages both provide the same broad access to multimodal, multidimensional data from varied data sources. The ITS Virtual Data Warehouse includes more advanced functionality to enable interoperability between physically distributed ITS archives that are each locally managed.

5.2 Market Package Benefits

The assessment of ITS benefits has progressed significantly since the Architecture was originally developed. A wealth of benefits information, ranging from pamphlets including testimonials and anecdotal reports of realized benefits to detailed evaluations of major ITS deployments, have been published since the Architecture was developed. Among other sources, recent information on ITS benefits is available in the report “Intelligent Transportation Systems Benefits: 1999 Update” by Mitretek Inc. (Report Number FHWA-OP-99-012). In this section, the original benefits analysis that was performed for each Market Package is revised to reflect this new benefits information and the currently defined set of Market Packages.

Generalizing projected benefits from Market Package implementation is very difficult due to the number of exogenous factors that affect the level of impacts. Travel demand, operational policies, intensity of ITS asset deployment, and population and employment densities are examples of factors that affect the performance of a service provided by a given Market Package. Additionally, as noted in the previous section, Market Packages emanate from the integration framework of the National ITS Architecture. As such, infrastructure put in place for a Market Package, as well as the information generated by that package, can often be of value to other Market Packages. Thus Market Packages implemented in an integrated manner will usually generate benefits in excess of that found from summing individual benefits of Market Packages deployed in isolation. For example, the effectiveness of the Emergency Management Market Packages can be significantly enhanced if implemented in concert with the Incident Management Market Package. Section 5.1.1 discusses modeling tools being developed to capture some of these integration and other "non-traditional" benefits to support pre-implementation benefits estimation.

The discussion of Market Package benefits in this section is presented as follows. First, a description of the six Intelligent Transportation System goals identified by the US DOT in the National ITS Program Plan is provided. The Market Packages are then assessed based on the degree to which they appear to support these goals. The goals provide the context from which benefits can be determined and measured. Second, benefits data derived from recent ITS implementations are noted. Third, Market Package benefits flow diagrams, which can be used to trace Market Package impacts to ITS goals, are introduced. Finally, an assessment of Market Package benefits and important factors affecting the level of benefits realized is provided.

5.2.1 Intelligent Transportation System Goals

The six goals identified by the US DOT for the National ITS program are listed below. Table 5.2.1-2 indicates the relative influence of the Market Packages in advancing these goals.

Increase Transportation System Efficiency: This refers to movement of greater numbers of travelers throughout the transportation network without expanding physical infrastructure. The indicated Market Packages, which increase the effective capacity of existing roads, provide an attractive alternative to new construction. Many of these same packages are actively being deployed today providing early system benefits.

Improve Mobility: An improvement in traveler mobility is defined as the greater reliability in travel times and/or reduced travel delay experienced by system users. More reliable travel times result in higher-value trip end opportunities. This goal applies to congested areas that wish to influence both demand and capacity to improve mobility for individuals and goods through more efficient use of the overall transportation system. Those Market Packages identified as strongly correlated with this goal provide service enhancements and better information regarding these improved services.

Reduce Fuel Consumption and Environmental Cost: This refers to potential reduction in harmful emissions that result from vehicle use. Strongly correlated Market Packages smooth traffic flow resulting in higher average network speeds and fewer stops, which suggests reductions in fuel usage and emissions. The Demand Management and HOV Management packages allow proactive response to any induced demand, which might negate improvements in network performance. Public transit packages are also included to optimize transit performance. These packages could induce demand shifts away from single occupant vehicle use toward transit modes. Basic Traffic Management and Traveler Information Market Packages, which smooth traffic flow and provide better information to travelers, provide early system benefits.

Improve Safety: This refers to enhanced safety that a traveler would experience while traveling throughout the transportation network due to improvements in safety equipment, and faster emergency detection and response times. However, only a subset of these safety-enhancing services will be available or partially available in the near term. This smaller set provides safety benefits to early or first users of ITS technologies. ITS services that will provide early safety benefits include Standard Railroad Grade Crossing, Transit Security, and Mayday Support.

Increase Economic Productivity: This is a universal goal that may be particularly attractive to the individuals, public agencies, and private agencies that closely equate transportation efficiency with business performance. Achieving this goal through the Market Packages involves providing individuals as well as public and private agencies with a more efficient and cost-effective means of doing business. Selected Market Packages automate financial transactions, enhance management and maintenance of commercial, transit, and emergency fleets, and facilitate the movement of goods. Basic commercial vehicle Market Packages provide the early user and system benefits in this area.

Create an Environment for an ITS Market: This goal directly affects the characteristics of the Physical Architecture and its deployment; however, it does not closely correlate with individual Market Packages. To the extent that Market Packages embody new goods and services, they are likely to encourage growth in the ITS industry. The differentiation in table 5.2.1-2 is based on potential market size; the vehicle products market served by the ATIS and AVSS Market Packages is larger than the ATMS infrastructure products and APTS markets. The success of new industries supporting ITS depends on an open architecture and a non-restrictive deployment strategy to encourage participation and innovation.

Table 5.2.1-1 gives a set of benefits metrics that can be used to qualify and quantify each of these ITS goals. These echo similar types of metrics suggested by the Mission Definition document and the ITS National Program Plan. These metrics, in turn, are used to characterize the benefits of ITS market packages in section 5.2-4.

Table 5.2.1-1 Benefits Metrics

ITS Goal	Related Metric
Increase Transportation System Efficiency and Capacity	Traffic Flows / Volumes / Number of Vehicles
	Lane Carrying Capacity
	Volume to Capacity Ratio
	Vehicle Hours of Delay
	Queue Lengths
	Number of Stops
	Incident-related Capacity Restrictions
	Average Vehicle Occupancy
	Use of Transit and HOV modes
	Intermodal Transfer Time
	Infrastructure Operating Costs
	Vehicle Operating Costs
Enhance Mobility	Number of Trips Taken
	Individual Travel Time
	Individual Travel Time Variability
	Congestion and Incident-related Delay
	Travel Cost
	Vehicle Miles Traveled (VMT)
	Number of trip end opportunities
	Number of Accidents
	Number of Security Incidents
	Exposure to Accidents and Incidents
Improve Safety	Number of Incidents
	Number of Accidents
	Number of Injuries
	Number of Fatalities
	Time Between Incident and Notification
	Time Between Notification and Response
	Time Between Response and Arrival at Scene
	Time Between Arrival and Clearance
	Medical Costs
	Property Damage
	Insurance Costs
Reduce Energy Consumption and Environmental Costs	NO_X Emissions
	SO_X Emissions
	CO Emissions
	VOC Emissions
	Liters of Fuel Consumed
	Vehicle Fuel Efficiency
Increase Economic Productivity	Travel Time Savings
	Operating Cost Savings
	Administrative and Regulatory Cost Savings
	Manpower Savings
	Vehicle Maintenance and Depreciation
	Information-Gathering Costs
	Integration of Transportation Systems
Create an Environment for an ITS Market	ITS Sector Jobs
	ITS Sector Output
	ITS Sector Exports

Table 5.2.1-2: ITS Goals Supported by Market Packages

	Market Packages	ITS Goals					
		Increase Transportation System Efficiency	Improve Mobility	Reduce Fuel Consumption and Environmental Cost	Improve Safety	Increase Economic Productivity	Create an Environment for an ITS Market
APTS	Transit Vehicle Tracking	*	**	*		*	*
	Fixed-Route Operations	*	**	*		*	*
	Demand-Responsive Operations	*	**	*		*	*
	Passenger and Fare Management					**	*
	Transit Security				**		*
	Transit Traveler Information	*	**		*	*	*
	Transit Maintenance					*	*
	Multi-modal Coordination	*	*			*	
ATIS	Broadcast Traveler Info	*	**	*			***
	Interactive Traveler Info	**	***	*			***
	Autonomous Route Guidance	**	***				***
	Dynamic Route Guidance	**	***	*	*		***
	ISP-Based Route Guidance	**	***	*	*		***
	Integrated Transp. Mgmt/Route Guidance	***	***	**	*		**
	Yellow Pages and Reservation	*					**
	Dynamic Ridesharing	**	*	*			*
	In Vehicle Signing		*		*		***
ATMS	Network Surveillance	*	*	*			*
	Probe Surveillance	*	*	*			**
	Surface Street Control	**	***	**	**		*
	Freeway Control	**	***	**	*		*
	Regional Traffic Control	***	***	***	**		*
	HOV Lane Management	*	**	*			*
	Reversible Lane Management	**	*	*			
	Incident Management System	**	**	***	**		*
	Traffic Information Dissemination	**	*	*			*
	Traffic Forecast and Demand Management	**	**				*
	Electronic Toll Collection					**	*
	Parking Facilities Management	**		*		*	
	Emissions Monitoring and Management			***			**
	Virtual TMC and Smart Probe Data	*	*	*		*	*
	Road Weather Information Systems	**	*		***	**	*

Market Packages		ITS Goals					
		Increase Transportation System Efficiency	Improve Mobility	Reduce Fuel Consumption and Environmental Cost	Improve Safety	Increase Economic Productivity	Create an Environment for an ITS Market
	Standard Railroad Grade Crossing				***		*
	Advanced Railroad Grade Crossing				***		*
	Railroad Operations Coordination	*	*	*			*
	Regional Parking Management	**	*	*			
CVO	Fleet Administration		***			***	**
CVO	Freight Administration		***			***	**
CVO	Electronic Clearance	**	***			***	**
CVO	CV Administrative Processes					**	*
CVO	International Border Electronic Clearance	**	***			***	**
CVO	Weigh-In-Motion	**	***			***	**
CVO	CVO Fleet Maintenance	*			**	**	*
CVO	HAZMAT Management	*			**	**	*
CVO	Roadside CVO Safety	*	**		**	**	**
CVO	On-board CVO Safety				***	**	**
AVSS	Vehicle Safety Monitoring				***		***
AVSS	Driver Safety Monitoring				***		***
AVSS	Longitudinal Safety Warning				***		***
AVSS	Lateral Safety Warning				***		***
AVSS	Intersection Safety Warning				***		***
AVSS	Pre-Crash Restraint Deployment				***		***
AVSS	Driver Visibility Improvement				***		***
AVSS	Advanced Vehicle Longitudinal Control	**	*		***		***
AVSS	Advanced Vehicle Lateral Control	**	*		***		***
AVSS	Intersection Collision Avoidance				***		***
AVSS	Automated Highway System	***	***		***		***
EM	Emergency Response	*		*	***	**	*
EM	Emergency Routing	*		*	***	**	*
EM	Mayday Support				***	*	**
ADUS	ITS Data Mart	**	**	**	**	**	***
ADUS	ITS Data Warehouse	**	**	**	**	**	***
ADUS	ITS Virtual Data Warehouse	**	**	**	**	**	***

5.2.2 Reported ITS Benefits

This section provides summary statistics from the recently completed report *ITS Benefits – 1999 Update* prepared by Mitretek Systems for the US DOT Joint Program Office. The report summarizes much of the available quantifiable data relating to the impacts of ITS deployments collected by the US DOT Joint Program Office. Most of the data collected to date are concentrated on the metropolitan and CVO ITS programs rather than the rural program. However, several states and National parks are now examining the potential benefits of providing improved tourism and travel information. In addition, many states are researching the benefits of incorporating ITS, especially weather related services, into their infrastructure operations and maintenance plans.

The benefits information documented in the Mitretek report is organized according to the nine Metropolitan ITS components described in section 41. As such, Table 41.2-1 could be referenced to correlate the benefit data with Market Packages. Table 5.2.2-1 highlights selected summary benefits of Metropolitan ITS Infrastructure components documented in the report. Table 5.2.2-2 identifies some of the benefits reported for one element of CVISN, i.e., electronic clearance. As indicated in both tables, benefits data is lacking in several key metropolitan and CVO areas. The interested reader is referred to the full report for the specific examples, locations, and contexts within which the results were obtained. Another useful recently completed reference on ITS benefits is the TTI report*, ITS Benefits: Review of Evaluation Methods and Reported Benefits*.[2]

Table 5.2.2-1. Reported Metropolitan ITS Benefits

Metropolitan ITS Infrastructure Component	Metric	Impact
Regional Multimodal Traveler Information[3]	Percentage of users that change route when provided traveler information	50%
	Percentage of users that change time of travel when provided traveler information	45%
	Percentage of users that change mode of travel when provided traveler information	5% - 10%
	Estimated percentage reductions in emissions resulting from altered travel plans	25% (HC) 1.5% (NOx) 33% (CO)
Arterial Management Systems	Percent reduction in stops due to adaptive control	22% - 41%
	Percent reduction in travel time due to adaptive control	8% - 20%
	Percent delay reduction due to adaptive control	15% – 44%
Freeway Management System	Percent accident reduction due to ramp metering	14% - 50%

[2] Turner, Shawn, Stockton, Wm., James, S., Rother, T., and Walton, M. ITS Benefits: Review of Evaluation Methods and Reported Benefits. Report No. FHWA/TX-99/1790-1. October 1998.
[3] Benefits based on surveys from Seattle and Boston

Metropolitan ITS Infrastructure Component	Metric	Impact
	Percent increase in speed due to ramp metering	8% - 60%
Transit Management System	Data not provided	
Incident Management Program	Percent reduction in incident clearance time	66%
	Percent reduction in incident response time	20%
	Percent reduction in number of accidents	35% – 40%
	Percent reduction in secondary accidents	30% - 50%
	Percent reduction in accident rates	41%
	Cost savings per year ($ millions)	0.95 – 8.40
	Delay savings (1000's hrs. / year)	95 – 255.5
Electronic Toll Collection Systems	Percent reduction in annual operating costs for building utilities	2%
	Percent reduction in annual operating costs for building maintenance	2%
	Percent reduction in annual operating costs for money handling staff	10%
	Percent reduction in annual operating costs for roadway maintenance	14%
	Per cent reduction in annual operating costs for toll collection staff	43%
Electronic Fare Payment Systems	Data collection cost reductions ($ millions)	5 (Ventura, CA, estimate)
	Revenue growth from ridership increases ($ millions)	49 (New York, estimate)
	Cost reduction from cash handling ($ millions)	2 (Atlanta, estimate) - 2.7 (New Jersey, estimate)
Highway-Rail Intersection system	Data not provided	----------
Emergency Management Services	Data not provided	----------

Table 5.2.2-2. Reported ITS CVO Benefits

Metropolitan ITS Infrastructure Component	Metric	Impact
Roadside Safety Assurance	Data not provided	----------
Credentials Administration	Data not provided	----------
Electronic Screening	Hazardous materials incident costs per state ($ millions)[4]	1.7
	Reduction in tax evasion losses per state ($ millions)[2]	0.5 to 1.8

[4] Based on the HELP/Crescent Project

[5]These diagrams are available for the original 53 National ITS Architecture Market Packages. The Performance and Benefits document has not been updated to reflect the latest Market Packages

Metropolitan ITS Infrastructure Component	Metric	Impact
	Percent reduction in overweight loads / cost savings ($ millions) [2]	5% / 5.6
	Weigh station operating cost reductions	$169,000
	Cost of avoided accidents from credentials checking ($ millions) [2]	4.3 – 8.6
	Cost of avoided accidents from automated safety inspections ($ millions) [2]	$156,000 - $781,000

5.2.3 Market Package Benefits Flow Diagrams

This section addresses the need to connect the benefits metrics identified in Table 5.2.1-1 with the Market Packages. This allows a preliminary causal inference of quantitative benefits for particular Market Packages. Once these connections are made, the performance metrics may in turn be logically connected to the six ITS goals mentioned above. The tool used to describe this process is the "benefit flow diagram." As presented in the Performance and Benefits document of the National ITS Architecture document collection, this diagram consists of two halves. In one half, Market Packages[5] are linked with benefits metrics and in the other half, the various metrics are tied back to the ITS goals. These diagrams are helpful to the process of benefits identification and quantification in that they show what transportation performance metrics are affected by each market package. The diagrams also demonstrate the logical connection of transportation performance metrics to the broader goals of ITS. A schematic of the diagram is shown in Figure 5.2.3.-1.

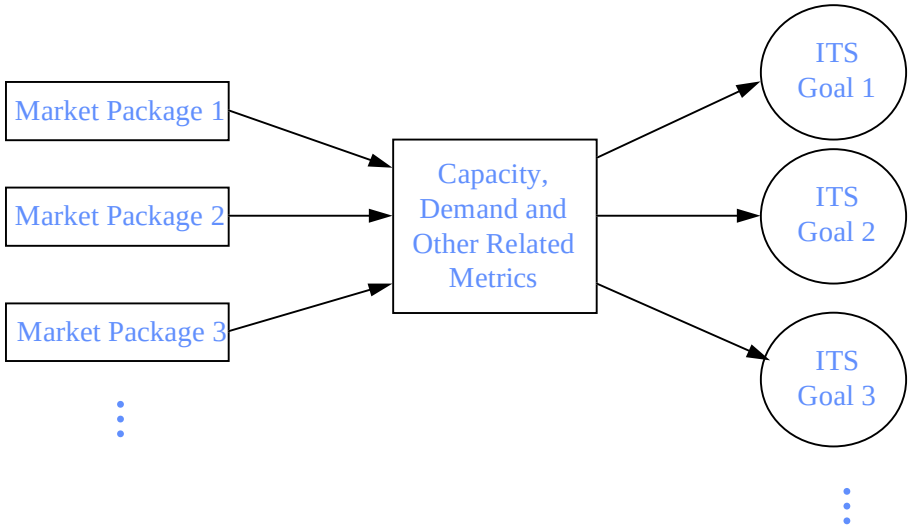


Figure 5.2.3-1. Benefits Flow Diagram Schematic

One important fact to be kept in mind for these logic flow diagrams is that the diagrams present only logical dependencies among different elements. It is not possible to infer the magnitude of these connections. The point is to show the logical connection only, and not the strength or magnitude of that connection.

To illustrate the use of use of the diagrams with one example consider the Broadcast Traveler Information, which is intended to be a low-end service for driver information about current traffic conditions. Figure 5.2.3-2 suggests that information about travel characteristics on alternate routes and modes provided to the traveler in this manner, both before and during their trip, will result in reductions in the individual's travel time and the day-to-day travel time variability. These effects will result from the traveler making better decisions about possible modes and routes for their trip. One may also expect that this information will cause travelers to avoid bottlenecks and congestion, with resulting reductions in delay, avoidance of queues, and less exposure to accidents and other travel-related incidents.

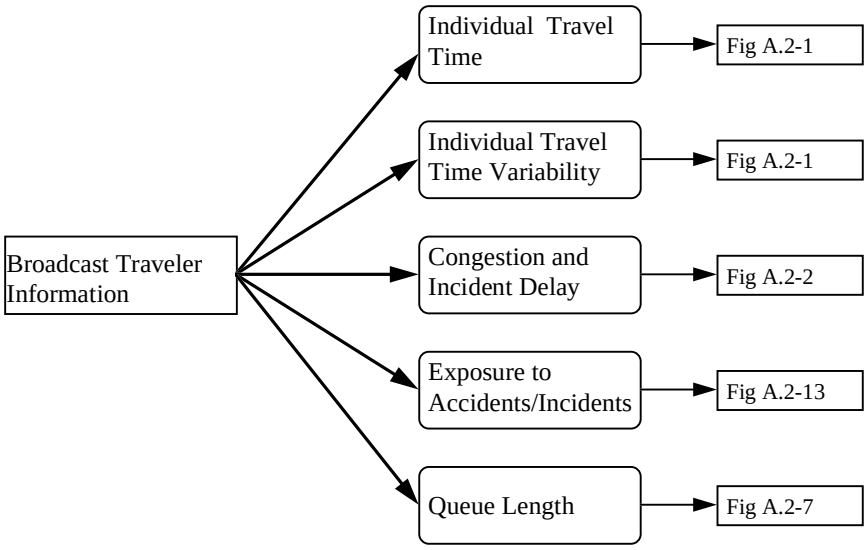


Figure 5.2.3-2: Metrics from Broadcast Traveler Information

Figure 5.2.3-3 traces two of the metrics, i.e. individual travel time and travel time reliability, to the applicable ITS goals. This figure was taken directly from the *Performance and Benefits* report which links all the various metrics with the ITS goals. The arrow from the travel utility metric in the figure below to Figure "Figure A 2-4" is a reference to a diagram in the Appendix of the Performance and Benefits document which indicates that increase in travel utility is ultimately traced to an increase in the Mobility ITS goal.

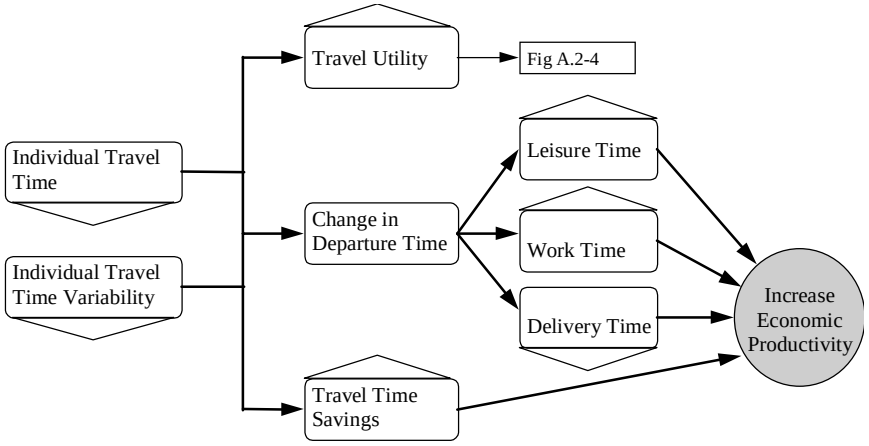


Figure 5.2.3-3 Metric of Travel Time

5.2.4 Market Package Benefits Tables

Tables 5.2.4-1 through 5.2.4-7 show the types of benefits that might be expected from each Market Package and where these benefits may accrue. This survey of benefits should be considered in conjunction with other benefits assessments for ITS. This general information allows a community to narrow their choice set and subsequently focus their effort on obtaining better benefits estimates for their locality for a reduced set of alternatives

Table 5.2.4-1: Benefits of Traveler Information Market Packages

Market Package	Likely Benefits	Context Where Benefits May Accrue
Broadcast Traveler Information	▪ Possible benefits as high as other interactive ATIS services (see below), depending on capability of in-vehicle devices	▪ Primary value for incident-related (accidents, weather, special events, etc.) traffic delays, across all geographic areas ▪ Higher benefits to travelers with long trips, multiple mode and route alternatives
Interactive Traveler Information	▪ Reduction in travel time for equipped travelers ▪ Increases in speeds, decrease in number of stops for equipped travelers ▪ Some benefits for non-equipped travelers ▪ Higher benefits for pre-trip versus on route information ▪ Decreasing benefits with higher market penetrations	▪ Primary value for incident-related (accidents, weather, special events, etc.) traffic delays, across all geographic areas ▪ Higher benefits to travelers with long trips, multiple mode and route alternatives ▪ Decreasing benefits with higher network loadings (i.e. higher congestion)
Autonomous Route Guidance Dynamic Route Guidance ISP Based Route Guidance Integrated Transportation Management/Route Guidance	▪ Reduction in travel time for equipped travelers ▪ Increases in speeds, decrease in number of stops for equipped travelers ▪ Some benefits for non-equipped travelers ▪ Higher benefits for pre-trip versus en route information ▪ Decreasing benefits with higher market penetrations	▪ Primary value for incident-related (accidents, weather, special events, etc.) traffic delays, across all geographic areas ▪ Higher benefits to travelers with long trips, multiple mode and route alternatives ▪ Higher benefits for visitors and other unfamiliar travelers
Yellow Pages and Reservation	▪ Potential reduction of VMT spent searching for trip destinations	▪ Benefits highest for visitors and other unfamiliar travelers ▪ Familiar travelers benefit from parking reservation
Dynamic Ridesharing	▪ Increased vehicle occupancy and use of HOV modes ▪ Improved individual mobility	▪ Significant density of related trips is necessary to ensure ride matching
In Vehicle Signing	▪ Reduction in search time and excess VMT ▪ Reduction in accidents	▪ Anticipated benefits in congested areas, night driving, rural areas ▪ Aid to visually challenged drivers

Table 5.2.4-2: Benefits of Traffic Management Market Packages

Market Package	Likely Benefits	Context Where Benefits May Accrue
Network Surveillance	▪ Indirect benefits only ▪ Data support for other ATMS services	▪ Essential component for incident detection and sometimes for signal control ▪ Higher value for regions where traffic patterns are transient and unpredictable
Probe Surveillance	▪ Indirect benefits only ▪ Data support for other ATMS services	▪ Essential component for incident detection and sometimes for signal control ▪ Higher value for regions where traffic patterns are transient and unpredictable
Surface Street Control	▪ Reduction in travel time ▪ Reduction in queue time ▪ Increase in speeds ▪ Reduction in stops ▪ Reduction in fuel consumption ▪ Reductions in VMT ▪ Reductions in HC and CO emissions ▪ Reduction in intersection-related accident rates, with higher reductions possible for left-turn accidents ▪ Significant benefit-to-cost ratio	▪ Most surface street systems will benefit from this Market Package ▪ Cities with major traffic generators such as theme park or stadium will benefit more ▪ It is expected that signal coordination tailored to specific local traffic patterns can have significantly higher benefits
Freeway Control	▪ Increase in freeway speed (before-after) during congested peak hours, depending on level of congestion ▪ Increase in freeway throughput ▪ Reduction in travel time ▪ Reduction in queue time ▪ Reduction in fuel consumption ▪ Reduction in emissions	▪ Most freeway systems will benefit from this market package ▪ Essential component for HOV Lane Management and Reversible Lane Management Market Packages ▪ Capacities of freeway on and off ramps may be diminished by ramp metering
HOV Lane Management	▪ Reduction in travel time ▪ Increase in lane carrying capacity ▪ Increase in use of transit and HOV modes ▪ Reduction in number of stops (HOV priority at ramp meters)	▪ Benefits will be greatest in areas with high levels of congestion, concentrated residential and employment land uses, and limited route options. ▪ Improved service on HOV lanes could induce more HOV travelers and improve flow on non-HOV facilities.
Traffic Information Dissemination	▪ Positive value but quantitative estimates have yet to be determined	▪ Regions where travelers respond to traffic information by either changing departure time, route choice, etc. ▪ Regions that have alternate routes, mode choices, etc.
Regional Traffic Control	▪ Uncertain level of benefits, but can be significant in many instances	▪ High benefits in regions with many cities or jurisdictions
Incident Management System	▪ Reduction in incident response times for large urban areas ▪ FSP programs report significant reductions in incident-related vehicle hours of delay ▪ Significant benefit to cost ratio	▪ Regions with high frequency of incidents ▪ Regions where incident delays constitute a substantial part of delays
Traffic Forecast and Demand Management	▪ Reductions in data collection cost ▪ Benefits depend heavily on current surveillance and analysis activities	▪ Regions that have TDM programs ▪ Regions that have traffic management plans responding to performance evaluation
Electronic Toll Collection	▪ Reduce peak hour congestion ▪ Reduction in toll plaza operating costs ▪ Reduced incidents and emissions	▪ Regions that have TDM programs or existing manual toll collection systems ▪ Toll collection infrastructure can be leveraged to provide traffic surveillance capabilities
Emissions monitoring and management	▪ Improve air quality	▪ High value in geographic areas in air quality non-attainment
Virtual TMC and Smart Probe	▪ Reduction in incident notification time ▪ Reduction in infrastructure operating costs ▪ Support traffic management and traveler information services	▪ Assumed value in rural and inter-urban areas with low capital
Standard Railroad Grade Crossing Advanced Railroad Grade	▪ Some grade crossing accidents may be avoided ▪ Condition of rail roadside equipment can be monitored	▪ Requires institutional cooperation between rail operators and traffic managers

Market Package	Likely Benefits	Context Where Benefits May Accrue
Crossing		
Railroad Operations Coordination	▪ Further contribution to benefits identified under Surface Street Control. Level of benefits unknown.	▪ Larger traffic networks with significant highway-rail intersection closures.
Parking Facilities Management	▪ Reduction in administrative costs ▪ Reduction in queues at parking entrances and exits ▪ Can support use of HOV and transit modes	▪ Can leverage electronic toll collection equipment ▪ Most effective when coupled with other urban traveler information services
Reversible Lane Management	▪ Reduction in travel time ▪ Increase in lane carrying capacity ▪ Mitigate safety risks with existing reversible lanes	▪ Viable in corridors with clear directional patterns or to respond to dynamic demand changes and special events
Road Weather Information System	▪ Improved safety via valuable pre-trip and en-route information ▪ Enhanced facility maintenance efficiency	▪ Especially relevant in rural areas with diverse terrain and variable weather patterns.
Regional Parking Management	▪ Improved facility utilization ▪ Reduced travel time, fuel use, and emissions associated with traveler parking searces	▪ Regional (i.e., Mutli-jursidictional / multi-agency) parking environments

Table 5.2.4-3: Benefits of Transit Management Market Packages

Market Package	Likely Benefits	Context Where Benefits May Accrue
Transit Vehicle Tracking	▪ Improvement in vehicle on-time performance ▪ Reductions in field supervision	▪ Higher benefits to areas with significant transit service reliability problems
Fixed-Route Operations	▪ Improved productivity of vehicles, labor	▪ All transit scenarios
Demand-Responsive Transit Operations	▪ Improved productivity of vehicles, labor ▪ Efficiencies in routing and trip scheduling	▪ All transit scenarios
Transit Passenger and Fare Management	▪ Passenger convenience of common fare instrument ▪ Reduction in cash handling losses ▪ Reduction in costs of data collection and fare processing	▪ Benefits clearest where multiple agencies share services, transfers, etc.
Transit Security	▪ Faster response to incidents ▪ Record of security incidents	▪ High benefits in less secure areas (e.g. large urban areas)
Transit Maintenance	▪ Effective scheduling of maintenance activities ▪ Reduction in maintenance and system repair costs	▪ All transit scenarios
Multi-modal Coordination	▪ Reduction in transit travel times from signal priority	▪ Good institutional cooperation between traffic and transit managers is necessary ▪ Level of benefits depends on ambient traffic volumes and cross traffic in selected corridors or in area-wide systems
Transit Traveler Information	▪ Improved individual mobility ▪ Enhanced attractiveness of transit as alternative to SOV use ▪ Reduced travel stress due to knowledge of real time schedules and ability to generate custom itineraries	▪ Areas with unpredictable system route times and complex service.

Table 5.2.4-4: Benefits of Commercial Vehicle Market Packages

Market Package	Likely Benefits	Context Where Benefits May Accrue
Fleet Administration	▪ Improvements in vehicle and driver productivity ▪ Increase in loaded miles	▪ Local and long-haul systems
Freight Administration	▪ Largely unknown level of benefits	▪ Hazardous materials and other sensitive cargo
Electronic Clearance	▪ Reduction or elimination of border clearance times ▪ Reductions in commercial and public administrative costs ▪ Improvements in vehicle and driver productivity	▪ Highest benefits for long-haul carriers
Commercial Vehicle Administrative Processes	▪ Significant cost savings for commercial vehicle operators and regulatory agencies ▪ Reduced HAZMat incidents ▪ Reduced tax evasion	▪ Most effective when implemented across jurisdictions.
International Border Electronic Clearance	▪ Reduction or elimination of border clearance times ▪ Reductions in commercial and public administrative costs ▪ Improvements in vehicle and driver productivity	▪ Highest benefits for long-haul carriers
Weigh-In-Motion	▪ Reduction in vehicle weighing times ▪ Reductions in commercial and public administrative costs ▪ Improvements in vehicle and driver productivity	▪ Highest benefits for long-haul carriers
Roadside CVO Safety	▪ Reduction in safety inspection times ▪ Reduction in commercial vehicle accidents	▪ The capabilities for performing the safety inspection are shared between this market package and the On-Board CVO Safety Market Package which enables a variety of implementation options
On-board CVO Safety	▪ Reduction in commercial vehicle accidents	▪ The capabilities for performing the safety inspection are shared between this market package and the Roadside CVO Safety Market Package which enables a variety of implementation options
CVO Fleet Maintenance	▪ Improvement in vehicle productivity ▪ Reduction in commercial vehicle accidents	▪ All CVO scenarios
HAZMAT Management	▪ Faster and more appropriate response to HAZMAT incidents ▪ Reduction in number of accidents	▪ Requires coordination between fleet administration, traffic management, and emergency management officials.

Table 5.2.4-5: Benefits of Vehicle Safety Market Packages

Market Package	Likely Benefits	Context Where Benefits May Accrue
Vehicle Safety Monitoring	▪ Lower vehicle maintenance costs ▪ Lower accident and vehicle breakdown rates	
Driver Safety Monitoring	▪ Lower accident rates due to driver impairment	
Longitudinal Safety Warning	▪ Reduction in backing and rear-end accidents	
Lateral Safety Warning	▪ Reduction in lane departure accidents	
Intersection Safety Warning	▪ Difficult to estimate level of reduction of intersection-based accidents ▪ Some intersection-related accidents may be avoided	▪ Higher possible value at unsignalized intersections
Pre-Crash Restraint Deployment	▪ Reduction in accident severity	
Driver Visibility Improvement	▪ Reduction in accidents due to driver vision impairment ▪ Reduction in night vision impairment accidents	▪ Higher benefits in night driving, inclement weather ▪ Significant benefits for visually challenged drivers
Advanced Vehicle Longitudinal Control	▪ Improvement in highway lane capacity ▪ Reduction in rear-end and backing accidents with other automobiles ▪ Reduction in rear-end and backing accidents with fixed objects	▪ Applications most likely on freeway and other restricted-access roads
Advanced Vehicle Lateral Control	▪ Reduction in lane departure accidents	▪ Applications most likely on freeway and other restricted-access roads
Intersection Collision Avoidance	▪ Unknown level of benefits, difficult to quantify	▪ Possible high value at unsignalized intersections
Automated Highway System	▪ Significant improvements in highway lane capacity ▪ Broad range possible safety and environmental benefits, depending on system design	▪ Likely scenarios still under discussion

Table 5.2.4-6: Benefits of Emergency Management Market Packages

Market Package	Likely Benefits	Context Where Benefits May Accrue
Emergency Response	▪ Assumed reduction in response times through system-coordinated response	▪ Higher level of benefit realized in areas with multiple jurisdictions and independent response agencies
Emergency Vehicle Routing	▪ Unknown level of benefits	▪ Effectiveness can be enhanced with local signal preemption capabilities
Mayday Support	▪ Anticipated faster routing of calls, shorter response times	▪ Higher level of benefit realized in areas with multiple jurisdictions and independent response agencies ▪ High benefits in rural areas

Table 5.2.4-7: Benefits of Archived Data Market Package

Market Package	Likely Benefits	Context Where Benefits May Accrue
ITS Data Mart	▪ Largely unknown level of benefits; rarely measured in quantitative terms, however the Archived Data Market packages improved system planning by reducing sampling biases and providing more detailed data ▪ Potential reduction in effort required for data collection and analysis for system planning	▪ Agencies and analysts engaged in detailed modeling / simulation ▪ Agencies with significant data reporting responsibilities
ITS Data Warehouse	▪ Largely unknown level of benefits; rarely measured in quantitative terms, however the Archived Data Market packages improved system planning by reducing sampling biases and providing more detailed data ▪ Potential reduction in effort required for data collection and analysis for system planning ▪ Support data integration and multi-variable analyses	▪ Data standards efforts will have a significant impact on ease of data sharing and integration ▪ Agencies and analysts engaged in detailed modeling / simulation ▪ Agencies with significant data reporting responsibilities
ITS Virtual Data Warehouse	▪ Largely unknown level of benefits; rarely measured in quantitative terms, however the Archived Data Market packages improved system planning by reducing sampling biases and providing more detailed data ▪ Potential reduction in effort required for data collection and analysis for system planning ▪ Support data integration and multi-variable analyses	▪ Institutional relationships at a regional level must be sufficient to facilitate cooperation between different agencies and jurisdictions

5.3 Enabling Technologies and Market Packages

While the National ITS Architecture was developed to be as independent of technology as possible, technology constraints and technology choices ultimately have a large bearing on the success of ITS implementations. A range of technologies, each with unique performance, cost, and maturity characteristics can be used to implement ITS. The majority of these technologies are commercially available and expose the implementor to little technical risk. The most problematic technology implications exist where a required ITS function is not supported by any cost-effective, commercially available technology.

In a few cases, required technologies may not exist or may be too costly and/or unreliable for commercial application. Market Packages that are dependent on such technologies require further research and development to provide the enabling technology and integrate it into a commercially viable deployment package. This paragraph identifies the technologies associated with the Market Packages, defines and determines the maturity for each technology area, and postulates the potential impact to deployment for those critical technologies requiring additional research and development.

Table 5.3-1 identifies functional groups of technologies and relates them to the Market Packages. Each column in the table represents a general technology area which is applied through one or more Market Packages to support ITS user

services. The technology requirements for each Market Package are presented in the body of the table using the following icons:

- ■ The opaque (black) squares denote a basic relationship between the Market Package and the technology area. This assignment indicates that the technology area is fundamental to the core services provided by the Market Package.

- ❑ The transparent (white or gray) squares denote a secondary relationship between the Market Package and the technology area. This assignment indicates that the technology would enhance the Market Package through provision of optional features or by playing a supplementary role in supporting core services. Use of this technology area is desirable but not necessarily required for Market Package implementation.

The columns in Table 5.3-1 are highlighted for technology areas that require further development. The rows in the table are highlighted where a Market Package requires at least one of these critical technology areas.
Table 5.3-2 defines the ITS-relevant technologies identified in Table 5.3-1 and highlights those areas which have been defined as critical. In the table, each basic technology area is defined and qualitatively assessed with regard to relative maturity. The maturity assignments used in the table are defined as follows:

- **Mature:** Current commercially available technology supports the identified ITS requirements in this area. Deployment of the ITS user services is not predicated on further research and development of these technologies.

- **Mature with rapid innovation:** Current commercially available technology supports the identified ITS requirements. The area is one of rapid technology growth, which indicates that the basic support provided by current technologies will likely be superseded within the deployment period. While further research and development is not required to support ITS, future deployments may benefit from technology enhancements that should not be precluded by excessive rigidity in the Architecture or deployment definitions.

- **Mixed:** This technology area satisfies a range of ITS requirements including some that are not supported by current technology. Useful services may be deployed using currently available technologies; however, satisfying all user service requirements will require additional research and development to bolster the identified deficiencies. Where this assignment is made, the associated description in Table 5.3-2 highlights the specific areas where technology advancement is required.

Table 5.3-1: Market Package Requirements by Technology Area

	Market Packages	Technology Area																								
		Sensor									Location Determination	Comm					Algorithms	Information Mgmt	Payment	User I/F			Control		
		Traffic	Vehicle Status	Environment	Vehicle Monitoring	Driver Monitoring	Cargo Monitoring	Obstacle Ranging	Lane Tracking	Security		Cell-Based (U1t)	Vehicle-Roadside (U2)	Vehicle-Vehicle (U3)	Broadcast (U1b)	Fixed (W)				Driver	Traveler	Operator	Signals	Signs	Vehicle
ATMS	Network Surveillance	■		❑												■	❑	■				■				
	Probe Surveillance				■						■	■	❑			❑	■	■				■				
	Surface Street Control	■														■						■	■			
	Freeway Control	■														■						■	■	❑		
	HOV Lane Management	■									■	■				■	❑					■	❑	■		
	Reversible Lane Management															■						■		■		
	Traffic Information Dissemination														■	■	❑	■				■		❑		
	Regional Traffic Control	■			■											■	■	■				■	■	■		
	Incident Management System	■			■						■	■				■	■	■				■	❑	❑		
	Traffic Forecast and Demand Management	■			■											❑	■	■				■				
	Parking Facility Management	■											■									■				
	Electronic Toll Collection	■	■									❑	■		❑	■	■	■	■	■		■	❑	❑		
	Emissions Monitoring and Management		■	■	❑											■	■	■			❑		■		❑	
	Virtual TMC and Smart Probe Data				■						■	■	❑			❑	■	■					■			
	Standard Railroad Grade Crossing	■														■		❑						■		
	Advanced Railroad Grade Crossing	■	❑			❑		❑								■	■	❑						■		
	Railroad Operations Coordination				■						■	■	❑			■	■	■					■			
	Regional Parking Management				■								■			■							■			
	Road Weather Information System						■								❑	■	❑			❑			■		❑	
APTS	Transit Vehicle Tracking				❑	❑					■	■	❑			❑		■			❑	■				
	Transit Fixed-Route Operations											❑	❑			❑		■		❑	❑	■				
	Demand Response Operations											■				❑	❑	■		■	❑	■				
	Transit Passenger and Fare Mgmt									❑	❑	❑				❑		■	■		■	■				
	Transit Security									■	❑	❑				❑		❑		■	■	■				
	Transit Maintenance				■	❑					❑	❑				❑		■		■		■				
	Multi-modal Coordination										■	■	■			■	❑	■		■		■				
	Transit Traveler Information										■				❑	■		■				■				
ATIS	Broadcast Traveler Information	■		❑											■	■	■	❑		■	■	■				
	Interactive Traveler Information	■		❑							❑	■				■	■	❑		■	■	■				
	Autonomous Route Guidance										■						■	❑		■	■					
	Dynamic Route Guidance	■		❑							■	❑			■	■	■	❑		■	■					
	ISP-Based Route Guidance	■		❑							■	■				■	■	■	❑	■	■	■				
	Integrated Transportation Mgmt/RG	■		❑							■	■				■	■	■	❑	■	■	■				
	Yellow Pages & Reservation										❑	■				■	■	❑		■	■	■				
	Dynamic Ridesharing									❑		■				■				■	■	■				
	In Vehicle Signing		❑	❑	❑	❑	❑				■	❑	■			❑	❑	❑		■		❑				
AVSS	Vehicle Safety Monitoring				■							❑					❑			■						
	Driver Safety Monitoring				■	■						❑					■			■						
	Longitudinal Safety Warning				■	❑		■									■			■						
	Lateral Safety Warning				■	❑		■	■								■			■						
	Intersection Safety Warning		■	❑	■	❑		■	■			❑	■	❑		■	■	❑		■			❑	❑		
	Pre-Crash Restraint Deployment				■	❑		■									■								❑	
	Driver Visibility Improvement					❑		■												■						
	Advanced Vehicle Longitudinal Ctrl				■	❑		■									■			■					■	
	Advanced Vehicle Lateral Control				■	❑		■	■								■			■					■	
	Intersection Collision Avoidance		■	❑	■	■		■	■			❑	■	❑		■	■	❑		■			❑	❑	■	
	Automated Highway System	❑	■	❑	■	■		■	■	❑	■	■	■	■		■	■	■	❑	■		■	❑	❑	■	
CVO	Fleet Administration				■						■	■	❑			❑	❑	■		■		■				
	Freight Administration						■				■	■	❑			■	❑	■		■		■				
	Electronic Clearance												■			■		■		■		■	❑	❑		
	CV Administrative Processes											❑				■		■								
	International Border Clearance												■			■		■		■		■	❑	❑		
	Weigh-In-Motion		■										❑				❑					■	❑	❑		
	Roadside CVO Safety		■		❑		❑						■			■	❑					■	❑	❑		
	On-board CVO Safety				■	■	■					❑	❑				❑			■						
	CVO Fleet Maintenance				■						■	■				❑	❑	■		■		■				
	Hazmat Management						■				■	■	❑			■	❑	■		■		■				
EM	Emergency Response									■	❑	❑				■	❑	■				■				
	Emergency Routing				❑	❑					■	■	❑			❑	❑	■		■		■				
	Mayday Support		❑								■	■				■		❑		■	■	■				
ADUS	ITS Data Mart	❑		❑						❑	❑					■	❑	■				■				
	ITS Data Warehouse	❑		❑						❑	❑					■	❑	■				■				
	ITS Virtual Data Warehouse									❑	❑					■	❑	■				■				

- **Immature:** Additional research and development is required before technologies in this area can be cost-effectively and reliably applied to support ITS services. In some cases, potentially suitable technologies have been applied in defense or aerospace applications. Additional research and development is still required in these areas to address the unique producibility, safety, and cost issues associated with larger commercial markets.

Technology areas identified as "Mixed" or Immature" are highlighted in Table 5.3-3 and considered further as "pacing technologies" in this analysis.

Few absolute conclusions can be drawn from the technology maturity assessment alone. The identification of a technology area as immature is not the same as an absolute prediction that deployments will not occur without significant further research. There are numerous examples where relatively immature technologies have been applied in successful products, depending on the customer's needs and expectations. Voice recognition is an example of a technology that might be labeled as immature by this analysis and yet one already finds many workable voice recognition products on the market. Where the need is great enough, creative providers will find other approaches that can be used for interim deployments. For example, technologies which automate vehicle occupant sensing for purposes of determining compliance with HOV requirements are in their infancy. Special rules and manned surveillance stations with high speed cameras are being used in the Fast-Trac Tollway in Southern California to support vehicle occupant sensing today.

Although the relationship is not absolute, the deployment timing for the dependent Market Packages will be influenced by the timing of the required technology advancements. Unfortunately, accurately forecasting technology development timing is extremely difficult. This timing is dependent upon the current status of the required technology and the quantity and productivity of the research that will be performed in the area. Despite the difficulties, many forecasts of technology development timing have been made based on assessment of the best available information. Table 5.3-3 draws on the assessments contained in the National Program Plan, augmented by other sources, for each pacing technology area.

Table 5.3-2: ITS Technology Areas

Technology	Description	Maturity
Traffic Sensors	Sensor technology which monitors overall traffic conditions. Enables collection of basic aggregate measures such as occupancy, volume, and speed.	Mature
Vehicle Status Sensors	Sensors which determine individual characteristics of passing vehicles. Technologies which assess individual vehicle length, weight, number of axles, lane position, and speed are available. Enforcement application technologies that monitor emissions, passenger counts, and operational status for specific vehicles are less mature.	Mixed
Environment Sensors	Sensor technology which monitors local climate (temperature, humidity, precipitation, wind, pollution) and road surface status (dry, wet, ice, snow).	Mature
Vehicle Monitoring Sensors	The range of on-board sensor technologies which monitor vehicle condition (e.g. engine, brake, tire, and suspension status) and performance (current speed, acceleration, yaw, traction, current steering, throttle, braking, and transmission status).	Mature
Driver Monitoring Sensors	Technologies which monitor driver condition by monitoring driving characteristics and/or other psychophysiological symptoms associated with impaired performance.	Immature
Cargo Monitoring Sensors	Technologies which monitor various indicators of cargo status. Load distribution, temperature, acceleration, and pressure are among potential indicators that may be monitored depending on the nature of the cargo.	Mature
Obstacle Ranging Sensors	Technologies which detect and characterize potential obstacles (other vehicles, people, road debris) in a vehicle's vicinity. Supports family of applications with variable performance requirements. Advanced headway maintenance requires high frequency and precision. Driver warning systems may have reduced requirements due to human time scale. Vision enhancement sensors must support overall environment imaging.	Immature
Lane Tracking Sensors	Technologies on-board the vehicle which monitor the position of the vehicle with respect to the travel lane and optionally support interpretation of travel lane geometry ahead of the vehicle.	Immature
Security Sensors	Technologies which provide surveillance of, and restrict access to, secure public areas. Card readers which restrict access and closed circuit television cameras are examples.	Mature
Location Determination	Technologies which determine absolute position. Examples include GPS and other systems that apply trilateration to known locations, either terrestrial or space based. Augmenting these technologies are those which measure travel path and distance (e.g., odometer, compass, gyroscope) from a known location. Very high-precision systems associated with vehicle control are one remaining research area.	Mature w/ rapid innovation

Table 5.3-2: ITS Technology Areas

Technology	Description	Maturity
Wide-Area Wireless Communication (U1t)	Two-way wide-area wireless communications. Primary examples of mature systems for transmitting ITS information include circuit-switched cellular, Cellular Digital Packet Data (CDPD), and Enhanced Specialized Mobile Radio. Maturing technologies include Personal Communications Services (PCS) and various Satellite Communications Networks.	Mature w/ rapid innovation
Broadcast Communication (U1b)	Primary examples include alternative FM Subcarrier technologies. Low data rate RBDS is already standardized with initial market penetration. Multiple high data rate approaches (HSDS, STIC, and DARC) are being considered for standardization.	Mature w/ rapid innovation
Vehicle-Roadside Communication (U2)	Short range wireless communications between infrastructure and vehicle using active radio frequency, passive (backscatter) radio frequency, and/or infrared.	Mature w/ rapid innovation
Vehicle-Vehicle Communication (U3)	High data rate, short range, reliable two way digital communications between vehicles using RF, microwave or infrared spectrum. Favored technical approach has not been selected.	Immature
Fixed Communication (W)	Technologies used to carry information between fixed locations; technology choices are largely dependent on local service provider or local preference for private networks. Various networks (PSTN, ISDN, IP, PDN, private local network) support ITS requirements.	Mature w/ rapid innovation
Algorithms	Processing technology and advanced algorithms which enable advanced vehicle and traffic control applications. Overlap exists between this computational element and the other technology areas it supports.	Mixed
Information Management	Information storage, fusion, and retrieval systems supporting access to distributed heterogeneous data.	Mature w/ rapid innovation
Payment	Technologies which enable secure automated financial transactions in conjunction with information management and communications technologies above. Magnetic strip cards and Smart Card technologies are examples. Both contact and contactless technologies may be used.	Mature w/ rapid innovation
Driver Interface	Audio, visual, and tactile interface technologies appropriate for interaction with drivers during vehicle operation. Console displays (LED, LCD, etc.), heads-up displays and synthesized speech are primary examples of mature technologies. Technologies enabling voice input and non-distracting visual enhancement of the driver's view are less mature.	Mature w/ rapid innovation
Traveler Interface	Same technologies as for driver interface with other, varied constraints. Extreme portability requirements restrict interface options for hand-held devices. Additional capabilities, including hard copy options, for fixed presentation devices.	Mature
Operator Interface	Same as for traveler interface.	Mature

Table 5.3-2: ITS Technology Areas

Technology	Description	Maturity
Signals	Control signals, barriers, or other physical control devices and supporting electronics.	Mature
Signs	Variable message signs including those which include interface to vehicle-roadside communications technologies enabling complementary in-vehicle displays.	Mature
Vehicle Control	Vehicle control system actuators and supporting processing technologies	Immature

Table 5.3-3: Pacing Technology Development Forecasts

Technology	Current Status	Research Projections	Delay
Vehicle Status Sensors -Emissions -Pass. Counts -Operational Status	Infrared technology commercially available to support remote sensing of CO and Hydrocarbons. On-going research in application to remote NOx sensing. Technologies which remotely count passengers without vehicle cooperation in infancy. Each of these sensor technologies can also contribute to an assessment of stationary vehicle operational status. Implementations that rely on vehicle reporting face fewer technical challenges but face similar institutional obstacles.	Uncertain market potential suggests research will primarily be funded by the public sector	Moderate - Long
Driver Monitoring Sensors	Research stage. Tests indicate marginal performance (75% detection rate with 3% false alarm rate cited in National Program Plan) for current implementations. New monitoring algorithms, monitoring of new symptoms, and combinational approaches are under research.	Uncertain market potential suggests research will primarily be funded by the public sector	Long Term
Obstacle Ranging Sensors	Preliminary commercial market initiatives. Ultrasonic, radar, and machine vision technologies have been developed and marketed in heavy vehicle proximity detection systems. Additional research required to extend performance/reliability to satisfy preemptive control app.'s and decrease cost to achieve private vehicle market price points.	Large market potential indicates continued robust private sector research initiatives, supplemented by federal research driven by safety benefits and AHS program.	Moderate
Lane Tracking Sensors	Research stage. Proof-of-concept systems using various infrastructure support concepts (e.g., magnetic nails, special paint/markers, active beacons) have been developed with promising results in controlled environments. Machine vision application to lane departure warning systems without special infrastructure support under study.	Potentially large market in the long term indicates continued private sector research initiatives, supplemented by federal research driven by safety benefits and AHS program.	Long Term

Table 5.3-3: Pacing Technology Development Forecasts

Technology	Current Status	Research Projections	Delay
Vehicle-Vehicle Comm (U3)	Preliminary research stage. Academic research supported by isolated tests in US (PATH program), Japan (Toyota), and Europe (RACE Programme).	Near-term US research will continue on limited scale substantially augmented by AHS program in the near term.	Long Term
Algorithms	Varied status depending on application area (see other entries in this table). Traffic forecasting algorithms (not covered elsewhere) are rudimentary since sufficient source data is not commonly available.	Level of research dependent on application area.	Moderate - Long
Vehicle Control	Academic research as well as proof-of-concept tests in US, Japan, and Europe funded by public sector and automotive industry. Sensory support and control algorithms are primary research areas.	Potentially large market suggests continued private sector research initiatives, supplemented by federal research driven by safety benefits.	Moderate - Long

5.4 Early Market Packages

The Market Packages presented in section 2.2 are inter-related and are also dependent on external factors such as technology advancement, policy change, and development of common interface standards. Moreover, each Market Package provides different benefits, lends itself to different cost recovery mechanisms, and is subject to different levels of market influence. It is through the interplay of these influences that ITS deployments will occur over time.

Figure 5.4-1 is a generalized view of some of the factors that influence deployment of each Market Package. The factors that are discussed in the Market Packages document include Market Package synergies, evaluation / benefits analysis, and enabling technologies (standards are covered in the *Standards Requirements* and *Standards Development* documents). The boxes shown on the left-hand side of the figure represent factors that can stimulate or "motivate" deployment. The boxes on the right-hand side of the figure represent factors that can impede deployment. The interplay between the motivators and impediments will determine the risk, and ultimately, the deployment potential of particular Market Packages. An efficient deployment strategy can reduce the need for motivators by recognizing the time-dependent nature of the impediments on the right hand side of the figure in the deployment strategy.

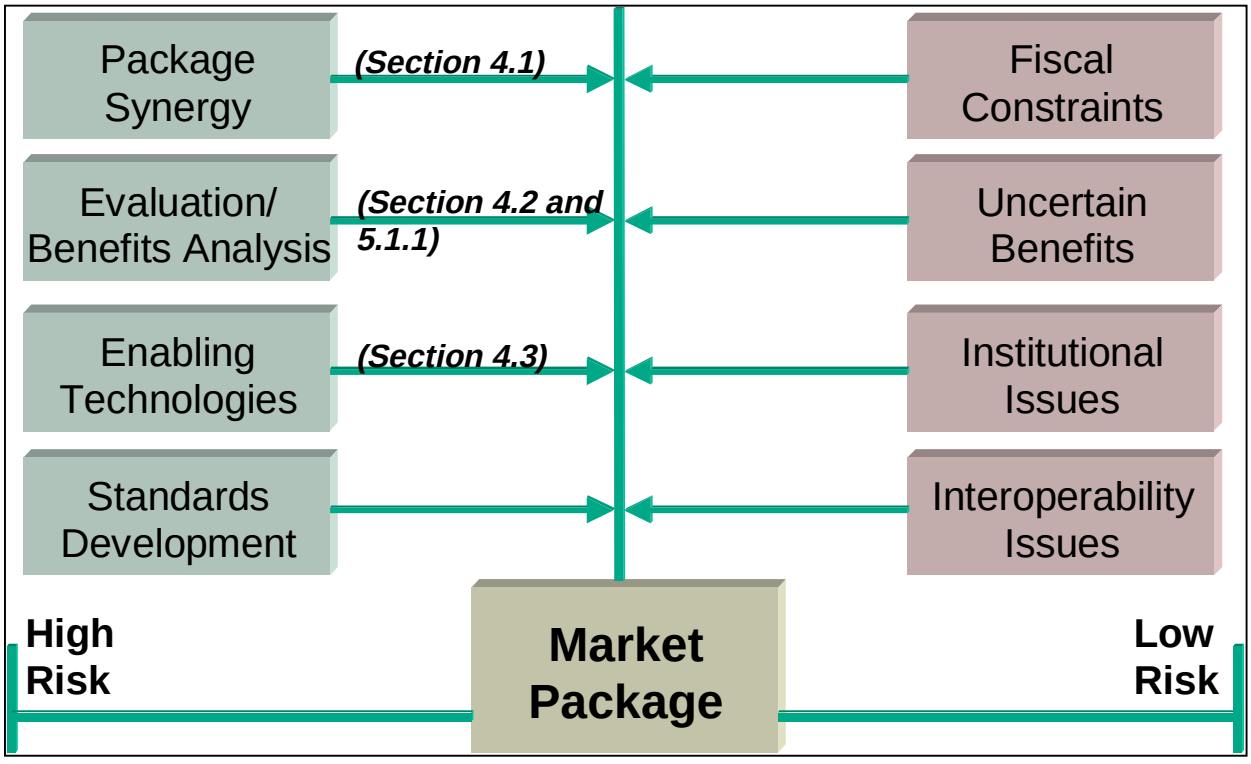


Figure 5.4-1: Factors Affecting Market Package Deployment

The deployment impediments identified in figure 5.4-1 are generally reduced over time. As ITS deployment is initiated and basic Market Packages are deployed, the deployment of more advanced Market Packages which build on the existing capabilities will be enabled. As technology advances, technical constraints for a Market Package should be reduced. As the required standards are developed and approved, interoperability issues are resolved. Thus, as a natural progression, market demand may overcome the challenges associated with Market Package implementation. An implementation strategy then requires a forecast of this market driven deployment coupled with a plan for judicious application of additional motivators where this forecast natural progression is unsatisfactory.

By considering each of these factors, a subset of the Market Packages have been highlighted as important early deployments. Such Market Packages are identified as *Early Market Packages* in this section. The evaluation leading to this Market Package prioritization is based on the supporting analysis earlier in sections 5.1 through 5.3. The Early Market Packages are those packages that meet, or nearly meet, three general criteria:

- *Enabling function.* An Early Market Package satisfies fundamental requirements that enable implementation of a range of more advanced packages that can be selectively implemented over time to meet local needs.

- *Feasible.* An Early Market Package can be implemented with existing technologies, is not dependent on forthcoming national standards for basic implementations, and is also subject to limited non-technical risk since existing institutions and policy are also adequate to support basic implementations.

- *Established Benefit.* An Early Market Package has already been implemented in several locations around the nation which is an indicator of potential demand for the package. Moreover, these preliminary deployments have demonstrated tangible benefits in an operational setting. As such, an Early Market Package is shrouded by fewer unknowns and is likely to subject the local implementor to limited risk. These criteria indicate that market influence is likely to be a significant near-term force in enabling early deployment for the identified packages.

In short, the Early Market Packages appear to be early winners due to a promising combination of low risk implementation characteristics, developing public or private markets for the packages, and tangible system or user benefits.

Table 5.4-1 evaluates the Market Packages against these attributes and identifies the Early Market Packages. A summary of the source and approach for developing each dimension of the evaluation summarized in the table is described.

Enabling Function: Market Packages that are checked (✔) are highlighted in the Market Package synergy analysis presented earlier in section 5.1. as providing

critical early capabilities that will enable future deployments of more advanced services.

Technology Supports: The majority of the Market Packages require only relatively mature, commercially available technologies for implementation. Market Packages that are checked (✔) are identified in section 5.3 of this Market Packages document as not reliant on an identified critical technology area. In interpreting the analysis from section 5.3, basic implementations were also considered. For instance, the HOV Lane Management Market Package is identified in section 5.3 as reliant on a critical vehicle passenger occupancy verification technology. Since useful implementations of this Market Package can be achieved, even without this technology, this Market Package is still identified as technically feasible in table 5.4-1.

Standards Not Required: Market Packages that are checked (✔) are not dependent on forthcoming national standards for basic implementations. In reviewing the standard interface requirements associated with each of the Market Packages, interfaces that are fundamental to provision of a service were distinguished from optional interfaces. Also, it was recognized that even fundamental "national interoperability" requirements will often be met through multiple, competing product-specific "standards". For instance, the Autonomous Route Guidance Market Package is identified as requiring a national interoperability interface to a Map Update Provider. Viable implementations can occur in the absence of a nationally prescribed standard using proprietary map databases that provide the required coverage. Emerging standards efforts such as the Spatial Data Transfer Standard and Open GIS may ultimately enable plug and play interoperability between different map databases. In the mean time, viable products can and will be developed based on the existing proprietary standards. These assumptions to some degree accurately reflect the interplay of market forces and standards and the evolution through proprietary interfaces to open standards as the products and market matures. All Market Packages for which standardization is not a major roadblock to implementation are identified in the column.

Few Institutional Issues: Market Packages that are subject to limited non-technical risk per the analysis included in section 3 of the Implementation Strategy are checked (✔). Market Packages that were identified as having associated interjurisdictional issues, liability implications, antitrust issues, privacy issues, or regulatory constraints are not checked in the column.

Established Benefit: The Market Package benefits that are summarized in section 5.2 of this Market Packages document were used as a basis for this column. Only Market Packages that were highlighted as particularly beneficial are checked in this column. To further reduce the set of candidate Market Packages, only those Market Packages which have existing or currently emerging implementations were

considered since the benefits associated with these Market Packages can be more reliably estimated.

The Early Market Packages are those that best satisfy the combination of these criteria as identified in the last column of table 5.4-1. In some cases, a compelling benefit, significant market activity, or evident public sector interest (for instance, through inclusion in the ITS Infrastructure initiative) caused a Market Package to be identified as early even though there may be remaining standards or institutional issues associated with that package. The shaded boxes in the table identify where a Market Package designated as early is dependent on development of a standard or resolution of institutional issues; such activities are crucial near-term activities to support successful deployment of ITS.

Table 5.4-1: Identifying Early Market Packages

Market Package	Enabling Function	Technology Available	Standards not Reqd	Few Institu-tional Issues	Established Benefit	Early Package
Traffic Management						
Network Surveillance	✓	✓	✓	✓	✓	✓
Probe Surveillance	✓	✓			✓	✓
Surface Street Control	✓	✓	✓	✓	✓	✓
Freeway Control	✓	✓	✓	✓	✓	✓
HOV Lane Management		✓	✓		✓	✓
Reversible Lane Management		✓	✓	✓		
Traffic Information Dissemination		✓	✓	✓	✓	✓
Regional Traffic Control	✓	✓			✓	✓
Incident Management System		✓	✓		✓	✓
Traffic Forecast and Demand Management		✓	✓			
Electronic Toll Collection	✓	✓			✓	✓
Parking Facility Management	✓	✓	✓	✓		
Emissions Monitoring and Management		✓				
Virtual TMC and Smart Probe Data		✓				
Standard Railroad Grade Crossing		✓	✓	✓	✓	✓
Advanced Railroad Grade Crossing			✓			
Railroad Operations Coordination		✓	✓	✓		✓
Regional Parking Management	✓	✓	✓			
Road Weather Information System		✓	✓	✓	✓	✓
Transit Management						
Transit Vehicle Tracking	✓	✓	✓	✓	✓	✓
Transit Fixed-Route Operations	✓	✓	✓	✓	✓	✓
Demand Response Transit Operations	✓	✓	✓	✓	✓	✓
Transit Passenger and Fare Mgmt	✓	✓		✓	✓	✓
Transit Security		✓				✓
Transit Maintenance		✓	✓	✓		✓
Transit Traveler Information	✓	✓	✓	✓	✓	✓
Multi-modal Coordination		✓				✓
Traveler Information						
Broadcast Traveler Information	✓	✓		✓	✓	✓
Interactive Traveler Information	✓	✓	✓	✓	✓	✓
Autonomous Route Guidance	✓	✓	✓	✓	✓	✓
Dynamic Route Guidance		✓		✓		
ISP Based Route Guidance		✓				
Integrated Transportation Mgmt/ Route Guidance						
Yellow Pages and Reservation		✓		✓		
Dynamic Ridesharing		✓				
In Vehicle Signing		✓				
Advanced Vehicle Systems						
Vehicle Safety Monitoring	✓	✓	✓	✓	✓	✓

Market Package	Enabling Function	Technology Available	Standards not Reqd	Few Institu-tional Issues	Established Benefit	Early Package
Driver Safety Monitoring			✓			
Longitudinal Safety Warning			✓	✓		
Lateral Safety Warning			✓	✓		
Intersection Safety Warning						
Pre-Crash Restraint Deployment			✓	✓		
Driver Visibility Improvement			✓			
Advanced Vehicle Longitudinal Control			✓			
Advanced Vehicle Lateral Control			✓			
Intersection Collision Avoidance						
Automated Highway System						
Commercial Vehicle Operations						
Fleet Administration	✓	✓	✓	✓	✓	✓
Freight Administration		✓	✓	✓	✓	
Electronic Clearance	✓	✓		✓	✓	✓
CV Administrative Processes	✓	✓		✓	✓	✓
International Border Electronic Clearance		✓			✓	
Weigh-In-Motion		✓	✓	✓	✓	
Roadside CVO Safety	✓	✓		✓	✓	✓
On-board CVO Safety						
CVO Fleet Maintenance		✓	✓	✓		
HAZMAT Management		✓			✓	✓
Emergency Management						
Emergency Response	✓	✓			✓	✓
Emergency Routing		✓	✓	✓	✓	✓
Mayday Support	✓	✓			✓	✓
Archived Data Management						
ITS Data Mart	✓	✓		✓	✓	✓
ITS Data Warehouse	✓	✓			✓	
ITS Virtual Data Warehouse	✓	✓			✓	

Notes: Check marks (✓) indicate the Market Package meets the criteria identified in the column heading.
Shaded cells indicate areas requiring resolution to support identified Early Market Packages.
See supporting text for additional information.

Further rationale is provided for each of the Early Market Packages in the following:

Traffic Management:
Network Surveillance. This Market Package provides the basic sensing elements for traffic management. It is the foundation upon which control and management systems can be implemented. It is also a vital source of information supporting real-time traveler information systems which makes it among the most crucial of the identified "core functions".

Probe Surveillance. This Market Package is a potentially cost-effective alternative to infrastructure surveillance. The traffic information that is made available through this package is a key enabler for other traffic management and traveler information services.

Surface Street Control. Benefits are well established for this Market Package and existing technologies and institutional arrangements support its deployment. Interjurisdictional issues which may be associated with broader implementations are also resolvable based on the success of existing wide area implementations. The arrival of the NTCIP standard further facilitates advanced implementations.

Freeway Control. See surface street control.

Traffic Information Dissemination. The equitable distribution of basic traffic information through Dynamic Message Signs and Highway Advisory Radio implemented through this Market Package provides immediate benefit to the traveling public using established technologies and without the need for new standards or investment in new in-vehicle equipment. The implementations represented by this Market Package have been, and will continue to be, judiciously deployed as the technical and non-technical challenges of more advanced en-route driver information systems are addressed.

Regional Traffic Control. Traffic control strategies are increasingly regional in scope with emphasis on improving flow along major travel corridors. The potential benefits of integrated regional strategies have been clearly established through many trial implementations. Such implementations are also one of the focus areas within the Metropolitan ITS Infrastructure Initiative (see section 4.1). The peer-to-peer interjurisdictional arrangements and regional communications internetworking that enable regional control strategies facilitate implementation of many of the other traffic control and traveler information Market Packages.

Incident Management. Since incidents account for a significant percentage of congestion, this Market Package is a key early deployment which is actively being deployed in larger metropolitan areas. Preliminary implementations that achieve significant benefit are possible without new standards activity. Interjurisdictional issue resolution which is inherent in this Market Package has already successfully occurred in many areas.

Dynamic Toll/Parking Fee Management. This Market Package provides tangible benefits to users when compared to manual systems and is generally well accepted and widely deployed. This Market Package is also naturally self sustaining through user fees. The Market Package provides core dedicated short range communications, basic driver interface, and AVI functions that can enable several other Market Packages.

Standard Railroad Grade Crossing. Passive warning systems and active warning devices may be augmented with standard traffic control devices and interconnected with adjacent intersections to provide safer and more efficient management of highway traffic at highway-rail intersections. Each of these capabilities can be implemented with today's technology and without need for major new standardization efforts or institutional change.

Railroad Operations Coordination. Many rail operations today have detailed and up-to-date information available on the location and planned itinerary for each train in the system. This information may be made available to highway traffic managers with existing technology and relatively modest institutional and standardization impediments. This rail schedule information may be applied to anticipate highway-rail intersection closures, a significant source of delay in many areas. Adaptive regional traffic control strategies may take this advanced information into account to minimize the impact of rail operations.

Transit Management:

Transit Vehicle Tracking. This Market Package provides the communications between vehicles and transit centers and current vehicle location information that is required by other packages. The technology of Automatic Vehicle Location is proven and in use by many transit agencies. While insufficient data exists at this time to validate transit benefits, its usage in commercial transportation such as the trucking industry has shown it to be beneficial.

Transit Fixed Route Operations. This Market Package provides many of the operations and planning functions required in an automated transit management system. It is in place in many parts of the United States with many vendors providing automated transit management system software products.

Demand Response Transit Operations. As with the fixed route operations package, this Market Package provides many of the core operations and planning functions that would be required by the larger demand responsive fleet.

Transit Passenger and Fare Management. This Market Package provides immediate and tangible benefit to transit users who enjoy the convenience of an electronic fare medium. The benefits of more efficient, cashless operations also accrue to the implementing transit agencies. These deployments are possible in the interim while industry standards move towards the ultimate goal of a common fare medium that transcends transportation modes and regions and may be applied in other consumer transactions.

Transit Security. ITS applications which improve the security of transit users are one of the tools available to transit agencies. Current US DOT support for these systems is demonstrated by their inclusion within the ITS Infrastructure initiative. Potential privacy issues associated with this Market Package must be considered

and implementations selected which strike an appropriate balance between individual privacy and personal safety.

Transit Maintenance. Advanced applications that enhance maintenance monitoring and support for transit vehicles can improve overall transit system performance and make operations more efficient.

Multi-modal Coordination. This Market Package provides real-time coordination between traffic and transit management that can reduce and improve the consistency of transit travel times. Potential inter-jurisdictional issues must be resolved to support local implementation. Careful application is necessary to avoid adverse impacts to the overall efficiency of the network. Current US DOT support for these systems is demonstrated by their inclusion within the ITS Infrastructure initiative.

Traveler Information:

Broadcast Traveler Information. This package contains the core collection and processing capabilities in other ATIS packages. This package provides many of the traveler information functions in basic forms. It is currently in use today through mediums such as FM subcarrier in Europe. This Market Package does require the establishment of national standards for basic viable implementations.

Interactive Traveler Information. This package is a foundation for interactive ATIS and provides the interconnects for the two-way interchange. Examples of current usage are kiosks, telephone, and as an emerging information provider for on-line services and the Internet. Stated-preference surveys indicate that pre-trip access to information through these existing access mechanisms will be well received. More advanced implementations which seamlessly cater to the mobile traveler with en-route information require additional standards work.

Autonomous Route Guidance. Basic autonomous implementations are enjoying preliminary market success, at least in niche markets such as rental fleets. These deployments are not predicated on further technology, institutional policy, or standards development. The in-vehicle equipment provides core position location and routing functions that may be applied to a host of more advanced packages.

Advanced Vehicle Systems

Vehicle Safety Monitoring. This Market Package provides the processing and display basis for most of the AVSS Market Packages. In various simplified forms, this package already exists in vehicles, e.g., brake light outage indicators, electrical system malfunctions indicators, etc. The benefits of these systems are validated by their growing usage by automobile manufacturers. Whether the existing electrical systems will accommodate requirements from this package is a current issue, especially in light of developments of data bus architectures such as J1850

Commercial Vehicle Operations:
Fleet Administration. This Market Package provide the capabilities of Automatic Vehicle Location and Fleet Management. These capabilities are in place and have proven benefit to the trucking industry.

Electronic Clearance. This Market Package established the dedicated short range communications between the vehicle and roadside that supports electronic clearance as well as many of the other Market Packages that are extended applications dependent on the short range communications link. Time savings for participating carriers have been measured and reported in several operational tests.

CV Administrative Processes. This Market Package establishes electronic communications between the commercial vehicle administration and fleet management subsystems. This connectivity enables carrier enrollment that provides a basis for paperless trucking and also supports many of the more advanced commercial vehicle services. An area of active interest which forms a foundation for programs like IRP and IFTA.

Roadside CVO Safety. The promise of improved safety is a principal motivator for application of ITS to commercial vehicle operations. The more effective and focused roadside safety inspections offered by this Market Package most directly address this objective. This Market Package also develops the roadside equipment and interfaces that will ultimately leverage the separate On-board CVO Safety Market Package.

HAZMAT Management. Hazardous material management addresses one of the more serious safety issues associated with commercial vehicle operations. The potential for this Market Package to address key public safety risks justifies designation as an early Market Package in spite of several existing roadblocks to its implementation. Including this Market Package in the set of Early Market Packages is in effect a recommendation for prioritization of the standards development efforts and resolution of the non-technical issues associated with this Market Package.

Emergency Management:
Emergency Response. This Market Package is central to developing coordinated emergency management including emergency management, traffic, and transit stakeholders. This Market Package is a key component to enhancing safety in conjunction with the Incident Management and Mayday Support Market Packages.

Emergency Routing. An area of active private sector interest and public sector procurement, this Market Package leverages the same vehicle location, wide area digital communications, dispatch support, and in-vehicle interactive interface technologies that are instrumental to the related commercial and transit fleet support Market Packages. New standards are not required to support basic

implementations. Progressive implementations which address more extensive inter-agency coordination in routing may be added as new standards become available and are adopted for the implementing region.

Mayday Support. Active private sector deployment of Mayday systems as value-added options on new automobiles highlights the potential for this package as an early deployment. Based on outreach performed through the Architecture program and other industry activity, this appears to be an area of near-term and active development. Early deployments establish interactive, digital communications capabilities in the vehicle which can be leveraged by other Market Packages. National standards may enhance the performance and reliability of the service provided.

ITS Data Mart. This Market Package is key to better utilizing the transportation information collecting during operation of ITS systems to facilitate and enhance the quantitative support for transportation planning, research, and analysis. Early implementations may consider the existing planning tools that are used in the region and align the historical data collected during transportation system operation to support these interfaces. Resolution of inter-jurisdictional and standardization issues will promote greater regional data integration through the ITS Data Warehouse and ITS Virtual Data Warehouse Market Packages.

6 Using the Market Packages

State and local transportation agencies play a pivotal role in identifying the transportation problems and needs facing their communities and formulating appropriate and cost-effective solutions to address these problems and needs. These institutions will determine which ITS services and implementation options should be prioritized given regional goals, objectives, financial capabilities, travel demand estimates, technology development, and environmental constraints. They will also have to explore opportunities for integrating traditional alternatives with ITS services and using ITS services to enhance existing systems and services. Market Packages enable transportation planners and decision-makers to determine appropriate ITS services that satisfy local needs.

Market Packages are useful for organizing and planning the implementation of technology solutions to transportation problems in a manner that ensures that these technology applications work in concert with one another. They can act as "building blocks" which can either stand alone or work in combination with other packages. Figure 6-1 shows the transportation system implementation process at the very highest level. As indicated in the figure, Market Package analyses will be most applicable to the planning phase since this is when regional integration strategies, regional architectures, and project concepts are formulated. Because Market Packages encompass "real world" elements (i.e. centers, travelers, field devices, and vehicles) to which stakeholders can relate, they often serve as catalysts to the cooperative transportation decision-making process. This chapter provides guidance for using Market Packages to craft and refine regional ITS integration strategies. Lesser emphasis is placed on guidance for implementation of specific projects once the general integrating framework has been defined. Such detailed guidance is better left to specialists familiar with the specific local requirements.

Some of the areas in the planning process where Market Packages can be applied include:

- Identifying transportation services that can be implemented to address specific regional transportation problems or to support broader regional plans.
- Identifying necessary architecture elements (e.g. Subsystems, Terminators, and Architecture Flows) associated with a particular service.
- Identifying key stakeholders and institutions responsible for service delivery, the functions they need to perform, and degree to which they will need to cooperate and share information with other stakeholders and institutions to fairly allocate costs, benefits, control, and liability.
- Supporting a preliminary examination of the functionality underlying a particular service, which can be used as the basis for technology choices and preparing initial cost, estimates.

- Defining key subsystem interfaces, determining the opportunity for using standardized interfaces, and identifying interface options and opportunities for systems integration.

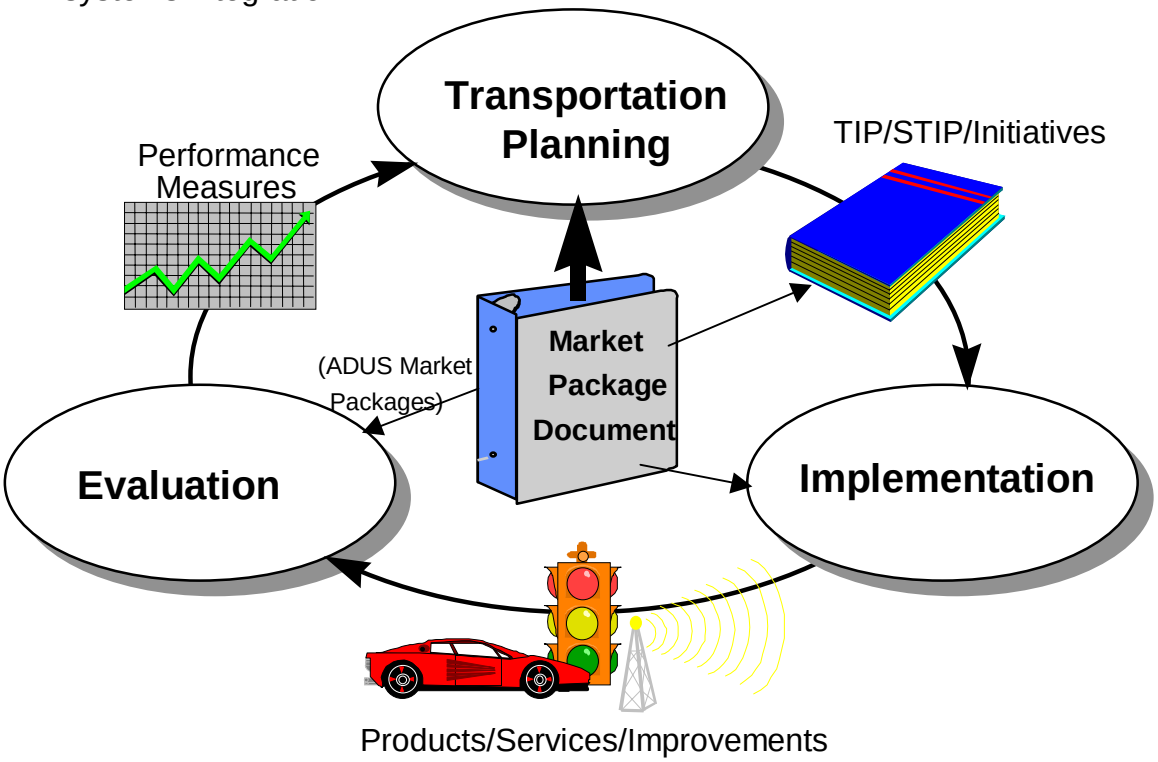


Figure 6-1. ITS Implementation

This chapter illustrates the primary contexts for applying the Market Packages and some of the related considerations and design options associated with their use. Section 6.1 provides guidance for selecting Market Packages. Section 6.2 describes how Market Packages can be used to prepare regional ITS integration plans or regional architectures. Section 6.3 illustrates the use of Market Packages in defining projects.

6.1 Selecting Market Packages to Align with Regional Problems, Needs, Goals, and Objectives

Early activities in the transportation planning process typically include the identification of problems, inventory of regional transportation system assets, and cultivation of institutional coalitions. These activities are usually followed by the identification of alternative strategies to address the problems identified. One of the most prevalent uses of Market Packages to date has been to serve as a mechanism for linking common transportation problems, challenges, goals, and policies with potential ITS solutions. A broad range of alternative solutions may be

applied to solve identified transportation problems. Only some of these solutions may be labeled "ITS" and directly supported by the National ITS Architecture. Other viable solutions include conventional transportation improvements (such as highway capacity expansion), policies (such as pricing), and alternative advanced technology applications not specifically covered by the Architecture. Solutions could be devised that consist of ITS and non-ITS components. The planner's challenge is to select a relevant set of Market Packages by screening the 63 Market Packages defined in the National ITS Architecture, and then customizing Market Packages by adding and deleting elements where appropriate.

Market Packages can be linked to regional needs and priorities in various ways. One approach is to map Market Packages against specific problems, deficiencies, or objectives. This bottom up approach might be representative of the situation where local agencies, that have a specific need and/or localized perspective, submit candidate projects for consideration in a state or metropolitan transportation plan. Alternatively, Market Packages can be selected in a top down manner where broad regional or corridor goals and policies establish a desired course of action and strategies are identified that are consistent with most or all of the enumerated priority areas. The top down approach requires more comprehensive evaluation processes and trade-off analyses since the candidate services need to satisfy multi-dimensional requirements. Section 6-3 discusses issues related to Market Package evaluation.

6.1.1 Relationship of Market Packages to Early Deployment Plans and User Services

Mapping Market Packages to problems was a key step in many of the Early Deployment Plans (EDP) and ITS Strategic Studies conducted throughout the country since ISTEA was enacted. Figure 6.1-1 depicts the fundamental EDP process[6].

[6] Sections 6.2 and 6.3 describe how Market Packages are increasingly being used to support step 6 in Figure 6-2; i.e. definition of functional requirements and the development of a regional architecture.

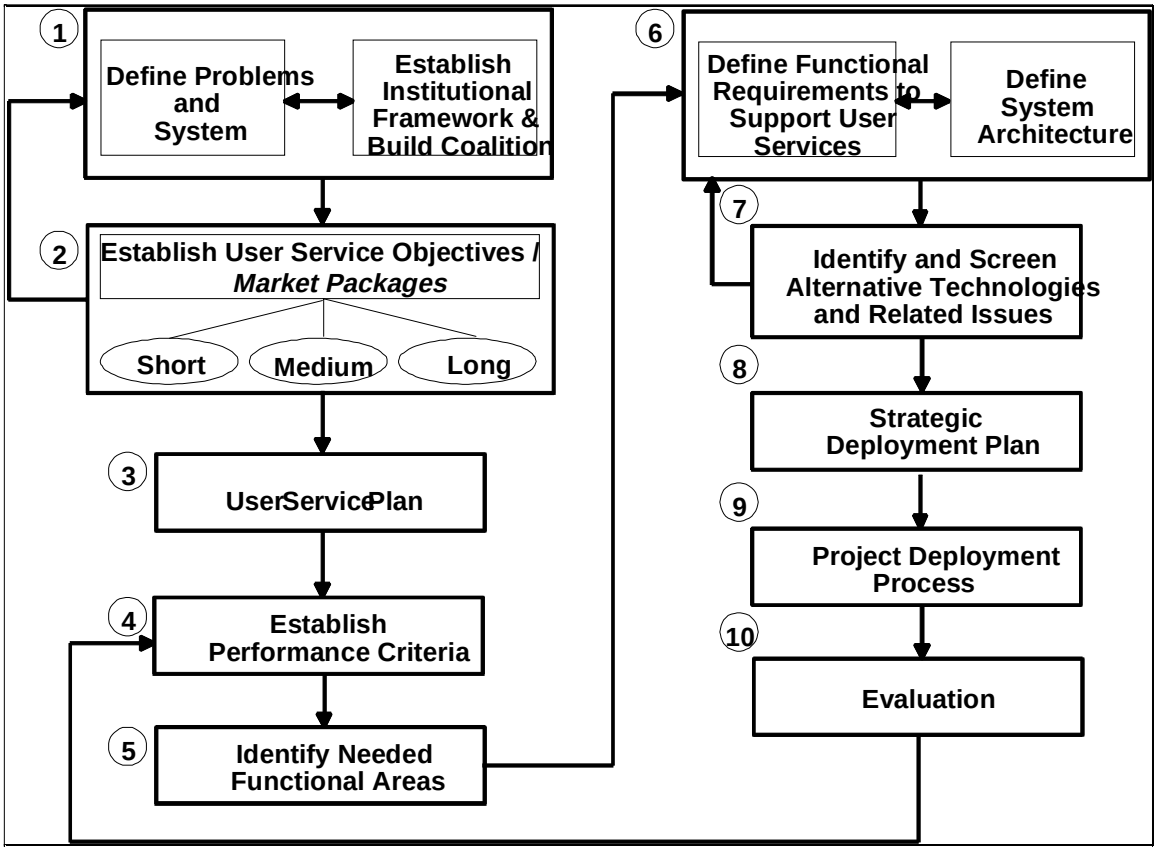


Figure 6.1-1. Guiding Process for Many ITS Early Deployment Plans

Since the concept of User Services preceded that of Market Packages, many early ITS studies used User Services as the available palette of implementation alternatives (see box 2 in the above figure). As presented in Section 3, the User Services and Market Packages are well correlated. This relationship allows a translation between a set of prioritized User Services and the equivalent Market Package prioritization. Since Market Packages are defined to a finer level of granularity than the User Services (63 Market Packages vs. 31 User Services), the Market Package prioritization that is derived based on the User Service to Market Package relationship should be viewed as an initial prioritization. The finer granularity of the Market Packages allows a more refined prioritization of User Service sub-elements that are identified separately in the Market Package definitions. Through this process, a Market Package plan may be efficiently derived by leveraging the existing User Service analysis. Consequently, regions that have performed a prioritization analysis based on User Service analysis can assess the Market Packages with minimal rework.

An example of this translation, derived from the Dallas Early Deployment Plan, is shown in Table 6.1-1. The relationship between User Services and Market

Packages identified in the body of the table is then used to translate the User Service prioritization into an equivalent Market Package prioritization that is identified in the left most column in the table.

Whether User Services or Market Packages are used, the process of selecting and prioritizing the appropriate ITS services for a region is no small task, primarily because of the broad consensus that is required. The process typically involves participation from a wide coalition of stakeholders in a series of meetings and outreach forums before consensus is reached on an accepted set of priority services.

Table 6.1-1: Translating from User Service to Market Package Priorities (Dallas-Area Example)

	High Priority											Medium				Low Priority																				
Market Packages	Pre-Trip Travel Information	Traffic Control	Incident Management	Travel Demand Management	Public Transportation Management	Route Transit Information	Public Travel Security	Highway-Rail Intersection	Hazardous Material Incident Response	Emergency Notification And Personal Security	Emergency Vehicle Management	Route Driver Information	Ride Matching And Reservation	Electronic Payment Services	Board Safety Monitoring	Emissions Testing And Mitigation	Route Guidance	Traveler Services Information	Personalized Public Transit	Commercial Vehicle Electronic Clearance	Automated Roadside Safety Inspection	Commercial Vehicle Administrative Process	Commercial Fleet Management	Longitudinal Collision Avoidance	Lateral Collision Avoidance	Intersection Collision Avoidance	Vision Enhancement For Crash Avoidance	Safety Readiness	Crash Restraint Deployment	Automated Vehicle Operation
High Priority Market Packages																																			
Network Surveillance		✓																																	
Probe Surveillance		✓																																	
Surface Street Control		✓	✓																																
Freeway Control		✓	✓	✓																															
HOV and Reversible Lane Management		✓		✓																															
Traffic Information Dissemination		✓						✓																											
Regional Traffic Control		✓																																	
Incident Management System			✓																																
Traffic Network Performance Evaluation		✓		✓																															
Dynamic Toll/Parking Fee Management				✓										✓																					
Virtual TMC and Smart Probe Data		✓	✓									✓																							
Transit Vehicle Tracking					✓	✓	✓																												
Transit Fixed-Route Operations					✓	✓																													
Demand Response Transit Operations					✓	✓																													
Transit Passenger and Fare Management														✓																					
Transit Security					✓		✓																												
Transit Maintenance					✓																														
Multi-modal Coordination		✓		✓	✓																														
Broadcast Traveler Information	✓					✓						✓																							
Interactive Traveler Information	✓					✓						✓		✓					✓																
Freight Administration									✓																										
Standard Railroad Grade Crossing								✓																											
Railroad Operations Coordination								✓																											
HAZMAT Managment			✓						✓																										
Emergency Response											✓																								
Emergency Routing											✓																								
Mayday Support										✓	✓																								
ITS Planning					✓																														
Medium Priority Market Packages																																			
Yellow Pages and Reservation	✓											✓		✓				✓																	
Dynamic Ridesharing												✓	✓	✓																					
In Vehicle Signing								✓				✓																							
On-board CVO Safety															✓																				
Low Priority Market Packages																																			
Emissions and Environmental Hazards Sensing																✓																			
Advanced Railroad Grade Crossing								✓																											
Autonomous Route Guidance																	✓																		
Dynamic Route Guidance																	✓																		
ISP Based Route Guidance																	✓																		
Integrated Transportation Mgmt/Route Guidance																	✓																		
Vehicle Safety Monitoring																													✓	✓					
Driver Safety Monitoring																													✓						
Longitudinal Safety Warning																								✓					✓						
Lateral Safety Warning																									✓				✓						
Intersection Safety Warning								✓																		✓			✓						
Pre-Crash Restraint Deployment																													✓	✓					
Driver Visibility Improvement																											✓								
Advanced Vehicle Longitudinal Control																								✓											
Advanced Vehicle Lateral Control																									✓										
Intersection Collision Avoidance								✓																		✓									
Automated Highway System																																			✓
Fleet Administration																							✓												
Electronic Clearance																				✓		✓													
CV Administrative Processes																				✓		✓													
International Border Electronic Clearance																				✓		✓													
Weigh-In-Motion																				✓															
Roadside CVO Safety																					✓														
CVO Fleet Maintenance															✓								✓												

6.1.2 Relationship of Market Packages to Identified Problems and Solutions

Table 6.1-2 was developed to assist in directly mapping Market Packages to problems. The table provides a range of solutions that can be considered to address identified problems and deficiencies. Note that the distinction between "conventional" and "advanced" transportation solutions identified in the table is often obscured since there are many examples where "conventional" solutions are implemented in innovative ways and other examples where "advanced" solutions have been implemented using manual systems for years.

The column in the table that identifies "Supporting Market Packages" provides the necessary linkage between the general solutions and the National ITS Architecture to support succeeding steps in the process. As implied by the table, the conventional transportation solutions do not map directly into the National ITS Architecture. In addition, there are several alternative solutions (such as telecommuting) which are not directly supported by the National Architecture definition. Complete descriptions for each of the Market Packages defined by the Architecture is included in Section 2.2.

The EDP for the I-40 Corridor in Northern Arizona provides an example of how Market Packages can be mapped to identified problems. The goals of the study were to develop a Strategic Plan for deployment of rural ITS technologies along the I-40 corridor in northern Arizona and to create a long term coalition of I-40 stakeholders, both in Arizona and from neighboring corridor states. Table 6.1-3 shows the corridor needs that were identified and the Market Packages that mapped to the needs. Study Participants estimated the time frame when the Market Packages would likely be implemented. The analysis also drew upon the Rural Critical Program areas defined by USDOT that represent categories of rural ITS needs. The Market Packages selected were then used to develop the corridor architecture. Section 6-2 discusses how Market Packages can be used to formulate regional (or corridor) architectures.

Table 6.1-2: Connecting Problems, Solutions, and the National ITS Architecture

Problem	Solutions	Conventional Approach	Advanced Systems Approach	Supporting Market Packages	Considerations
Traffic Congestion	Increase roadway capacity (vehicular throughput)	▪ New roads ▪ New lanes	▪ Advanced traffic control ▪ Incident Management ▪ Electronic Toll Collection ▪ Corridor Management ▪ Advanced vehicle systems (Reduce headway)	▪ Surface Street Control ▪ Freeway Control ▪ Incident Management System ▪ Dynamic toll/parking fee management ▪ Regional Traffic Control ▪ Railroad Operations Coordination ▪ Advanced vehicle longitudinal control ▪ Automated highway system	<u>Conventional</u> Environmental constraints Land use and community resistance High cost of construction <u>Advanced</u> Near-term services yield modest benefits Latent demand effects Inter-jurisdictional issues
	Increase passenger throughput	▪ HOV Lanes ▪ Car Pooling ▪ Fixed route transit	▪ Real-time ride matching ▪ Integrate Transit and Feeder Services ▪ Flexible route transit ▪ New personalized public transit	▪ Dynamic Ridesharing ▪ Multi-modal coordination ▪ Demand Response Transit Operations	Privacy and personal security
	Reduce demand	▪ Flex Time Programs	▪ Telecommuting ▪ Other telesubstitutions ▪ Transportation Pricing	▪ Dynamic toll/parking fee management	Significant component of demand relatively inelastic.
Lack of Mobility and Accessibility	Provide User Friendly Access to Quality Transportation Services	▪ Expand Fixed Route Transit and Paratransit Services ▪ Radio and TV Traffic Reports	▪ Multi-modal pre-trip and en-route traveler information services ▪ Respond Dynamically to Changing Demand ▪ Personalized Public Transportation Services ▪ Common, enhanced fare card	▪ Interactive Traveler Information ▪ Demand Response Transit Operations ▪ Transit Passenger and Fare Management	<u>Conventional</u> Declining ridership <u>Advanced</u> Interjurisdictional cooperation Standards Equitable access to information
Disconnected Transportation Modes	Improve Intermodality	▪ Inter-agency agreements	▪ Regional Transportation Management Systems ▪ Regional Transportation Information Clearinghouse ▪ Disseminate multi-mode information pre-trip and en-route	▪ Regional Traffic Control ▪ Multi-modal Coordination ▪ Interactive Traveler Information	<u>Conventional</u> Often static and/or slow to adapt as needs change. <u>Advanced</u> Existing system incompatibilities Standards

Problem	Solutions	Conventional Approach	Advanced Systems Approach	Supporting Market Packages	Considerations
Severe budgetary constraints	Use existing funding efficiently	▪ Existing funding authorizations and selection processes	▪ Privatize Market Packages ▪ Public-private partnerships ▪ Barter right-of-way ▪ Advanced Maintenance Strategies	▪ ▪ Transit maintenance	Market uncertainties make private sector cautious Telecommunicatoins deregulation makes right-of-way barter a near-term opportunity.
	Leverage new funding sources		▪ Increased emphasis on fee-for-use services		Equity
Transportation following emergencies	Improve disaster response plans	▪ Review and improve existing emergency plans	▪ Establish emergency response center (ERC) ▪ Internetwork ERC with law enforcement, emergency units, traffic management, transit, ...	▪ Emergency response ▪ Incident Management System ▪ Emergency Routing	<u>Conventional</u> Interagency coordination challenges <u>Advanced</u> Interagency coordination challenges Standards
Traffic accidents, injuries, and fatalities	Improve safety	▪ Improve roadway geometry (increase radius of curvature, widen lanes,...) ▪ Improve sight distances ▪ Traffic signals, protected left hand turns at intersections ▪ Grade Separate Crossings ▪ Driver training ▪ Sobriety check points ▪ Lighten dark roads to improve visibility/better lighting ▪ Reduce speed limits/post warnings in problem areas	▪ Partially and fully automated vehicle control systems ▪ Intersection collision avoidance ▪ Automated warning systems ▪ Vehicle condition monitoring ▪ Driver condition monitoring ▪ Driver vision enhancement ▪ Advanced Grade Crossing Systems ▪ Automated detection of adverse weather and road conditions, vehicle warning, and road crew notification ▪ Automated emergency notification	▪ All AVSS Market Packages ▪ Intersection collision avoidance ▪ In vehicle signing ▪ Vehicle safety monitoring ▪ Driver safety monitoring ▪ Driver visibility improvement ▪ Standard Railroad Grade Crossing ▪ Advanced Railroad Grade Crossing ▪ Network surveillance ▪ Traffic information dissemination ▪ In vehicle signing ▪ Mayday Support	<u>Conventional</u> High costs Human error is primary cause <u>Advanced</u> Mixed results for initial collision warning devices Relatively slow roll out for AVSS services anticipated Tort liability issues hinder innovative deployments High speed grade crossing systems may require extended closure times

Problem	Solutions	Conventional Approach	Advanced Systems Approach	Supporting Market Packages	Considerations
Air Pollution	Increase transportation system efficiency, reduce travel and fuel consumption	▪ More efficient conventional vehicles ▪ Vehicle emissions inspections ▪ Promotion of alternatives to single occupant vehicle travel ▪ Increased capacity to reduce vehicle delay ▪ Regulations	▪ Remote sensing of emissions ▪ Advanced traffic management to smooth flows ▪ Multi-modal pre-trip info ▪ Telecommuting ▪ Other telesubstitutions ▪ Transportation Pricing ▪ Alternative fuel vehicles	▪ Emissions and environmental hazards sensing ▪ Surface Street Control ▪ Freeway Control ▪ Regional Traffic Control ▪ Interactive Traveler Information ▪ Dynamic Toll/Parking Fee Management	<u>Conventional</u> Increasing demand can offset initial benefit of added capacity. Regulations, inspections are unpopular and onerous. <u>Advanced</u> Increasing demand can offset efficiency improvements.

Table 6.1-3. I-40 Corridor Needs and Related Market Packages[7]

Rural Critical Program Area	I-40 Corridor Need	Market Package	Time Frame
Tourism and Traveler Information Services	Route, destination information, tourism, special event information, travel services information	• Broadcast traveler information • Interactive Traveler Information	Near term
		• In-vehicle signing	Long term
	Traffic, congestion information	• Interactive Traveler Information	Near term
		• In-vehicle signing	Long term
	Traffic reports; weather information	• Traffic Information Dissemination, Broadcast Traveler Information	Near term
		• In-vehicle signing	Long term
Infrastructure Operations and Maintenance	Incident detection and notification to motorists	• Incident Management • Freeway Operations	Near term
		• Surface Street Control	Long term
	Early warning of severe roadway geometry, ice and hydroplaning conditions, falling rock, reduced visibility	• Traffic Control	Mid term
		• Surface Street Control	Long term
Emergency Services	Improved emergency management Faster incident response	• Emergency Response	Near term
	Increase availability of automated emergency notification receivers; improve HAZMAT notification and emergency management notification	• HAZMAT Routing • Emergency Routing • MAYDAY Support	Mid term
Traveler Safety and Security	Collision Avoidance	• Traveler Security • Highway Rail Intersection	Mid term
Commercial Vehicle Operations	Improve safety, efficiency	• Fleet administration	Near term
Public traveler / mobility services	Improved coordination among modes	• Multi-modal coordination • Intermodal Traveler Fare Management	Long term

[7] Wall, Henry, E. Hauser, and A. Kolcz. *Strategic Plan for Early Deployment of Intelligent Transportation Systems on Interstate 40 Corridor*. Report No. FHWA-AZ-9743. May 1997.

6.1.3 Relationship of Market Packages to Objectives and Goals

In addition to mitigating "problems", long-range planners often view transportation decisions as instruments that can positively influence the character of a region. In this case, Market Packages may be mapped to objectives, which in turn, are mapped to goals. Table 6.1-4 lists goals typically considered in the long rang planning process, some example objectives established to support the goals, and some Market Packages that are likely to generate impacts consistent with the objectives.

One of the advantages both the problems to Market Packages and goals/objectives to Market Packages approaches is that they provide common frameworks that can be used to develop traditional *and* ITS (i.e., Market Package) alternatives. Using these approaches will support the mainstreaming of ITS into traditional transportation planning processes.

Another example of how Market Packages can encourage ITS mainstreaming is the fact that many ITS options represented in Market Packages can be linked with alternatives regularly considered in the planning process. For instance, metropolitan areas that are designated non-attainment areas with regard to air quality need to develop transportation control measures (TCM's). TCM's are transportation initiatives designed to reduce the level of motor vehicle emissions and often include strategies that wholly or partly include ITS strategies. Market Packages such as Surface Street Control, Freeway Control, Incident Management, Electronic Toll Collection, Traffic Forecast and Demand Management, and Emissions Monitoring and Management would be some of the options that could comprise part of a TCM package of strategies.

In addition, planners performing analyses of major transportation investments for corridors or sub-areas in metropolitan areas often consider various alternatives to roadway capacity expansion options. These alternatives typically include transportation system management (TSM), transportation demand management (TDM), high occupancy vehicle (HOV), and transit alternatives. All of these alternatives can be supported or enhanced through the services provided by Market Packages. Table 6-5 identifies some of the Market Packages that support these broader transportation alternatives.

Table 6.1-4. Example Mapping of Goals and Objectives to Market Packages

Typical Long Range Planning Goals	Objectives / Effectiveness Measures	Example Market Packages
Increase operational efficiency and capacity of the transportation system	Reduce vehicle miles traveled (VMT) experiencing congestion on regional freeways	• Freeway Control • Incident Management • Electronic Toll Collection
	Reduce VMT experiencing congestion in the central business district (CBD)	• Surface Street Control • Parking Facility Management
	Reduce travel time between selected origins and destinations	• Transit Traveler Information • ISP Based Route Guidance
Improve the safety of the transportation system	Reduce accident frequency and severity on regional freeways and arterials	• Incident Management • Vehicle Safety Monitoring • Freeway Control
	Improve safety of highway rail intersections	• Standard / Advanced Railroad Grade Crossing
	Warn travelers of adverse weather and roadway conditions	• Road Weather Information System
	Increase security of public transportation systems	• Transit Security
	Improve emergency response detection and clearance	• Incident Management • Emergency Routing • Emergency Response
Enhance personal mobility, convenience, and comfort while using the transportation system	Increase the amount and quality of transportation information available to travelers.	• Broadcast Traveler Information
	Provide improved access and more efficient intermodal passenger connections	• Multi-Modal Coordination • Transit Traveler Information
Improve regional air quality	Reduce vehicle emissions	• Emissions Monitoring And Management • Parking Facility Management • Surface Street Control
Support regional economic development	Reduce travel time variability in freight market	• Electronic Clearance • Commercial Vehicle Administrative Processes • Fleet Administration
	Improve access to regional airport	• Paratransit Operations • Dynamic Route Guidance • Air Shipment Management (Locally Developed Market Package)
Improve transit service utilization	Improve continuity of transit services	• Multi-Modal Coordination
	Provide timely distribution of transit information	• Transit traveler information
	Provide management tools to better utilize operations resources	• Transit maintenance

Table 6.1-5. Typical Alternatives Generated in Corridor or Sub-Area Studies and Some Related ITS Market Packages

Alternative Type	Examples of Supporting ITS Market Packages
Transportation System Management	• Broadcast Traveler Information • Surface Street Control • Incident Management System
Transportation Demand Management	• Dynamic Ridesharing • Electronic Toll Collection • Parking Facility Management
High Occupancy Vehicle	• HOV Lane Management • Dynamic Ridesharing
Transit	• Transit Fixed Route Operations • Transit Traveler Information • Transit Vehicle Tracking

In cases where the planning process has advanced to point where project definition has begun, Market Packages can be mapped directly to projects. This might be representative of the case where projects have advanced to the Transportation Improvement Program (TIP) stage prior to the development of a regional ITS architecture. Regional stakeholders may then want to revisit these projects to ensure they are consistent with the emerging regional ITS architecture. Table 6.1-6 shows excerpt of a table in Garden State Parkway EDP showing how projects previously identified for the corridor were mapped to Market Packages.

Table 6.1-6. Candidate Projects by Market Package in Garden State Corridor[8]

Candidate Projects	Market Package
• Install ramp metering on selected Garden State Parkway on-ramps • Coordinate ramp metering with local signals • Install lane use signals on Driscoll Bridge, Union/Essex sections and other areas with frequent accidents • Install variable speed limit signs in areas with frequent accidents and areas prone to reduced visibility	Freeway Control
• Install on-board surveillance cameras • Provide CCTV surveillance at major transit stops	Transit Security
• Support real time car pool/rideshare databases of NJ Traffic Management Associations	Dynamic Ridesharing
Etc.	Etc.

[8] Frederick R. Harris, Inc.. *"Garden State Parkway ITS Early Deployment Planning Study".* December, 1997.

Finally, ITS strategies produce a rich source of data that can be used for monitoring, planning, and research purposes. ITS data stored for future analysis can support multiple transportation functions including:

-
- Transit operations and service planning,
- Air quality analyses
- Commercial vehicle operations and freight planning
- Safety analyses
- Traffic operations
- Design, construction and maintenance management
- Emergency service planning
- Traveler information services

Three Market Packages have been developed to reflect the incorporation of the Archived Data User Service (ADUS) in the National ITS Architecture. The ADUS Market Packages encompass both decentralized (e.g. each agency operates their own archive) and centralized (e.g. multiple agencies contribute to a single repository) models. The three data archiving Market Packages are: (1) ITS Data Mart, (2) ITS Data Warehouse, and (3) Virtual Data Warehouse.

Regardless of the Market Packages that are selected or the selection approach used, consensus among institutions must be reached on the selected solutions, priorities, and timing. Fortunately, TEA-21 and the Clean Air Act were designed with specific provisions to create climates for such cooperative inter-jurisdictional relationships and integrated solutions.

6.1.4 Issues Related to Evaluating Market Packages

Section 4.2 described some of the anticipated benefits associated with each of the Market Packages. These general relationships along with an understudying of the regional needs and priorities (as discussed above) can provide the initial information needed to perform a preliminary Market Package screening. However, in order to more precisely assess candidate Market Packages and allow comparisons of ITS alternatives with traditional alternatives, a more rigorous evaluation process must be performed. The evaluation must include a reliable forecast of the benefit of the potential Market Package solutions so that these strategies can be compared with traditional alternatives. A clear understanding of the relationship between the Market Packages and the public sector costs, and the economic, environmental, and social impacts is necessary.

Technical models such as traffic simulation and travel demand forecasting models have limited ability to quantitatively estimate Market Package impacts. One difficulty, however is that Market Packages are not defined to a level of detail sufficient to perform detailed accurate analyses. Market Packages, for example, do not prescribe specific technologies, necessary asset deployment coverage

throughout the system, or operational concepts. All of these factors would affect the levels of impacts that would be derived from Market Packages.

Another difficulty with evaluation is that most models have not been designed to estimate the complex demand-supply interaction of ITS and the ability compare ITS with non-ITS alternatives. Models such the ITS Deployment Analysis System (IDAS)[9] are being developed and can serve as sketch planning tools for analyzing the impacts alternative ITS deployment scenarios and for testing tradeoffs of traditional highway and transit infrastructure options. In addition to the traditional benefits associated with ITS services such as travel time, emissions, and safety, IDAS will determine some non-traditional benefits of ITS deployments, such as improved travel time reliability, increased safety from incident management, and operating efficiencies. The model also attempts to capture the some of the benefits of systems integration by including default estimates of system benefits that exceed the benefits assumed for individual components. IDAS can also keep track of equipment installed on the network attribute (i.e., link or node) and will share those costs of equipment if the IDAS setup defined by the user allows equipment to be shared. In order to apply a model such as IDAS for evaluating Market Packages, users would need to carefully estimate component costs and specific deployment details (e.g. location of equipment, time frame of implementation, etc.).

Because of the Market Packages are not defined at a level of detail necessary for rigorous quantitative evaluation, Smith suggests the use of a matrix showing, qualitatively, how various Market Packages seem to satisfy identified performance criteria[10]. Table 6.1-7 shows an example of such a matrix.

Table 6.1-7. Example Market Package Evaluation Matrix.

	Performance Evaluation Criteria		**Other Evaluation Criteria**		
Market Package	**Safety**	**Vehicle Miles of Travel**	**Public Acceptance**	**Proven Technology**	**Etc.**
Market Package 1	High	Medium	High	High	Etc
Market Package 2	Low	High	Medium	High	Etc
Market Package 3	Medium	Medium	High	Low	Etc
Etc.	Etc	Etc	Etc	Etc	Etc

In addition to its simplicity and understandability, another advantage of the matrix approach is that it simultaneously allows performance and non-performance criteria to be assessed. Other possible performance criteria identified by Smith

[9] See http://www-cta.ornl.gov/cta/research/idas/index.htm

[10] Smith, Steve. *Integrating Intelligent Transportation Systems within the Transportation Planning Process: An Interim Handbook.* FHWA-SA-98-048. January 1998, pp. 5-37.

include vehicle hours of travel, average speed, number of accidents, percentage of trips by mode, vehicle emissions, energy consumption, transit on-time performance, cost (capital, operating, maintenance), and benefit/cost ratio or net present value. Other possible non-performance criteria include degree to which problems are addressed, consistency with regional goals and objectives, operational feasibility, extent to which Market Package enables other functions.

Another useful tool for displaying the relative utility (or implementation time frame) of a set of regional Market Packages is to graph Market Package Implementatability vs. Goal Satisfaction and place the various Market Packages within the appropriate regions. This technique was employed in the Garden State Parkway (NJ) Early Deployment Planning Study[11]. Figure 6.1-2 illustrates a mapping of Market Packages to Implementability / Goals Satisfaction. In this case, Market Packages that fall within upper right hand region of the graph (high goal satisfaction *and* high feasibility) would receive top priority.

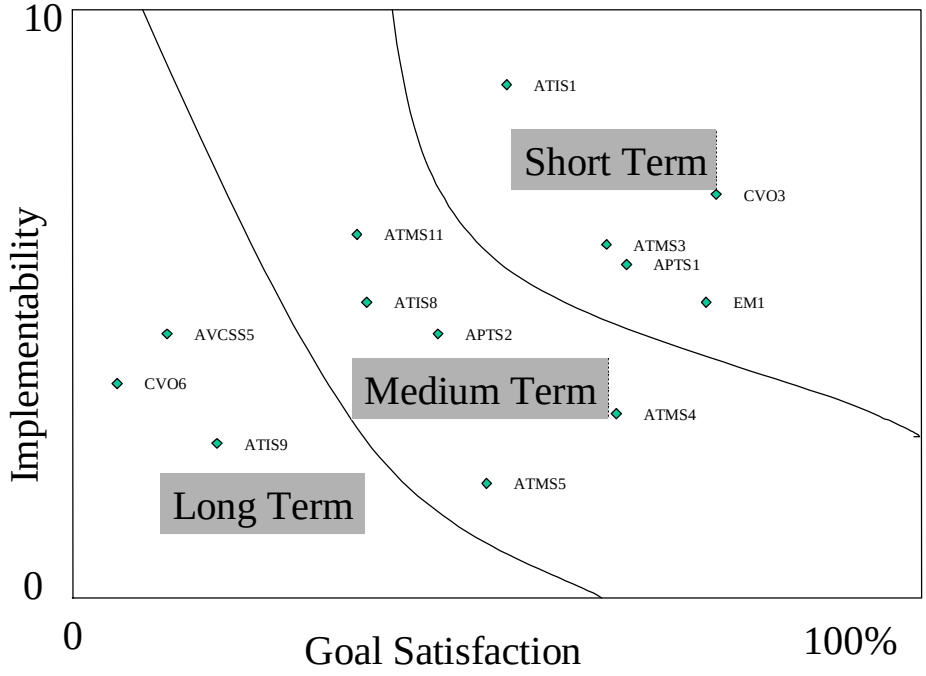


Figure 6.1-2. Example Mapping of Market Packages into Implementation Time Frames

It has been mentioned that Market Packages represent an important tool for ITS mainstreaming because selections can made within the frameworks of traditional processes. Notwithstanding the similarities of ITS Market Package services and traditional alternatives, planners need to be aware, and their evaluations need to reflect, the fact that implementing Market Packages can generate benefits not

[11] Frederick R. Harris, Inc.. *"Garden State Parkway ITS Early Deployment Planning Study"*. December, 1997.

often considered when evaluating traditional alternatives. One characteristic of Market Packages that can result in substantial benefits in both transportation and financial performance is the ability to *integrate systems*. Once a Market Package is put in place, infrastructure, information, or functionality is established that can be used in another system. This ability to tie systems together is due to the modularity of Market Package components and the wealth of information that the Market Package services generate and collect. There are three primary implications of the ability to integrate ITS systems. They are: (1) implementations can be leveraged to reduce or eliminate redundant data collection, information processing functions, or communications infrastructure (2) systems can be combined to create higher quality services, and (3) systems can be expanded incrementally from providing basic services to more advanced services without requiring major system redesign.

As an example of leveraging ITS initiatives for multiple purposes, consider data collected from the Network Surveillance Market Package (e.g. travel speeds, densities, and volumes) used for incident management purposes. If appropriately integrated, the network surveillance data could be applied to better control traffic signals and manage travel demand, emissions, and traveler information programs. Thus, cost savings would be realized since network surveillance capabilities would not need to be repeated for these various systems. Another example of leveraging systems is the deployment of signal preemption devices that can be triggered by both transit *and* emergency vehicles that request extended "green time" as the vehicles approach a signalized intersection

Systems integration can also create synergies that improve service delivery. For example, regional integration of information and services across jurisdictions in a region (e.g. coordination of signal timing, transit schedules, and incident management) can result in *system* efficiencies. These efficiencies may be manifested in reduced travel times, more efficient transit routing, and reduced travel time impacts caused by incidents. Such efficiencies would not be possible if systems were implemented in isolation. Another example of ITS system synergy is a real time transit information system. In this case the benefits of the system exceed the benefits from the system's constituent components; i.e. a passenger information system and transit automatic vehicle location system, although both these systems have independent utility and are often implemented separately.

Finally, integrating additional information and functionality with existing ITS components can enhance basic systems to enable more sophisticated services to be provided. Systems integration, therefore, supports scaleable implementation. An example of how Market Packages can migrate to provide increasingly advanced capabilities is provided in Figure 6.1-3. Here, the basic Transit Vehicle Tracking Market Package can be expanded to support Fixed Route or Demand Responsive Transit Operations. Either of these Market Packages, in turn, enables the Transit Maintenance Market Package to be implemented. Section 5.1 provided a full accounting of Market Package synergies.

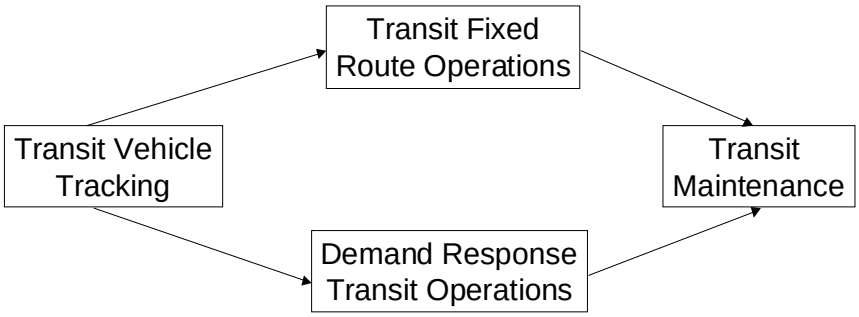


Figure 6.1-3. Example of Transit Market Package Synergies

Section 5.2 highlighted other Market Package benefits that evaluations need to capture. One benefit particularly important in evaluating ITS services is the *operating efficiencies* stemming from the automation of functions previously done manually. Examples include electronic toll and passenger fare collection systems, traveler information systems, and certain traffic management functions (e.g. the direct reporting from the field that equipment is malfunctioning). Another benefit that is more prevalent in ITS alternatives than traditional alternatives is increased traveler *comfort and convenience*. Access to accurate and timely information on transportation system conditions and travel options reduces traveler stress and allows travelers to make more informed travel decisions. Furthermore, Market Packages that include vehicle safety features and public area security surveillance can reduce traveler anxiety and increase the utility of travel. Electronic payment can also enhance travel convenience by allowing travelers to access services (e.g. transit vehicles, attraction reservations, toll or parking facilities) with a common fare media.

In conclusion, while evaluation frameworks can be designed to allow both traditional and ITS (Market Package) alternatives to be evaluated using similar criteria, planners must account for the benefits of integration, operating efficiencies, comfort and convenience and other non-traditional benefits generated by the Market Package services.

6.2 Using Market Packages in Regional Architecture Development

Regional ITS architectures are valuable tools for planning the delivery of ITS services. In addition to helping identify the systems integration benefits described above, they provide the framework that helps regions tie together disparate systems so that they work together in harmony. A regional ITS architecture also assist regions in defining their future systems and how projects advanced today fit

in with the vision established for the future. Market Packages can serve as a valuable tool for facilitating the establishment of the regional architecture and in stimulating discussion on the institutional cooperation necessary to implement the regional architecture.

One of the most challenging aspects of crafting a regional architecture involves converting transportation services and project concepts into their constituent architecture elements. This step is crucial in order to leverage the National ITS Architecture to the fullest extent. For example, mapping services and projects to the National ITS Architecture provides planners and implementers with a better understanding of where various functions should take place, what information sharing opportunities might be possible, and where standardized interfaces can be utilized. Figure 6.2-1 shows a high level process, and the one employed in the *TurobArchitecture* tool, that can be used for creating a regional ITS architecture. Here, Market Packages provide the mechanism for linking real world services to their underlying architecture components (i.e., Subsystems, Terminators, and Architecture Flows.

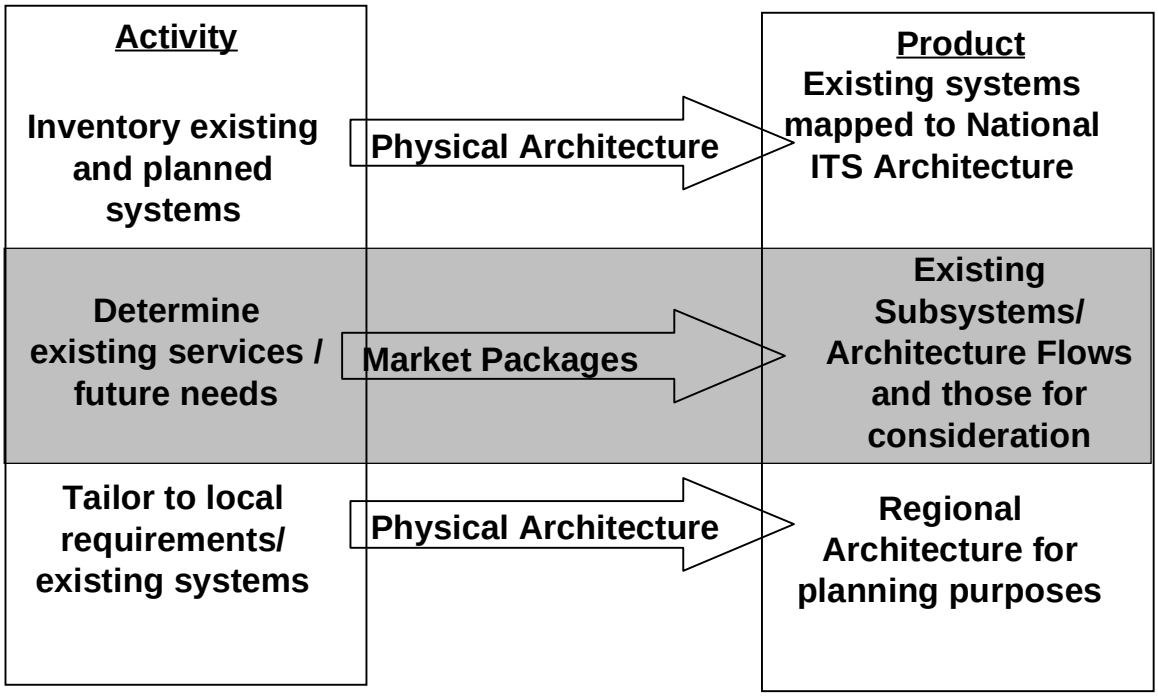


Figure 6.2-1. Example Regional Architecture Development Process

Although the process shows the inventory step preceding the selection of Market Packages, in reality these steps should be performed in an interative manner. For example, subsystems and terminators may be selected in the inventory that do not appear in any of the selected Market Packages. This suggests that some existing or planned entities may not be participating in any of the planned services. Alternatively, the Market Packages may imply entities should exist that have not been identified in the inventory. This could indicate that either the Market

Packages as defined in the National ITS Architecture Market Package need to be tailored, or that there are subsystems and/or terminators that may need to be added to the inventory. Figure 6.2-2 depicts this inventory-Market Package reconciliation step.

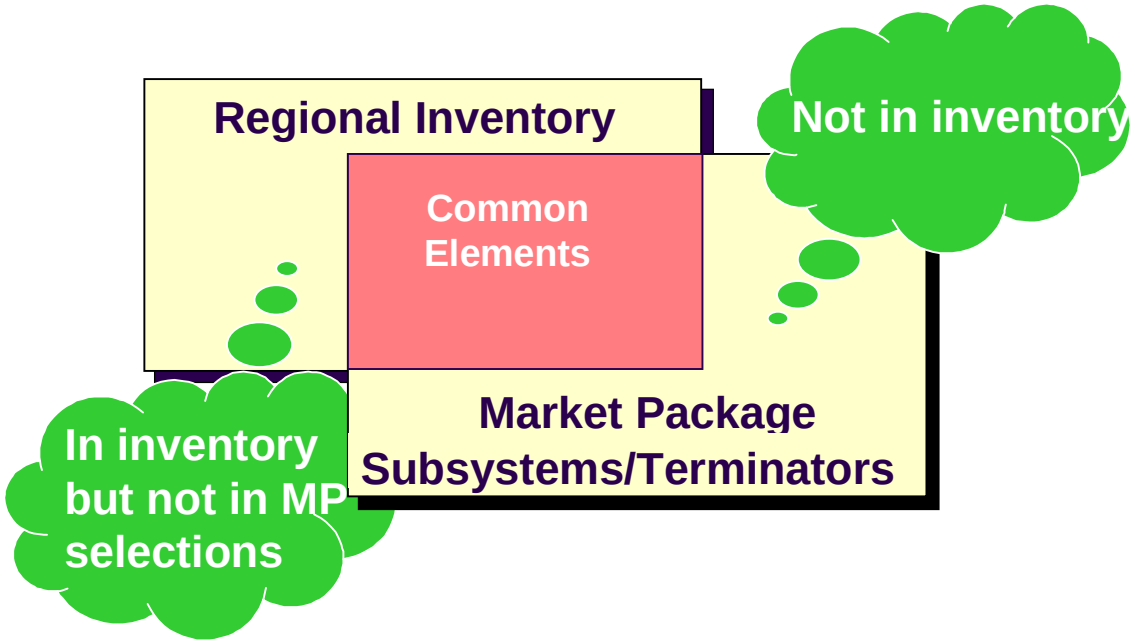


Figure 6.2-2. Using Systems Inventory and Market Packages to Determine Applicable Architecture Elements.

In addition to identifying necessary Subsystems and Terminators, Market Packages identify the relevant Architecture Flows exchanged between these physical entities for a particular transportation service. The final step in developing regional architecture shown in Figure 6.2-1 involves combining the Market Packages and inventory and tailoring the Architecture Flows implied in the selected Market Packages. This tailoring exercise is critical since there may be flows important to include in the regional ITS architecture that are not reflected in the National ITS Architecture. Conversely, Market Package may suggest flows that may not be relevant to a given region and should be removed. For example, consider a region with four traffic management centers (TMC's); i.e., a City Traffic Operations Center (TOC), County TOC, State TOC, and State Freeway Management Center (FMC). Assume the region has determined that the Network Surveillance, Surface Street Control, and Freeway Control Market Packages are the key services to include in its regional architecture. Due to functional and jurisdictional differences, however, the Architecture Flows shown in the Market Packages need to be customized. Figure 6.2-3 shows the TMC architecture resulting from the tailoring exercise. As shown the type and extent of information exchanged between field elements and the individual traffic management centers

varies depending upon local requirements. For example, while the City TOC plans on receiving traffic images from its roadway facilities, this provision is not planned for the County TOC. Also shown are flood monitoring flows that are exchanged between the City TOC and its field elements. These Architecture Flows are not included in the National ITS Architecture, but are added as auxiliary requirements.

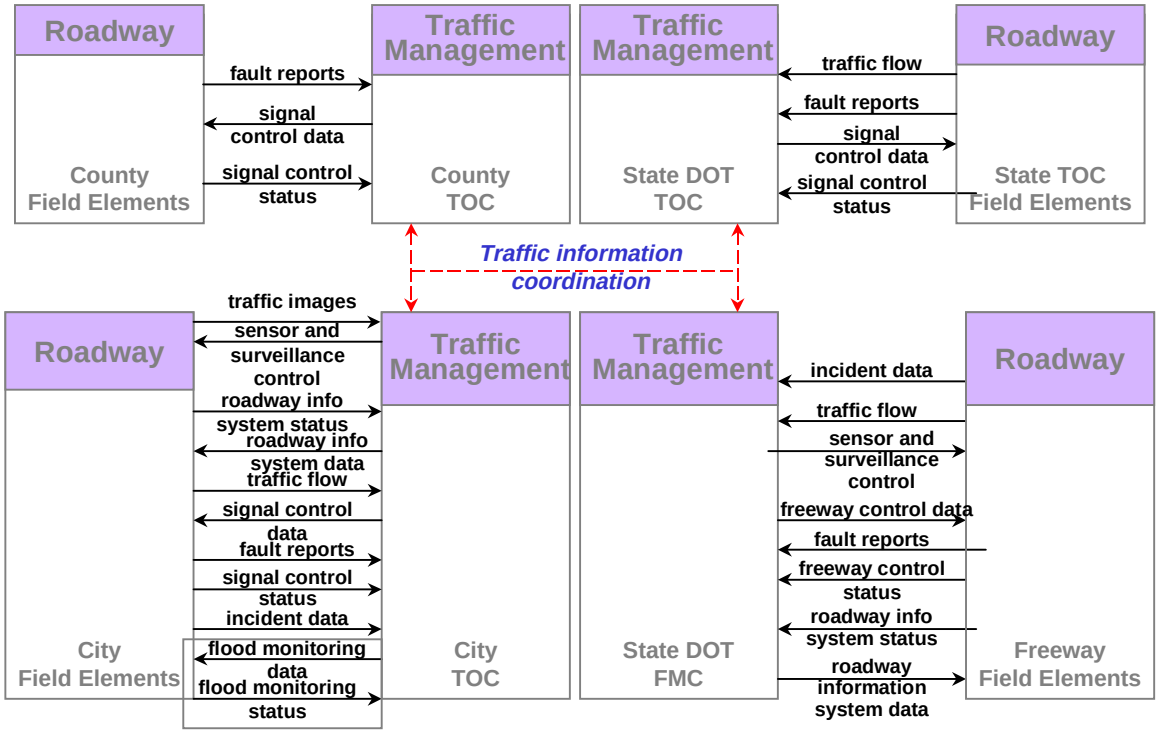


Figure 6.2-3. Example Regional Architecture Subset Resulting from Market Package Customization

This process of Market Package aggregation and tailoring would continue until the entire region is reflected and all the subsystem to subsystem and subsystem to terminator interfaces are accurately portrayed. Figure 6.2-4 provides and an example of a completed regional Architecture Flow diagram.

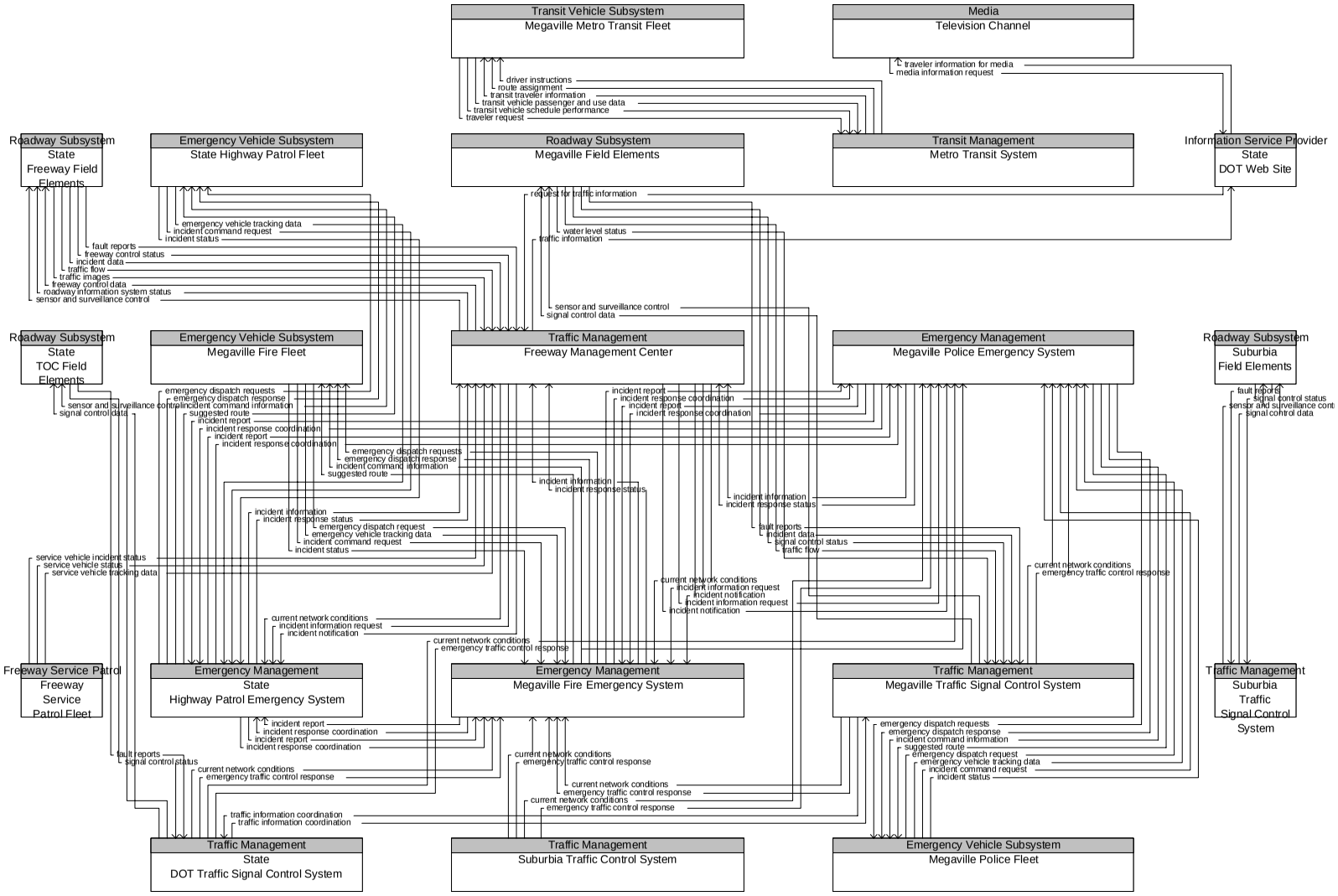


Figure 6.2-4 Example Regional Architecture Flow Diagram

The process of developing the regional architecture using Market Packages not only provides the technical foundation for the regional ITS integration strategy, but its also helps to identify key stakeholders and the requirements for regional information sharing. Since Market Packages represent real world services and the physical entities, they provide a means for organizing regional participants so that cooperation can begin early and alliances can be formed. The dialogue generated through this activity should also facilitate discussion of operational concepts and agreements and respective agency roles and responsibilities. Table 6.2-1 list some of the relevant stakeholders identified for the two of the Market Packages examined as part of the I-40 corridor EDP.

Table 6.2-1 I-40 Corridor Market Package to Stakeholder Mapping (excerpt)

Market Packages for Deployment	Responsible organizations and potential partners
Interactive Travel Information	▪ Local governments ▪ Tourist industry (AAA, other) ▪ Traffic information providers ▪ AZ Office of Tourism ▪ ADOT/FHWA ▪ National Weather Service ▪ National Park Service ▪ Department of Public Safety ▪ U.S. Forest Service ▪ Adjoining states ▪ All transit services ▪ Trucking companies ▪ Corridor attractions
HAZMAT Management	▪ Department of Public Safety ▪ ADOT/FHWA ▪ HAZMAT teams ▪ Department of Environmental Quality ▪ Trucking companies ▪ Railroads

Finally, the regional architecture generated by combining Market Packages can be used to partition the Architecture Flow requirements to subsystem pairs. This enables agencies to work on establishing information sharing agreements in a holistic fashion as opposed to a less efficient piecemeal or project-by-project fashion. Table 6.2-2 list various Architecture Flows that originate at the City Fire Department as indicated in the regional architecture shown in Figure 6.2-4. (Note that the *TurboArchitecture* software tool has the capability for automatically generating regional Architecture Flow tables).

Table 6.2-2: Example Regional Architecture Flow Requirements for One Stakeholder (City Fire Department)

Regional Source Name	National Architecture Source Name	Architecture Flows	Regional Destination Name	National Architecture Destination Name
City Fire Emergency System	Emergency Management	suggested route	City Fire Fleet	Emergency Vehicle
		emergency dispatch requests		
		incident report	City Police Emergency System	Emergency Management
		incident response coordination		
		incident report	State Highway Patrol Emergency System	Emergency Management
		incident response coordination		
		incident information	Freeway Management Center	Traffic Management
		incident response status		

6.2.1 Crafting New Market Packages

As noted in the previous sections, Market Package tailoring is a key step toward developing a customized regional ITS architecture. Usually the tailoring exercise; i.e., the process of adding and deleting physical entities, does not materially change the intended Market Package service. Occasionally, however, services are conceived that require Market Package adjustments that effectively result in new, non-National ITS Architecture, Market Packages. Even in these cases, though, most of the entities can be drawn from the National ITS Architecture.

As an example, in the developing the ITS architecture for the Greater Yellowstone region, the Western Transportation Institute created a number of new, rural oriented, Market Packages to address the particular transportation challenges in and around the National Park[12]. The new Market Packages were:

- Animal-Vehicle Collision Avoidance
- Animal-Vehicle Collision Counter Measures
- Emergency Vehicle Maintenance
- Dynamic Warning Systems
- Facility Use/Admittance Management
- Automated Road Closure Management

[12] Western Transportation Institute, Greater Yellowstone Rural ITS Priority Corridor Project, "Task 11: Define Regional Architecture", May 1999

- Mobile Traffic Management/Enforcement

A brief description and high-level graphic that is modeled after the National ITS Architecture definitions for the 60 existing Market Packages is provided for each of these new Market Packages in the following paragraphs.

Animal-Vehicle Collision Counter Measures
Encroachment of animals on the roadway is a significant problem in the Greater Yellowstone region and in other rural areas in the United States. The Animal-Vehicle Collision Counter Measures Market Package combines sensors that detect animals with a dynamic warning system that warns drivers of the animal's presence on or near the roadway. While early implementations are likely to operate autonomously, future implementations may allow remote status reporting and calibration of the system to facilitate fault detection and maintenance of these potentially remote systems. Figure 6.2.1-1 identifies the architecture elements associated with this market package.

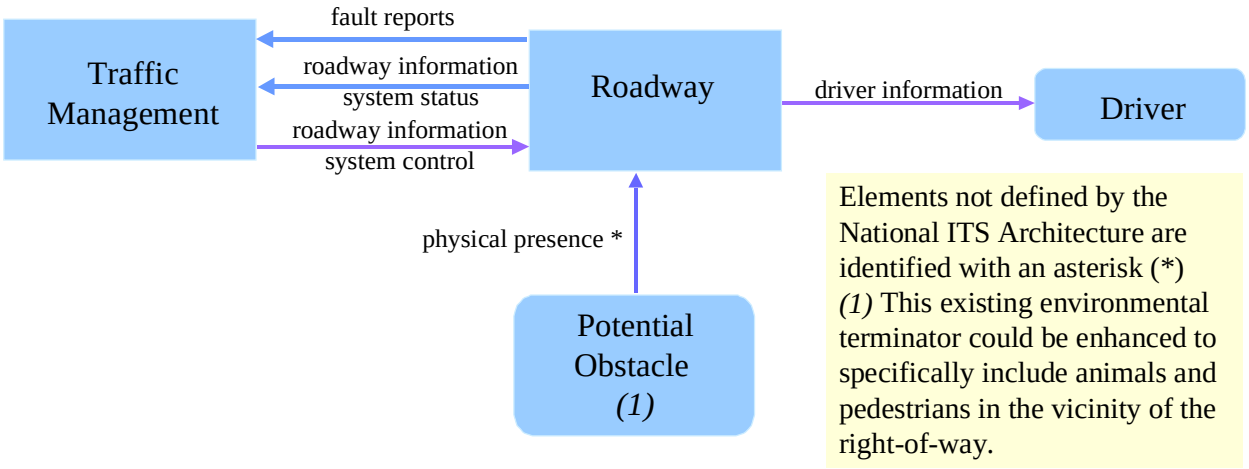


Figure 6.2.1-1: Animal-Vehicle Collision Counter Measures Market Package

Emergency Vehicle Maintenance
Large patrol areas and relatively small numbers of emergency vehicles that are in service at any given time place additional emphasis on emergency vehicle maintenance in the Greater Yellowstone region. This market package supports advanced monitoring of vehicle systems status and provides automatic maintenance scheduling and monitoring. On-board condition sensors monitor critical system status and provide this critical status information back to the Emergency Management Subsystem. Hardware and software in the Emergency Management Subsystem processes this data and schedules preventative maintenance activities.

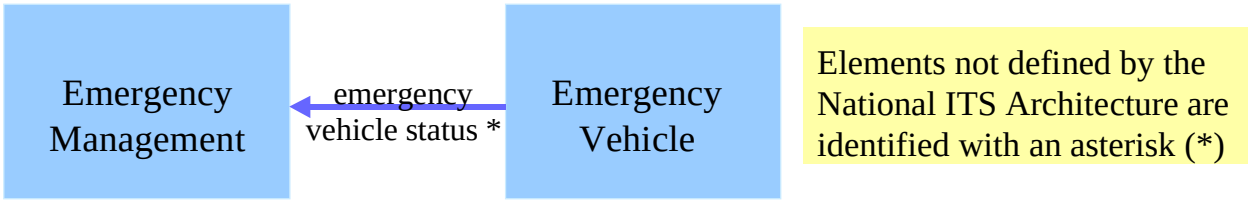


Figure 6.2.1-2: Emergency Vehicle Maintenance

Dynamic Warning Systems

A dynamic warning system monitors vehicle speeds and provides warnings to vehicles that are traveling at unsafe speeds. These systems can be deployed at spot locations where excessive speed is a problem such as locations in advance of curves and downgrades. Various levels of sophistication are possible including systems that simply measure vehicle speeds (safe speed advisory systems), systems that combine this speed information with real-time measures of road conditions, and systems that also classify approaching vehicles by weight and size so that increasingly selective warnings can be given to drivers that are exceeding the safe performance levels of either their vehicles and/or current conditions. Systems that operate autonomously and systems that communicate with and provide remote access to an operating center may be implemented.

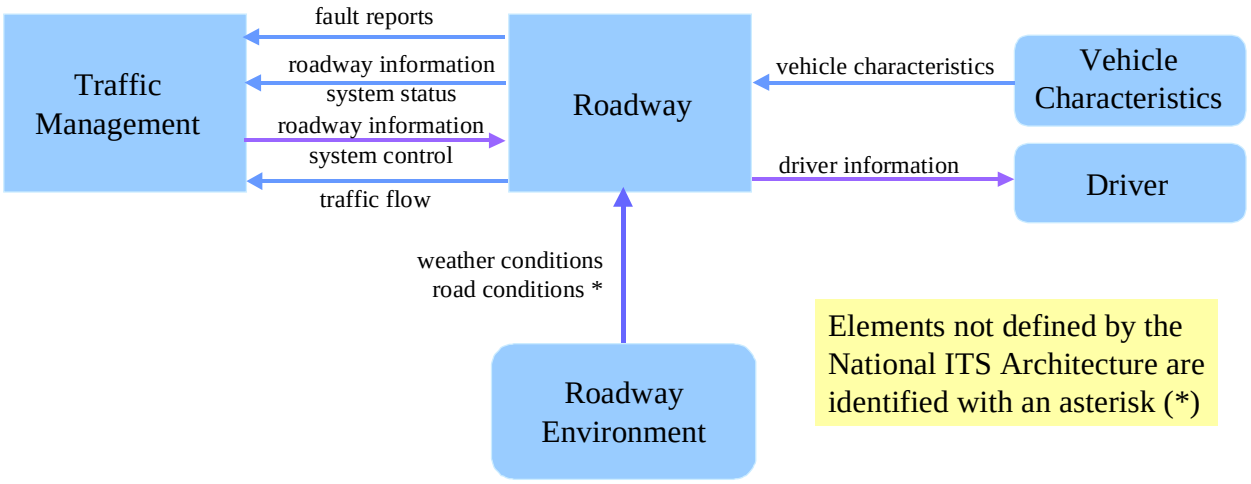


Figure 6.2.2-3: Dynamic Warning System Market Package

Facility Use/Admittance Management

This market package provides electronic fee collection at travel destinations, thereby providing traveler convenience and reducing delays and staffing requirements at facility entrances. Using the same tag/beacon systems that are used for electronic toll collection, this market package extends these systems to collect admittance and usage fees at various tourist destinations. In the Greater Yellowstone Region, early deployment of this market package will be at entrances to the National Parks, but the

same techniques and systems could be used at any gated facility that charges user fees. Special verification requirements may be included for these systems to prevent sharing or other misuse of the electronic pass "tag". In addition to the subsystems and architecture flows that support the admission fee transaction, this market package includes a connection to the information service provider so that information about the service can be made available to the traveling public.

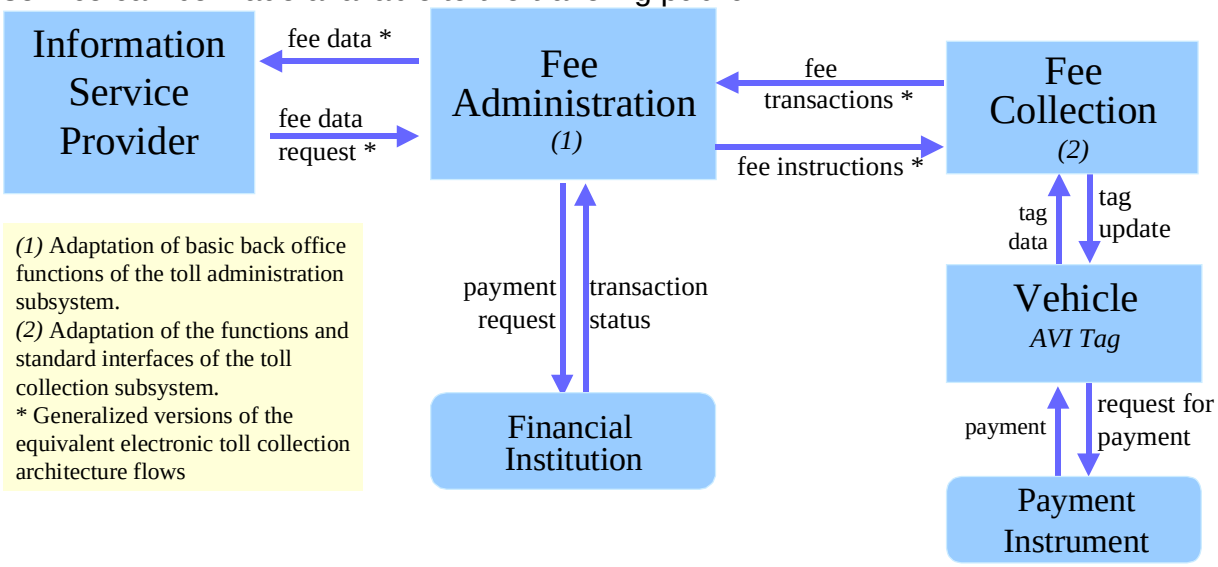


Figure 6.2.2-4: Facility Use/Admittance Fee Management

Automated Road Closure Management

This market package provides decision support for road closures, providing real time information on road conditions and allowing coordination between different agencies that may be impacted by, or otherwise involved in, the decision to close a road. Once the closure decision is made, automated gate closure systems are provided that allow the gates to be remotely closed, either from a patrol vehicle within line of site of the gate or remotely from an operating center. To improve the safety of remote operation, CCTV cameras can provide remote surveillance in the vicinity of the gate area and dynamic warning signs can provide closure warnings to drivers approaching the gates.

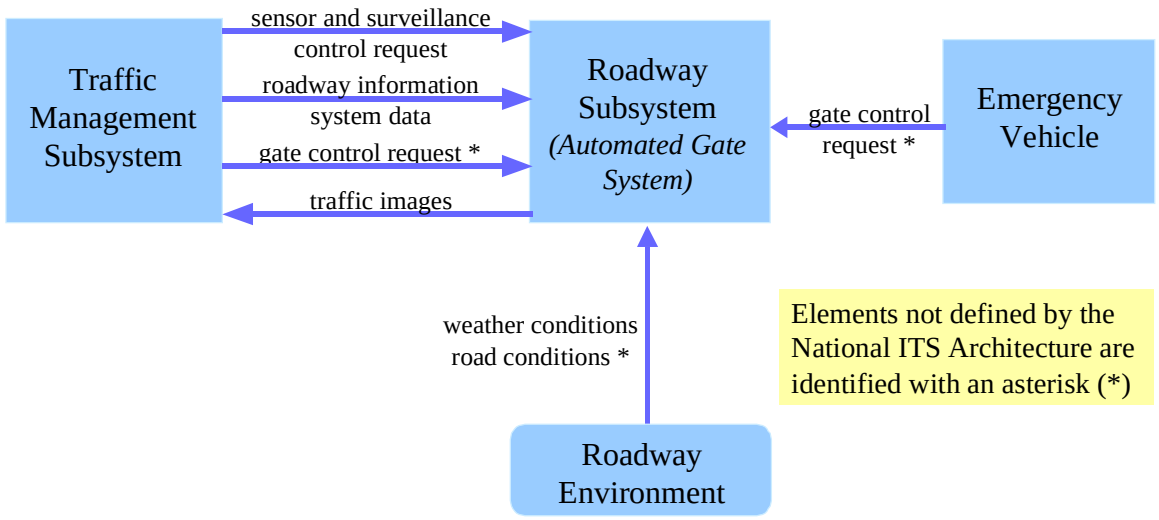


Figure 6.2.2-5: Road Closure Management Market Package

Mobile Traffic Management/Enforcement

The Mobile Traffic Management/Enforcement market package includes portable traffic control and enforcement equipment to be dynamically positioned in work zones and other locations where excessive speed is an issue. These systems use dynamic message signs to provide pertinent regulatory information to drivers at targeted locations. Optionally, sensors can be included to monitor the traffic stream and video imaging and recording systems can be added to support automatic detection and recording of infractions for enforcement applications.

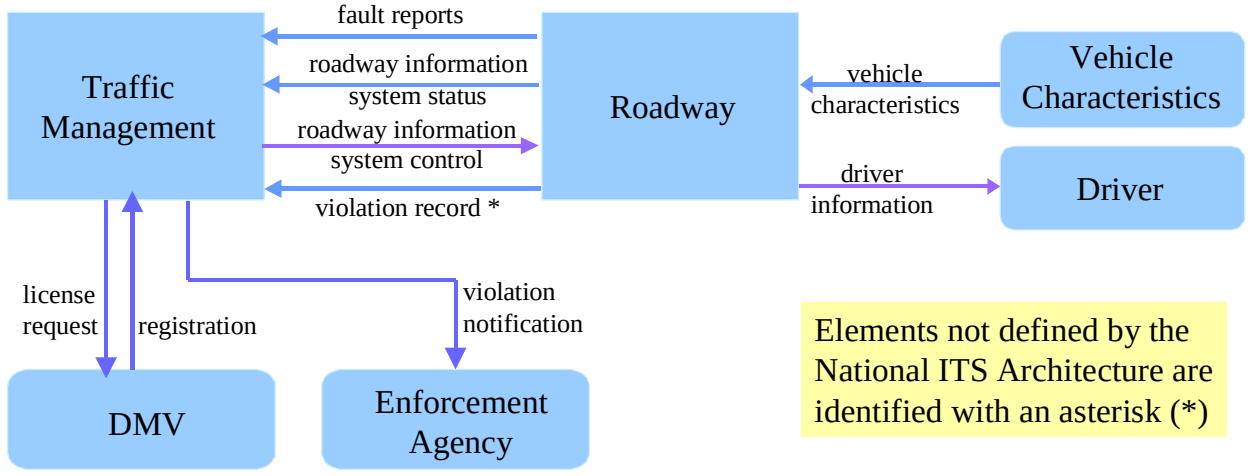


Figure 6.2.2-6: Mobile Traffic Management/Enforcement

6.3 Using Market Packages for Project Architecture Definition

In addition to providing the building blocks for structuring a regional ITS architecture, Market Packages can be applied directly to support the definition of specific projects. Although projects can be defined using Market Packages in the absence of a regional ITS architecture, developing a regional architecture first is beneficial in that projects can be specified with clear understanding of how they relate to entire regional plan. Projects can be implemented with future expansion needs in mind and available funding can be leveraged in the most economical manner. Additionally, the focussed project definition activity will often alter initial assumptions made in developing the regional architecture and these changes would need to be fed back into the architecture. This is one way in which the regional ITS architecture will evolve over time and maintain fidelity to the actual regional activities.

The example described in this section is based on defining a project within the context of an overall regional ITS architecture. The hypothetical region of Megaville has generated a regional ITS architecture (depicted in Figure 6.2-4) and the stakeholders are now ready to begin implementing the architecture project by project. One of the initial projects that has been prioritized for early implementation automatic vehicle location (AVL) system for Megavaille Metro Transit.

Buses will be equipped with devices that drivers can use to log on to receive information from the transit management center (route assignments, schedule details) and to report information (location, occupancy, and fare data) to the transit management center. As a bus travels along its route, dispatchers will use electronic maps to monitor the real time progress and location of the bus-pinpointed within a city block. A satellite based global positioning system (GPS) will share this information automatically between buses and the dispatch center. With this system, dispatchers will be able to adjust problematic route schedules quickly, reducing bus “bunching” and improving on-time service.

To begin defining the AVL project architecture, the regional planners first consult the list of National ITS Architecture Market Packages to determine if their project concept resembles any Market Packages. In this case the stakeholders were aware of a related Market Package, Transit Vehicle Tracking, since it was one of the Market Packages used to build the regional architecture. Figure 6.3-1 shows the Transit Vehicle Tracking Market Package.

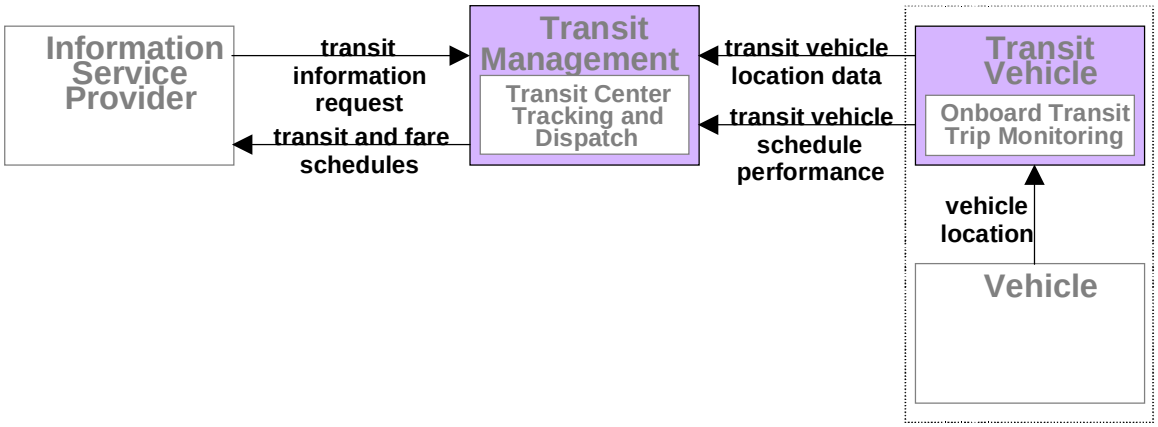


Figure 6.3-1. Transit Vehicle Tracking Market Package

In addition to the core vehicle tracking elements, the Market Package suggests that the vehicle location information would be valuable to an Information Service Provider (ISP) who could, in turn, provide real time schedule information to transit patrons. Although this capability was not described in the initial project concept, it leads the stakeholders to revisit the concept. Architecture flows that are envisioned in the region, based on the regional ITS architecture specification of the subsystems and terminators and the flows between those physical entities, are examined to determine if there are additional options that should also be considered.

To explore these other project options, Megaville planners refer to the regional ITS architecture and review all the Architecture Flows associated with the Transit Management Center; i.e., Metro Transit System, since the project will involve upgrades to the Center. Table 6.3-1 lists the Architecture Flows with either a source or destination at Metro Transit that were specified in the regional architecture. The flows are grouped into three categories. The grouping helps Megaville planners prioritize project options. The first set of flows ("In Project Market Package") are those that appear in the Market Package. The second set of flows ("In Region's Market Package") represents requirements based on other services planned and reflected in the regional architecture. The third set of flows ("Other Arch. Flows") are architecture flows that are in the National ITS Architecture related to the Transit Management Subsystem, but not captured in any project that is planned for the Megaville region.

Based on the above project definition analysis and discussion within the development team, Metro Transit has decided to refine the project scope. The definition of this project will now include an interface to the ISP subsystem, although the provision for information exchange will not be provided at this time. Full implementation will take place in a planned phase II upgrade. The Megaville traffic operators recognize that Metro Transit's receiver equipped bus fleet could provide a secondary benefit by acting as freeway probes. Bus location and time data sent to traffic managers at the three regional TOC's can assist in monitoring road conditions, identifying incidents, and

providing accurate traveler information services. As a result, it was decided that an interface will be provided to the Traffic Management Subsystems. The final project scheme is shown in Figure 6.3-2.

Table 6.3-1. AVL Project Potential Interface Scope

City Source Name	National Architecture Source Name	Architecture Flows	City Destination Name	National Architecture Destination Name	Regional Priorities	In Project	Comments
State DOT Web Site	Information Service Provider	transit information request	Metro Transit System	Transit Management	In Project Market Package	Future	System capacity and port provided. Phase II implementation pending pilot program assessment.
Metro Transit System	Transit Management	transit and fare schedules	State DOT Web Site	Information Service Provider	In Project Market Package	Future	System capacity and port provided. Phase II implementation pending pilot program assessment.
City Metro Transit Fleet	Transit Vehicle	transit vehicle location data	Metro Transit System	Transit Management	In Project Market Package	Yes	Flow provided in project design
City Metro Transit Fleet	Transit Vehicle	transit vehicle schedule performance	Metro Transit System	Transit Management	In Project Market Package	Yes	Flow provided in project design
Metro Transit System	Transit Management	transit system data	City Traffic Signal Control System	Traffic Management	In Region's Market Packages	Partial	"transit vehicle location data" component of "transit system data" planned for this project
Metro Transit System	Transit Management	transit system data	State DOT Traffic Signal Control System	Traffic Management	In Region's Market Packages	Partial	"transit vehicle location data" component of "transit system data" planned for this project
Metro Transit System	Transit Management	transit system data	Freeway Management Center	Traffic Management	In Region's Market Packages	Partial	"transit vehicle location data" component of "transit system data" planned for this project
City Fire Emergency System	Emergency Management	transit emergency coordination data	Metro Transit System	Transit Management	In Region's Market Packages	No	Arrangement with MPD in work. AVL package supports future "silent alarm" option.
State DOT Traffic Signal Control System	Traffic Management	traffic control priority status	Metro Transit System	Transit Management	In Region's Market Packages	No	FY99 Intertie Project to include. Design margins factored into this procurement.
Metro Transit System	Transit Management	bad tag list	City Metro Transit Fleet	Transit Vehicle Subsystem	In Region's Market Packages	No	FY99 Intertie Project to include. Design margins factored into this

City Source Name	National Architecture Source Name	Architecture Flows	City Destination Name	National Architecture Destination Name	Regional Priorities	In Project	Comments
							procurement.
Metro Transit System	Transit Management	emergency acknowledge	City Metro Transit Fleet	Transit Vehicle Subsystem	In Region's Market Packages	No	FY99 Intertie Project to include. Design margins factored into this procurement.
City Metro Transit Fleet	Transit Vehicle Subsystem	transit vehicle conditions	Metro Transit System	Transit Management	In Region's Market Packages	No	J1850A-compliant port on AVL system supports future integration opportunity
City Metro Transit Fleet	Transit Vehicle Subsystem	transit vehicle passenger and use data	Metro Transit System	Transit Management	In Region's Market Packages	No	FY99 Intertie Project to include. Design margins factored into this procurement.
City Metro Transit Fleet	Transit Vehicle Subsystem	traveler request	Metro Transit System	Transit Management	In Region's Market Packages	No	FY99 Intertie Project to include. Design margins factored into this procurement.
Metro Transit System	Transit Management	fare management information	City Metro Transit Fleet	Transit Vehicle Subsystem	In Region's Market Packages	No	FY99 Intertie Project to include. Design margins factored into this procurement.
Metro Transit System	Transit Management	traffic control priority request	State DOT Traffic Signal Control System	Traffic Management	In Region's Market Packages	No	FY99 Intertie Project PII to include. Design margins factored into this procurement.
Metro Transit System	Transit Management	traffic control priority request	Suburbia Traffic Signal Control System	Traffic Management	In Region's Market Packages	No	FY99 Intertie Project PII to include. Design margins factored into this procurement.
Metro Transit System	Transit Management	demand responsive transit plan	State DOT Web Site	Information Service Provider	Other Arch Flows	No	FYI Inc. providing service in pilot program. Under consideration for FY00.
State DOT Web Site	Information Service Provider	demand responsive transit request	Metro Transit System	Transit Management	Other Arch Flows	No	FYI Inc. providing service in pilot program. Under consideration for FY00.
Metro Transit System	Transit Management	demand responsive transit route	State DOT Web Site	Information Service Provider	Other Arch Flows	No	FYI Inc. providing service in pilot program. Under consideration for FY00.

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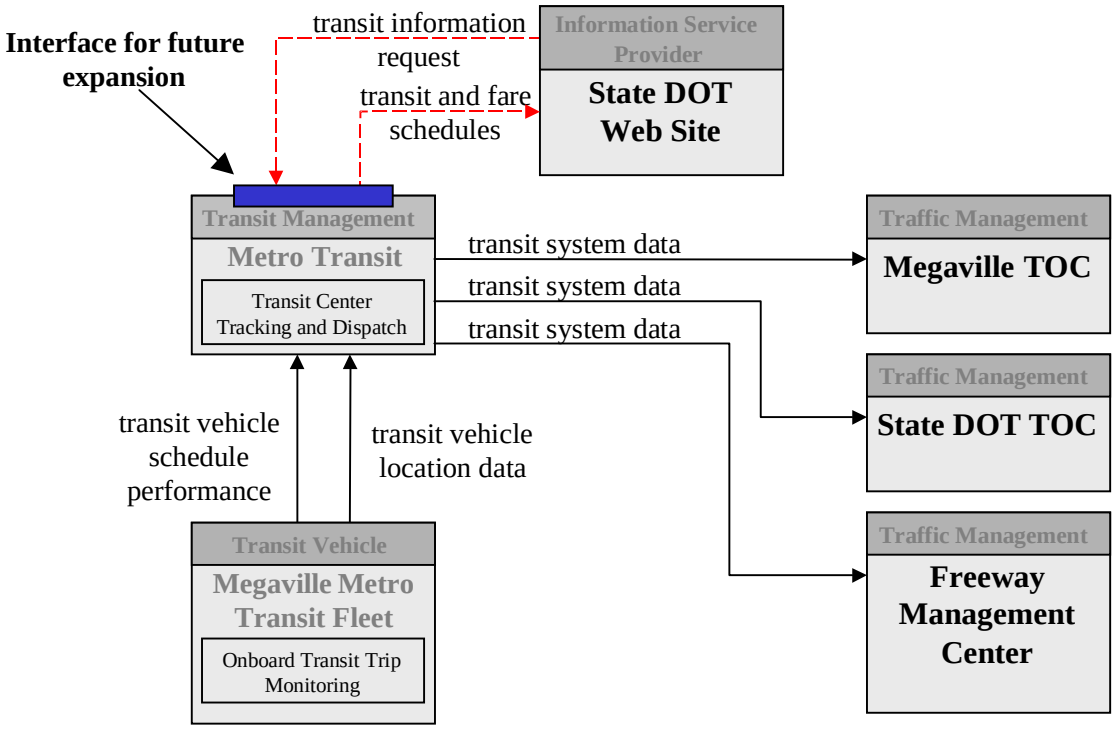

Figure 6.3-2. Final Megaville Project Architecture

The preceding analysis demonstrates that had Megaville planners not decided to examine the architecture flows associated with the Transit Management Subsystem (Metro Transit Center), interface opportunities to the Information Service Provider and Traffic Management Subsystems may have been overlooked. By not expanding the scope, retrofitting these interfaces at a later time would have likely lead to complex problems and additional costs.

The final Architecture Flows determined for the project can be used to identify the applicable ITS tandards. Each Architecture Flow may be related to one or more of the ITS standards. For the Megaville AVL Project, Table 6.3-2 details each applicable architecture flow mapped to ITS standards that are underway or completed. This information will help the Project Team to focus on important ITS standards based on the current standards approval status. The availability of ITS standards may influence what interfaces of the AVL Project are initially implemented. For those interfaces without corresponding ITS standards, an interface control document should be prepared.

Table 6.3-2 MetroTransit AVL Project Standards Analysis

Source	Source (Regional)	Destination (National)	Destination (Regional)	Architecture Flow	Applicable ITS Standards
Transit Vehicle	City Metro Transit Fleet	Transit Management	Metro Transit System	transit vehicle location data	TCIP - Onboard Objects
Transit Vehicle	City Metro Transit Fleet	Transit Management	Metro Transit System	transit vehicle schedule performance	TCIP - Onboard Objects
Transit Management	Metro Transit System	Traffic Management	City Traffic Signal Control System	transit system data	TCIP - Control Center Objects, TCIP - Traffic Management Objects, NTCIP - Class E
Transit Management	Metro Transit System	Traffic Management	State TOC	transit system data	TCIP – Control Center Objects, TCIP - Traffic Management Objects, NTCIP - Class E
Transit Management	Metro Transit System	Traffic Management	State FMC	transit system data	TCIP - Control Center Objects, TCIP - Traffic Management Objects, NTCIP - Class E
Information Service Provider	Internet PC via WWW	Transit Management	Metro Transit System	transit information request	TCIP - Passenger Information Objects, NTCIP - Class E
Transit Management	Metro Transit System	Information Service Provider	Internet PC via WWW	transit and fare schedules	TCIP - Schedules/Runcutting Objects, ATIS Data Dictionary, NTCIP - Class E

6.4 Applicable Market Package-based Analysis

The National ITS Architecture has been developed to support the greatest possible range of design options and technology choices. In the following subsections, some of the design options supported by the National ITS Architecture for each Market Package are highlighted.

6.4.1 Traffic Management Design Options

The architecture supports the widest possible range of ATMS designs while preserving national interoperability through identified standards. This approach frees implementers to select the best design to meet local needs. Table 6.4.1-1 illustrates some of the major design options for each Traffic Management Market Package.

Table 6.4.1-1: Major Traffic Management Design Options

Market Package	Design Options Consistent with the National Architecture
Network Surveillance	▪ Approaches: fixed instrumentation ▪ Types of data collected: occupancy, speed, volume, density, travel time, images ▪ Automation: fully automatic, require operator interpretation. ▪ Intelligence: field processors filter raw data, raw data transmitted to TMC ▪ Technologies: loop, CCTV, Machine Vision, acoustic and radar sensors; database management; data fusion. ▪ Communication media: wireline--fiber-optics, coaxial cable, leased phone line; wireless--microwave, ▪ cell-based digital ▪ Coordination: sharing surveillance data with neighboring TMCs versus not sharing.
Probe Surveillance	▪ Approaches: mobile instrumentation ▪ Types of data collected: voice, digital--travel time, speed, road conditions ▪ Automation: fully automatic, activation by drivers or operators ▪ Intelligence: processors in probe to filter raw data, all raw data transmitted to TMC ▪ Technologies: GPS at probe, other vehicle positioning systems; aerial surveillance; roadside beacons ▪ Frequency of communication: time-based, location-based, incident-based, on request; communications media: analog cellular, cell-based digital, dedicated short range (beacon-tag) ▪ Data transmitted to: TMC, independent service providers. ▪ Participation as probes: voluntary, compulsory, for-hire, contract.
Surface Street Control	▪ Approaches: isolated versus coordinated intersection control within a jurisdiction; pretimed plans versus real-time traffic adaptive plans ▪ Types of data used: occupancy, speed, travel time, video image; instrumentation--number of detectors per link ▪ Automation: fully traffic responsive, operators select timing plans ▪ Intelligence of processors: centralized, distributed (timing plans derived locally versus centrally) ▪ Technologies: algorithmic--adaptive versus non-adaptive ▪ Communication media: fiber-optics, coaxial cable, leased phone line. ▪ Communication between TMC and local controllers: timing plans, travel time, queue length;
Freeway Control	▪ Approaches: isolated versus coordinated ramp metering within a jurisdiction; pretimed plans versus real-time adaptive strategies for density control and incident management ▪ Types of data used: mainline occupancy, speed, travel time, imaging, density, ramp occupancy; instrumentation--number of detectors per ramp ▪ Automation: fully traffic and queue length responsive, operators in-the-loop incident management. ▪ Intelligence of processors: centralized, distributed (timing plans derived locally versus centrally) ▪ Technologies: detectors--loop, CCTV, Machine Vision; algorithmic--adaptive versus non-adaptive ▪ Communication media: fiber-optics, coaxial cable, leased phone line. ▪ Communication between TMC and local controllers: timing plans, travel time, queue length;
HOV Lane Management	▪ Approaches: Time of day versus traffic responsive HOV operations ▪ Types of data used: time of day, traffic volume ▪ Automation: fully automatic enforcement, manually invoked operations ▪ Intelligence of processors: centralized, distributed (ramp meter plans for HOV on-ramps derived locally versus centrally) ▪ Technologies: detectors--loop, CCTV, Machine Vision; algorithmic--adaptive versus non-adaptive; ▪ Communication media with TMC: wireline--fiber-optics, coaxial cable, leased phone line; wireless-- cellular phone, RF, cell-based digital

Market Package	Design Options Consistent with the National Architecture
Traffic Information Dissemination	▪ Approaches: Traffic information disseminated directly from TMC, or via the media. ▪ Data used: CMS or HAR messages, or media messages ▪ Automation: control and invoke of CMS and HAR messages directly from TMC via modem in real-time, or manually invoke message at the field units ▪ Intelligence: messages downloaded from TMC, versus setting up of messages by field personnel ▪ Technologies: (not much variation) ▪ Communication media: wireline versus wireless
Regional Traffic Control	▪ Coordination approach: deriving control plans --hierarchical, centralized, distributed with common cycle lengths; sharing surveillance information: centralized databases, distributed databases ▪ Types of data used: occupancy, speed, travel time, video image; instrumentation--number of detectors per link; inter-jurisdictional surveillance information ▪ Automation: fully traffic responsive, operators select timing plans or initiate response plan ▪ Intelligence of processors: centralized, distributed (timing plans derived locally versus centrally) ▪ Technologies: detectors--loop, CCTV, Machine Vision; algorithmic--adaptive versus non-adaptive; database management ▪ Communication media: fiber-optics, coaxial cable, leased phone line. ▪ Coordination: control plans--hierarchical, centralized, distributed with common cycle lengths; sharing surveillance information: centralized databases, distributed databases
Incident Management System (Design options for incident detection)	▪ Approaches: manual--operators reviewing CCTV; automatic--incident detection algorithms via using loop detector data or via VIP ▪ Types of data received: CCTV footage, surveillance data from ATMS1 ▪ Automation: fully automatic, manual initiation and confirmation ▪ Intelligence of processors: centralized, distributed (incident pattern processed locally versus centrally) ▪ Technologies: incident detection based on VIP, loop information ▪ Communication media: wireline for surveillance data (see Surveillance) ▪ Coordination: incident data may be shared through CAD with emergency management susbsystem; between TMC and signal control Market Packages to initiate response signal plans; between TMC and the incident dispatch Market Package to coordinate dispatch.
Incident Management System Design options for incident management)	▪ Approaches: manual notification--receiving cellular 911 calls, via FSPs, and other patrol field units; receiving automatic MAYDAY from troubled vehicles; manual dispatch with Computer Aided Dispatch (CAD) database shared among emergency agencies, automated dispatch based on AVL technologies ▪ Types of information used: incident location, severity (hazardous material or not) and its real-time status, locations of response units ▪ Automation: automatic dispatch via AVL application on response units, manual allocation of response units to incident ▪ Intelligence: amount of information (such as CAD information) available to response units (e.g., mobile data units), dispatch from the field command versus from a central dispatch center ▪ Technologies: database management--centralized and common CAD versus distributed CAD's (one for each agency); AVL on response units ▪ Communication: voice versus digital data communication between response units and dispatch center; ▪ Coordination: different levels of data flows and database management between TMC, Emergency Management subsystem, field units, and freeway and arterical control Market Packages to create seamless and coordinated response plans
Traffic Forecast and Demand Management	▪ Approaches: real-time simultaneous derivation of route plans and signal timing plans; off-line coupling for conducting planning studies such as improving signal timing plans. ▪ Types of data used/produced: traffic data, travel demand data, route plans from ISPs ▪ Degree of automation: fully automatic versus frequent manual intervention to correct and verify results ▪ Use of technologies: levels of model computational efficiency ▪ Communication: wireline and wireless media to handle large volume of data coming in especially for real-time on-line processing. ▪ Coordination or subsystem connectivity: traffic control and route plans from ISPs should be linked and processed together.

Market Package	Design Options Consistent with the National Architecture
Electronic Toll Collection	▪ Approaches: electronically collect tolls, and detect and process violators; combined with traffic data to implement demand management strategies either on-line or off-line ▪ Types of data used/produced: vehicle tag information, toll information, traffic data ▪ Degree of automation: fully automatic in the whole process, manually determining toll strategies based on off-line traffic data; manually detect and process violators ▪ Distribution of intelligence or processing capabilities: capabilities of the processors located at the field ▪ Use of technologies: communications---short-range communications, RF, cell-based digital; database management ▪ Communication: wireless (short-range, RF) between vehicle and tag reader, wireline between tag reader and financial institution ▪ Coordination or subsystem connectivity: levels of coordination may include--with ATMS1, ATMS2 and ATMS10 to set up demand management strategies, with financial institution to verify and clear financial transactions.
Emissions Monitoring and Management	▪ Approaches: manually or electronically sense emissions and environmental hazards; may include detection of emission violations; combined with traffic data to implement emission management strategies ▪ Types of data used/produced: human warnings, emission levels, environmental hazards such as fog, and icy road conditions ▪ Degree of automation: fully automatic in the whole process, manually determining the levels of hazards by field units ▪ Distribution of intelligence or processing capabilities: capabilities of field processors to filter sensor measurements ▪ Use of technologies: sophistication of environmental sensors ▪ Communication: wireless or wireline between sensors and TMC ▪ Coordination or subsystem connectivity: coordination with ATMS9 to disseminate information to travelers, and with ATMS10 to set up emission management strategies
Virtual TMC and Smart Probe	▪ Approaches: probes equipped with a variety of technologies for road surface sensing.
Standard Railroad Grade Crossing	▪ Approaches: Isolated vs. coordinated with adjacent intersections. Interconnection vs. Preemption connectivity with adjacent intersections. Constant warning time vs. Minimum warning time systems. ▪ Data Generated: Closure times and durations; health status; local highway traffic surveillance data. ▪ Automation: Fully automatic, train responsive operation. ▪ Intelligence: Interpretation of raw data may be locally performed by controller or transmitted back for processing at central facility. ▪ Technologies: Traditional crossing signals and gates may be augmented with traffic control devices identified in other Market Packages (e.g., Traffic signals, HAR, VMS). In most advanced applications, beacons may provide HRI information directly to the vehicle for display to driver or for processing by automated vehicle control systems. ▪ Communication: Relatively low data rates supported by many wireline/wireless options. ▪ Coordination: Shared health status between traffic operations and rail operations.
Advanced Railroad Grade Crossing	▪ Includes design options identified above for Standard Speed Market Package as well as: ▪ Approaches: Detection of entrapped vs. Immobile vehicles or other obstacles ▪ Data Generated: Obstruction alerts with supporting data for verification. ▪ Automation: Automatic with various degrees of person-in-the-loop for verification and response initiation. ▪ Intelligence: Interpretation of raw intersection surveillance data and images may be performed in the field or centrally. ▪ Technologies: Various sensor technologies and image processing algorithms may enable entrapped/immobile vehicle detection ▪ Coordination: Obstruction alerts may be communicated directly to railroad wayside equipment and/or rail operations center.

Market Package	Design Options Consistent with the National Architecture
Railroad Operations Coordination	▪ Approaches: Projected HRI closure times may be passed directly or developed from raw schedule information supplied by rail operations. Initial systems may use real-time closures detected by field equipment to anticipate closures down the line with little or no additional coordination with rail operations. ▪ Data Generated: Forecast closure times and durations for area grade crossings. ▪ Automation: Manual systems which notify highway officials of planned maintenance impacting normal HRI operation. Various degrees of automation up to fully automated sharing of pertinent schedule information between railroads and agencies.
Parking Facility Management	▪ Approaches: electronically collect tolls, and detect and process violators; combined with traffic data to implement demand management strategies either on-line or off-line ▪ Types of data used/produced: vehicle tag information, toll information, traffic data ▪ Degree of automation: fully automatic in the whole process, manually determining toll strategies based on off-line traffic data; manually detect and process violators ▪ Distribution of intelligence or processing capabilities: capabilities of the processors located at the field ▪ Use of technologies: communications---short-range communications, RF, cell-based digital; database management ▪ Communication: wireless (short-range, RF) between vehicle and tag reader, wireline between tag reader and financial institution ▪ Coordination or subsystem connectivity: levels of coordination may include--with ATMS1, ATMS2 and ATMS10 to set up demand management strategies, with financial institution to verify and clear financial transactions.
Reversible Lane Management	▪ Approaches: Time of day versus traffic responsive operations. Can either be implemented through moveable barriers or dynamic lane control signals to indicate to motorist which lane is reversible. ▪ Types of data used: time of day, traffic volume ▪ Intelligence of processors: centralized, distributed (e.g. lane access control plans derived locally versus centrally) ▪ Technologies: detectors— detector loops loop ▪ Communication media with TMC: wireline--fiber-optics, coaxial cable, leased phone line; wireless-- cellular phone, RF, cell-based digital
Road Weather Information System	▪ Approaches: Electronically sense weather and environmental conditions ▪ Types of data used/provided: Weather information, environmental hazards such as icy/fogy road condition. Weather information could include climatology, observations and forecasts of the atmosphere, and of pavement/ground conditions. ▪ Information delivery mechanisms: AM , FM or HAR subcarriers. Messages could either be provided to travelers using roadside signs or in-vehicle devices. ▪ Automation: fully automated ▪ Intelligence of process: Capabilities of field processors to filter sensor measurement ▪ Communication: Wireline or wireless communication between sensors and weather center
Regional Parking Management	▪ Coordination approach: sharing surveillance information using centralized databases, distributed databases ▪ Types of data used vehicle tag information, toll information, traffic data Automation: fully traffic responsive, operators select timing plans or initiate response plan ▪ Intelligence of processors: centralized, distributed (pricing and policy strategies derived locally versus centrally) ▪ Communication media: fiber-optics, coaxial cable, leased phone line.

6.4.2 Transit Management Design Options

The National ITS Architecture provides a framework that accommodates a wide range of system designs and technologies. By giving the local implementor the widest range of possible functions and data flows, and defining open interfaces between critical systems, the architecture may accommodate virtually any open system design. Table 6.4.2-1 shows several major design variations that are consistent with the architecture.

Table 6.4.2-1: Major Transit Management Design Options

Market Package	Major Options Consistent with the National ITS Architecture
Transit Vehicle Tracking	▪ Technologies for vehicle location: signpost or wayside beacons, global positioning system (GPS), differential GPS, radio signal trilateration (e.g. Loran-C), dead reckoning. ▪ Wide-area communications: cell-based, specialized mobile radio (SMR), trunked radio, other conventional two-way radio, wayside beacons. ▪ Real-time traveler information: may be provided directly by the transit agency and/or through a third-party information provider. Wide variety of possible communications technologies
Fixed-Route Operations	▪ Data processing approaches: Centralized control at yard or operations center, distributed data sharing (via a local or wide-area network) between different units within the agency ▪ Wide-area communications of short standard data messages ▪ Short-range communications (e.g. beacon-tag) with vehicles at garage or yard for data dump to / from the vehicle as it enters or exits. ▪ Traveler information: may be provided directly by the transit agency and/or through a third-party information provider. Wide variety of possible communications technologies
Demand-Responsive Operations	▪ Data processing approaches: Centralized control at yard or operations center, distributed data sharing (via a local or wide-area network) between different units within the agency ▪ Wide-area communications of short standard data messages ▪ Short-range communications with vehicles at garage/yard to allow data dump to and from the vehicle at the beginning or end of shift. ▪ Traveler information and rider requests: may be managed directly by the transit agency and/or through a third-party information provider. Wide variety of possible communications technologies
Passenger and Fare Management	▪ Fare media: electronic credit or debit card, magnetic stripe, proximity card, other “smart card” technologies. ▪ Data processing: data held on the vehicle and down-loaded off line, or may be communicated real-time to operations center
Transit Security	▪ Video or other surveillance data may be retained locally (e.g. on the vehicle or in the stop/station) or may be communicated back to management center
Transit Maintenance	▪ Vehicle condition data may be held on the vehicle and down-loaded off line, or may be communicated real-time to operations center
Multi-modal Coordination	▪ Approaches to signal priority: one- or two-way short-range vehicle communication with roadside beacon; similar to signal obtaining central authorization from traffic management center; short automated message from vehicle to transit management to traffic management center. ▪ Transit probe data shared over similar interfaces as other probes: roadside elements or wide-area wireless communication
Transit Traveler Information	▪ Approaches to information dissemination: Custom trip itineraries or general information. Information could be made available along transit stops, on-board transit vehicles, or through or through a third party information provider ▪ Types of data used: Real time transit information ▪ Automation: Fully automated in the whole process ▪ Technologies: Wide variety of possible communication technologies, ▪ Communication: Wireline or wireless communication between parking lots and regional parking management center

6.4.3 Traveler Information Systems Design Options

In a similar way, the national architecture supports multiple ways of providing for traveler information systems. Almost all conceivable options are supported by the architecture as identified in Table 6.4.3-1.

Table 6.4.3-1: Major Traveler Information Systems Design Options

Market Package	Major Options Consistent with the National ITS Architecture
Broadcast Traveler Information	▪ The Information Service Provider (ISP) can be a private firm charging a fee for service basis or a part of an existing TMCs ▪ Traffic information provided by traffic management can be from various sources, from probe vehicles or conventional loops. ▪ The communications between users and the ISP are via FM subcarrier or cellular data broadcast, using low-cost equipment.
Interactive Traveler Information	▪ The ISP can be operated by the public sector, but it is most likely run by private firms on a fee-recovery basis due to the additional value of tailoring of information according to a user's request. ▪ The communications between information service provider and users are through: two-way wide-area wireless (such as cellular digital) for mobile users, or wireline communication systems for home and office computers. ▪ A variety of interactive devices may be used: phone, kiosk, Personal Digital Assistant, home computer, and a variety of in-vehicle devices.
Autonomous Route Guidance	▪ This Market Package relies on in-vehicle equipment that determines location, contains a map database, and interfaces with the driver to assist in enable route planning and provide detailed route guidance based on static, stored information ▪ There is no external communication between the in-vehicle device and outside entities, except a periodical update of its map database. So the developer or manufacturer is free to develop proprietary systems, or systems may comply with open system interface standards.
Dynamic Route Guidance	▪ This Market Package uses current traffic information to guide vehicles. A device in the vehicle receives information about current traffic and road conditions and transit services from an information service provider (ISP) via FM subcarrier or cellular data broadcast.
ISP Based Route Guidance	▪ Routes are planned by the information service provider. An in-vehicle device submits a trip request, and the ISP replies with a trip plan. ▪ Two way data communications are needed. Options for two-way wide-area wireless include cellular digital or FM subcarrier. ▪ Turn by turn route guidance is provided by the ISP or by equipment on the vehicle which has data bases and location determination capability. ▪ The infrastructure will not deliver turn by turn route guidance information through short-range wireless communication.
Integrated Transportation Management / Route Guidance	▪ This Market Package couples the traffic control strategies of a TMC and the route guidance function of an ISP for simultaneous optimization. Heavy communications are expected between the TMC and ISP, and also between equipped vehicles and the ISP to confirm and log current route plans. ▪ Communications between TMC and ISP are through a number of high-volume wireline communication systems, such as fiber optics or through the internet. ▪ Communications between ISP and in-vehicle devices are mainly through cellular digital systems.
Yellow Pages and Reservation	▪ This Market Package enhances the Interactive Traveler Information package by adding infrastructure provided yellow pages and reservation capabilities. ▪ The ISP for this service is foreseen to be operated by the private sector on a fee-recovery basis. ▪ The design options are similar to Interactive Traveler Information.
Dynamic Ridesharing	▪ This Market Package enhances the package of Interactive Traveler Information with ridesharing information. All the hardware options for Interactive Traveler Information apply here. The user should be need additional equipment.
In-Vehicle Signing	▪ This Market Package supports local distribution of information regarding immediate roadway conditions. It includes a means of short-range radio transmission from the roadway to the vehicles, such as beacons, and wireline or wireless connection between the TMC and the roadway sign transmission device.

6.4.4 Fleet and Freight Management Systems Design Options

The major design options for Fleet and Freight Management Systems are listed in Table 6.4.4-1. Each of the options requires substantial coordination and negotiation among government agencies concerned with customs, safety, taxation and licensing functions, and private companies concerned with customer service, efficiency and cost. The National ITS Architecture provides a high-level framework for communication and coordination between freight operators and government agencies. This framework is supplemented by the Commercial Vehicle Information Systems Network (CVISN) program which provides additional architectural detail and offers suggestions for specific concepts for providing the necessary coordination.

An example of a specific implementation approach that is supported by the Architecture is the establishment of "clearinghouses" to support inter-jurisdictional coordination between government agencies. For carriers and vehicles that operate in multiple jurisdictions, arrangements among jurisdictions can and have been made to simplify the process of applying for the credentials to operate in those jurisdictions (e.g., International Registration Program and International Fuel Tax Agreement). To simplify the coordination between jurisdictions for reconciling fees collected in one jurisdiction that are due to another jurisdiction, several jurisdictional associations are pursuing the establishment of clearinghouses. For example, as envisioned, the IRP Clearinghouse will collect approved IRP registration information from member jurisdictions, compute the allocation of IRP fees due to each jurisdiction, initiate the transfer of funds among jurisdictions, and provide summaries to the member jurisdictions. This represents one possible implementation strategy for the interchange between jurisdictions that is generically modeled as a Commercial Vehicle Administration Subsystem interface in the National ITS Architecture.

Table 6.4.4-1: Major Fleet and Freight Management Systems Design Options

Market Package	Major Options Consistent with the National ITS Architecture
Fleet Administration	▪ Performs administrative and operational functions necessary to operate a commercial vehicle fleet. ▪ Functions include: vehicle dispatching and routing, processing vehicle location data, processing and storing regulatory data (permits, fuel usage by state, driver hours-of-service, driver pull notice, etc., with the exception of fleet maintenance) and responding to requests for assistance from drivers. ▪ Communication between vehicles and the Fleet Management Center can be through a cell-based digital system, satellite data link, or preexisting wireless infrastructure. ▪ Information flow between the Fleet Management Center and vehicles is tailored to need. ▪ A Fleet Management Center may connect to Intermodal Transportation Providers to coordinate trans-shipments. ▪ A Fleet Management Center may connect to its Freight Management system to support freight billing and shipment tracking. ▪ A Fleet Management Center may connect to an Information Service Provider to obtain optimal vehicle routes.
Freight Administration	▪ Tracks cargo and cargo condition and supports billing. ▪ Communication from vehicles to the Freight Management Center can be through a cell-based digital system, satellite data link, or pre-existing wireless infrastructure, and is used to transmit cargo status.

Market Package	Major Options Consistent with the National ITS Architecture
	▪ A Freight Management Center may connect to intermodal shippers and freight depots via existing wireline infrastructure in order to track cargo and transmit shipment documents.
Electronic Clearance	▪ Enables commercial vehicles to pass inspection facilities at highway speeds. ▪ Vehicle transponder communicates with the inspection facility to determine if clearance status is granted. Different dedicated short range wireless systems can be selected. ▪ Transponder can communicate vehicle, driver and carrier identification and status to the inspection facility. ▪ The roadside inspection facility communicates with Commercial Vehicle Administrator via existing wireline infrastructure to transmit credential requests, credential responses and database updates. ▪ Electronic clearance can be extended to support International Electronic Clearance through coordination with customs, immigration and agriculture activities. ▪ Electronic clearance equipment may be combined with weigh-in-motion and safety inspection equipment.
CV Administrative Processes	▪ Supports registration (electronic credential and tax filings) of drivers, vehicles, and carriers in electronic clearance programs. ▪ The primary communication linkage is between Fleet and Freight Management and Commercial Vehicle Administration and between Commercial Vehicle Administration Subsystems. Fleet managers submit applications, and the Commercial Vehicle Administrator issues credentials and a compliance review report via existing wireline infrastructure. ▪ Coordination among multiple Commerical Vehicle Administrators (jurisdictions) may be implemented using clearinghouses, peer to peer networks, or other strategies. See supporting text. ▪ Commercial Vehicle Administrators send payment requests to and receive transactions reports from financial institutions.
International Border Electronic Clearance	▪ Automates clearance specific to international border crossings. ▪ Provides an interface with customs and related functions and provides pre-clearance for shipment crossing NAFTA borders. ▪ Hardware design options are similar to Electronic Clearance. ▪ Requires agreements between Commercial Vehicle Administrator, customs, and agriculture agencies in the United States and other NAFTA countries.
Weight-in-Motion	▪ Provides high-speed weigh-in-motion with or without Automatic Vehicle Identification attachment. ▪ Additional equipment is provided at roadside facilities, either fixed or mobile. ▪ Can operate in conjunction with Automated Vehicle Identification equipment as a part of Electronic Clearance package, which may affect clearance message communicated to vehicle. ▪ It can be used as a stand-alone system; commercial vehicles do not need any equipment and will be pulled over by signs or radio when necessary.
Roadside CVO Safety	▪ Automates roadside safety monitoring, inspection and reporting. ▪ Capabilities are shared with On-Board CVO Safety Market Package. ▪ Basic option provides access to vehicle, driver and carrier safety and maintenance records. Identification and status information are read from electronic tags of vehicles pulled in for inspection. Package communicates with Commercial Vehicle Administrator via landline infrastructure to access additional safety data ▪ Advanced implementations access additional vehicle safety monitoring systems placed on the vehicle.
On-Board CVO Safety	▪ Provides for on-board commercial vehicle safety monitoring and reporting. ▪ Supports Roadside CVO Safety Market Package and includes roadside support for reading on-board safety data via tags. ▪ Uses the same communication links as the Roadside CVO Safety Market Package, and provides the commercial vehicle with a cellular link (data and possibly voice) to the Fleet and Freight Management and Emergency Management Centers. ▪ Safety warnings are provided to the driver, who may be required to notify the Fleet and Freight Management and Commercial Vehicle Check roadside elements. ▪ As an option, alerts driver of need for Preventive Maintenance or inspection.
CVO Fleet Maintenance	▪ Supports maintenance and regulation of CVO fleet vehicles. ▪ Dates, mileage and results from inspections, repairs, and component replacements are stored. Records of vehicle safety violations are maintained. Preventive maintenance schedule is maintained. ▪ Interface s with on-board monitoring and diagnostic equipment. ▪ Data are formatted to meet regulatory requirements for vehicle and terminal inspections. ▪ Options include transmitting vehicle status while en route through wireless means, or

Market Package	Major Options Consistent with the National ITS Architecture
	storing the data on-board and downloading when the vehicle arrives at a terminal.
HAZMAT Management	▪ Provides electronic application/issuance for HAZMAT credentials, electronic notification of hazardous material incidents and provides cargo characteristics and clean-up procedures to emergency management personnel. ▪ Emergency notification is provided from the vehicle by a cell-based digital system, satellite data link, or preexisting wireless infrastructure. ▪ Vehicles communicate to Emergency Management either directly or via Fleet Management. ▪ Credential applications are transmitted from Freight Management to Commercial Vehicle Administrators and electronic credentials are transmitted back. ▪ As an option, vehicles may store cargo manifests and cleanup procedures electronically; emergency management personnel download this information on-site. ▪ As an option, Freight Management electronically stores cargo manifests and cleanup procedures and emergency management personnel access these data via existing wireline infrastructure.

6.4.5 Emergency Management Design Options

Major design options for Emergency Management are described in Table 6.4.5-1. Detailed arrangements for the initiation and reception of emergency notification is subject to regional coordination and negotiation. The private sector may also participate in this function as an initial filter for emergency calls.

Table 6.4.5-1: Major Emergency Management Design Options

Market Package	Major Options Consistent with the National ITS Architecture
Emergency Response	▪ This Market Package automates the dispatch of emergency vehicle upon verification of incident, location, and nature of incident by the Emergency Management center. ▪ Existing or emerging wireline interconnects to sensors are used for incident detection. ▪ Mayday signals will be received via wireline from other centers or from phone lines. ▪ Instructions are provided to emergency vehicles via existing links or added cell based links between the emergency vehicle and the Emergency Management Center. ▪ Emergency vehicle have short wave RF links to allow for local signal preemption. The Emergency Management Center would include hardware and software for tracking the emergency vehicles.
Emergency Routing	▪ Emergency Routing utilizes the optimal route, supplied by the ISP, to provide dynamic routing of emergency vehicles and coordination with TMS for green wave functions and ISP for best route. ▪ Emergency vehicles can either preempt signals or request the TMC to provide priority through coordinated signal control (this will most likely happen during major emergencies.) ▪ Emergency Management may either provide route plans based on their experience or forward route requests to an ISP to generate route plans based on dynamic traffic information. ▪ Existing wireless communication systems or cell-based digital systems may be used for the communications between emergency vehicles and the emergency management.
Mayday Support	▪ This Market Package allows the user (driver or non-driver) to initiate a request for emergency assistance and enables the Emergency Management Center (EMC) to locate the user for efficient dispatch. ▪ The request may be manually initiated or automated and linked to vehicle sensors. ▪ The data is sent to the EMC using a wide-area wireless communications with voice as an option. ▪ Providing user location implies either a location technology within the user device or location determination within the communications infrastructure.

6.4.6 Archived Data Management Design Options

The Market Packages related to ITS data archiving were designed to accommodate a broad array of implementation options ranging from basic database generation derived from a single data source and outputting generic products to a complex mulit-source data warehouse with the capability to perform on-line analyses and produce customized reports. Table 6.4.6-1 identifies some of the major design options with the data archiving Market Packages.

Table 6.4.6-1: Major Data Archiving Design Options

Market Package	Major Options Consistent with the National ITS Architecture
ITS Data Mart	▪ Data can be stored in flat file, hierarchical, relational, and object oriented formats ▪ Users prescribe data quality control, privacy, aggregation procedures, and time duration that data remains on-line ▪ Off line storage media can include optical, hard disk, or tape. ▪ Data can be archived interactively or in batch mode ▪ Ad-hoc queries and custom reports available
ITS Data Warehouse	▪ Data Mining options: statistical, machine learning, and neural network ▪ Various user interfaces to facilitate data analysis and visual comparisons are possible ▪ Data can be stored in flat file, hierarchical, relational, and object oriented formats ▪ Users prescribe data quality control, privacy, aggregation procedures, and time duration that data remains on-line ▪ Off line storage media can include optical, hard disk, or tape. ▪ Data can be archived interactively or in batch mode ▪ Ad-hoc queries and custom reports, and graphic representations of data available
ITS Virtual Data Warehouse	▪ Data Mining options: statistical, machine learning, and neural network ▪ Various user interfaces to facilitate data analysis and visual comparisons are possible ▪ Ad-hoc queries and custom reports, and graphic representations of data available

Appendix A – Rural User Needs

Emergency Services

User needs in the area of Emergency Services address the response to an individual incident such as a traffic collision and to more widespread events such as natural disasters. Once an incident (accident or emergency situation) occurs, there is a need for emergency services. These services can be in the form of ambulances and medical care, police, fire, tow trucks, and other vehicle assistance, etc. The isolation of rural areas, extensive time from the incident to detection, and response once the incident is detected all contribute to notifications and response times much longer than found in urban areas. This may lead to more severe consequences than might occur with a more rapid response.

Many rural areas maintain evacuation and disaster response plans for dealing with events such as hurricanes and floods. Timely warning and evacuation are critical to successfully responding to these events.

Rural user needs in the area of Emergency Services focus on measures designed to improve the emergency response process, from reducing incident detection and verification times through the process of selecting the most appropriate response. Needs in this area also include the need for emergency notification or warning in the event of natural disasters. ITS rural user needs in the area of Emergency Management emphasize communications and emergency services fleet management.

Communication related needs include the need to facilitate the transmission of critical information to better prepare caregivers at the scene, en-route, and at medical facilities as well as to provide incident information and warning notices to emergency vehicle crews. Fleet management related needs include facilitating arrival of emergency vehicles at the scene through vehicle routing, identification, and in vehicle warning systems. User needs in this area also include the need for coordination of different services and the need to share critical and appropriate information on the emergency as rapidly as possible.

National ITS Architecture Support of Rural Emergency Services

Table A-1 shows the Market Packages that are applicable to the Emergency Services rural development track.

Table A-1: Market Packages that are Applicable to Rural Emergency Services

	Market Package	Applicability
ATIS1	Broadcast Traveler Information	◗
ATIS2	Interactive Traveler Information	❍
ATIS3	Autonomous Route Guidance	●
ATIS5	ISP Based Route Guidance	❍
ATIS7	Yellow Pages and Reservation	❍
ATMS01	Network Surveillance	❍
ATMS06	Traffic Information Dissemination	❍
ATMS12	Virtual TMC and Smart Probe Data	❍
EM1	Emergency Response	●
EM2	Emergency Routing	●
EM3	Mayday Support	●

Key:
❍ = applicable to rural user needs, but has limitations for the rural environment
◗ = applicable to a significant number of rural user needs, may require some augmentation for the rural environment
● = highly applicable to rural user needs and suitable for the rural environment

The National ITS Architecture currently has little or no coverage of the following Rural User Needs that have been identified in the Emergency Services development track:

- Rural Addressing
- Emergency Services Billing

Both of these items fall into the category of “derived” requirements; that is, they are not needs that have traditionally been explicitly listed in the User Service Requirements. Rather, they are needs that become apparent during the analysis of what is required to address other explicit functional requirements. Additionally, “rural addressing” has been identified as an implementation issue that is not likely to manifest itself in the National ITS Architecture.

There are also a number of areas of Rural User Needs that are only weakly covered by the National ITS Architecture:

- Disaster Response
- Guidance to Appropriate Emergency Facilities
- Emergency Shelter Locations and Information

These areas will be enhanced in the National ITS Architecture to ensure full coverage. Certain areas, like disaster response, may not be fully addressable

under the existing 31 User Services, but will be at least partially implemented, pending a new User Service that fully captures the requirements.

Tourism and Travel

User needs in the Tourism and Travel area include the need to provide information and mobility services to tourists and destination locations, since many times visitors have little choice of mode (no auto) and require special services. Knowing where desired destinations are, how to get to them, and conditions along the way adds to the mobility and convenience of an area. Likewise, travelers must be aware of destinations before they can visit them.

Many rural areas are characterized by long distances between tourist destinations and diverse landforms including mountainous areas, forests and deserts, complicating information delivery to travelers in the region. Alternative modes of transportation such as shuttle buses may or may not be available from gateway communities further limiting information dissemination opportunities.

Providing services to tourists and others unfamiliar with the rural surroundings enhances the economic vitality of the area. In addition, once in a resort area, tourists often are hindered due to lack of a vehicle. As such, user needs in this area address aspects of both the "Mobility and Convenience" and "Economic Vitality and Productivity" goals for the Rural ITS program.

Tourism may also be a concern in any rural setting during major events and festivals. At these events the traffic, local population, and transportation problems of the participants, local residents, and emergency services swell to many times their average levels. Event logistics, traffic and parking management, provision of emergency communications, etc., are crucial to the success of these events and yet must be temporary in nature, and in most cases understandable to volunteers.

The main focus of user needs identified to date in this area is access to/dissemination of information. This includes information typically associated with electronic yellow pages, as well as weather and condition forecasting, route advisory information, information dissemination in hotels, roadside, wide band radio, etc. Tourism and travel needs also include the need for mobility through transit, paratransit, and location and navigation systems (for personal and rental cars, as examples). User needs in the area of tourism and travel serve a variety of stakeholders including: Tourism and Visitors Centers, Economic Development Bureaus, as well as the local service providers (transit authorities, State and Local Departments of Transportation, and Park Agencies).

National ITS Architecture Support of Rural Tourism and Travel

Table A-2 shows the Market Packages that are applicable to the Tourism and Travel rural development track. Looking at the table, it may seem somewhat surprising that some of the Commercial Vehicle Operations (CVO) and Emergency Management (EM) Market Packages appear. In both cases, the individual Market Packages map to single rural user needs. For the CVO case, all three Market Packages map to a single rural user need, under Tourism and Travel, to "enhance business viability" in rural areas. Support for CVO was felt to be a possible element of addressing that need. Though many Market Packages indirectly support economic development and enhance regional economic competitiveness, the CVO Market Packages were singled out for the direct role they can play in lowering business operating costs.

Table A-2: Market Packages that are Applicable to Rural Tourism and Travel

	Market Package	Applicability
AD3	ITS Virtual Data Warehouse	❍
APTS1	Transit Vehicle Tracking	●
APTS2	Transit Fixed-Route Operations	●
APTS3	Demand Response Transit Operations	❍
APTS4	Transit Passenger and Fare Management	❍
APTS7	Multi-modal Coordination	❍
APTS8	Transit Traveler Information	●
ATIS1	Broadcast Traveler Information	◗
ATIS2	Interactive Traveler Information	❍
ATIS3	Autonomous Route Guidance	●
ATIS4	Dynamic Route Guidance	◗
ATIS5	ISP Based Route Guidance	◗
ATIS7	Yellow Pages and Reservation	●
ATIS9	In Vehicle Signing	◗
ATMS01	Network Surveillance	❍
ATMS02	Probe Surveillance	◗
ATMS06	Traffic Information Dissemination	◗
ATMS08	Incident Management System	◗
ATMS10	Electronic Toll Collection	❍
ATMS12	Virtual TMC and Smart Probe Data	●
CVO01	Fleet Administration	❍
CVO03	Electronic Clearance	◗
CVO04	CV Administrative Processes	◗
CVO05	International Border Electronic Clearance	◗
EM1	Emergency Response	◗
EM3	Mayday Support	◗

Key:

❍ = applicable to rural user needs, but has limitations for the rural environment

◗ = applicable to a significant number of rural user needs, may require some augmentation for the rural environment

● = highly applicable to rural user needs and suitable for the rural environment

The National ITS Architecture currently has little or no coverage of the following Rural User Needs that have been identified in the Tourism and Travel development track:

- Rural Addressing
- Support for Economic Development

"Rural addressing" has been identified as an implementation issue that is not likely to manifest itself in the National ITS Architecture. Support for economic development, while a very worthy goal for ITS, is not really directly addressable in an architecture. Rather, it is an institutional and policy matter.

There are also a number of areas of Rural User Needs that are only weakly covered by the National ITS Architecture:

- Disaster Response
- Information About and Guidance to Emergency Shelters
- Rural-Environment Incidents (fog, high winds, flash flooding, etc.)

These areas will be enhanced in the National ITS Architecture to ensure full coverage. Certain areas, like disaster response, may not be fully addressable under the existing 31 User Services, but will be at least partially implemented, pending a new User Service that fully captures the requirements.

Traffic Management

Travelers in rural areas are often faced with traffic congestion and excessive delays when traveling through construction areas or near seasonal or cyclical attraction areas such as ski areas, beaches, national parks, etc. Although congestion is less frequent than in urban areas, the lack of alternate routes in rural areas often results in traffic congestion as severe as that experienced in urban areas, creating costly and lengthy delays. Incident-related delay, exacerbated by the longer response times typical in rural areas and the high rate of fatal crashes (nearly twice that of urban areas) also contributes to traffic congestion and traveler delay along rural roadways. In addition, sudden, or unexpected areas of congestion may also contribute to secondary incidents and additional traveler delay.

Rural user needs in the area of Traffic Management focus on information requirements and management systems that can be adjusted or tailored to meet seasonal or periodic conditions. User needs include information regarding downstream traffic conditions, alternate routes around congested areas, road work requiring lane closure, changing or hazardous weather conditions, and adaptive traffic signal or traffic management systems for traffic control through small urban areas.

National ITS Architecture Support of Rural Traffic Management

Table A-3 shows the Market Packages that are applicable to the Traffic Management rural development track.

Table A-3: Market Packages that are Applicable to Rural Traffic Management

	Market Package	Applicability
AD2	ITS Data Warehouse	●
APTS2	Transit Fixed-Route Operations	●
APTS8	Transit Traveler Information	●
ATIS1	Broadcast Traveler Information	◗
ATIS2	Interactive Traveler Information	❍
ATIS3	Autonomous Route Guidance	◗
ATIS4	Dynamic Route Guidance	❍
ATIS5	ISP Based Route Guidance	❍
ATIS6	Integrated Transportation Management/Route Guidance	❍
ATIS8	Dynamic Ridesharing	❍
ATIS9	In Vehicle Signing	●
ATMS01	Network Surveillance	◗
ATMS02	Probe Surveillance	◗
ATMS03	Surface Street Control	❍
ATMS04	Freeway Control	❍
ATMS06	Traffic Information Dissemination	◗
ATMS07	Regional Traffic Control	❍
ATMS08	Incident Management System	◗
ATMS09	Traffic Forecast and Demand Management	◗
CVO10	HAZMAT Management	❍
EM1	Emergency Response	◗
EM2	Emergency Routing	❍
EM3	Mayday Support	◗

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The National ITS Architecture currently has little or no coverage of the following Rural User Needs that have been identified in the Traffic Management development track:

- Consistent Addressing
- Communications System Redundancy
- Enforcement

The first two needs are implementation issues that are not likely to manifest themselves in the National ITS Architecture. The third, enforcement, is a need that could appropriately be addressed in an ITS architecture. However, it is currently outside the scope of the 31 user services.

There are also a number of areas of Rural User Needs that are only weakly covered by the National ITS Architecture:

- Emergency Evacuation Routes
- Construction and Maintenance Information
- Work Zone Management
- Variable Speed Limits
- Bridge Warnings
- Seasonal Delays
- Remote Monitoring and Maintenance
- "Virtual" Traffic Operations Centers

These areas will be enhanced in the National ITS Architecture to ensure full coverage. Certain areas, like variable speed limits and enforcement, may not be fully addressable under the existing 31 User Services, but will be at least partially implemented, pending a new User Service that fully captures the requirements.

Rural Transit and Mobility

Isolation and accessibility to transportation services are critical concerns to many rural inhabitants. As the nation ages the need for accessible mobility services will become much more important. This is especially true for rural areas where neighbors are often miles apart, trip distances are long, and travel to common origins and destinations are infrequent. Key stakeholders in the area of rural transit needs include rural residents, visitors to tourist areas, rural transit agencies and social service providers.

Rural user needs in the area of rural transit focus on providing and having access to traditional fixed-route transit, flexibly routed transit, demand-responsive paratransit, and other services associated with the ability to make a desired trip. Identifying those who need services, determining what types of services are needed; and determining how to provide the needed services in an efficient and effective manner, are key elements in defining rural transit user needs from the transit agency perspective. Further, there are additional factors that must be considered. These include the needs of agencies to identify special non-transit services (nursing, meals on wheels, hospital out patient, etc.) and the needs associated with coordination and communication between the many providers of services that may be involved (such as transit agencies and social service providers). From the customer's perspective, the needs include services that go where and when customers need to travel; access to accurate, real-time information regarding arrivals and departures; and better customer service.

National ITS Architecture Support of Rural Transit and Mobility

Table A-4 shows the Market Packages that are applicable to the Transit and Mobility rural development track.

Table A-4: Market Packages that are Applicable to Rural Transit and Mobility

	Market Package	Applicability
AD1	ITS Data Mart	❍
AD2	ITS Data Warehouse	❍
APTS1	Transit Vehicle Tracking	◗
APTS2	Transit Fixed-Route Operations	◗
APTS3	Demand Response Transit Operations	●
APTS4	Transit Passenger and Fare Management	◗
APTS6	Transit Maintenance	❍
APTS7	Multi-modal Coordination	❍
APTS8	Transit Traveler Information	●
ATIS1	Broadcast Traveler Information	◗
ATIS2	Interactive Traveler Information	❍
ATIS3	Autonomous Route Guidance	●
ATIS4	Dynamic Route Guidance	◗
ATIS5	ISP Based Route Guidance	❍
ATIS7	Yellow Pages and Reservation	❍
ATIS8	Dynamic Ridesharing	❍
ATMS06	Traffic Information Dissemination	◗

Key:

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● = highly applicable to rural user needs and suitable for the rural environment

The National ITS Architecture currently has little or no coverage of the following Rural User Needs that have been identified in the Transit and Mobility development track:

- Rural Addressing
- Demographic Tracking
- Guaranteed Mobility
- Third Party Billing

Rural addressing has already received some discussion, but the other three needs may require some definition. Demographic tracking is concerned with the collection and correlation of demographic information with transit demand, to allow route planning and service development. Guaranteed mobility focuses on ensuring that all customers in a transit service area have access to the services, as mandated by federal law. This can include the use of paratransit to bring disabled persons to and from the main transit services. Third party billing concerns the handling of payment where more than one agency or group is involved (for example, a taxi company providing paratransit that bills the transit agency for services provided).

The first three of the needs in the list above are implementation issues that are not likely to manifest themselves in the National ITS Architecture. The last item, third

party billing, falls into the category of “derived” requirements; that is, it is not a need that has traditionally been explicitly listed in the User Service Requirements. Rather, billing is a requirement that becomes apparent during the analysis of what is required to address other explicit requirements, like "provide transit services".

There are also a number of areas of Rural User Needs that are only weakly covered by the National ITS Architecture:

- Cooperative Coordination between Peer Transit Agencies
- “Points-of-Interest” (POI) Traveler Information for Rural Attractions

These areas will be enhanced in the National ITS Architecture to ensure full coverage. Both of these needs can be addressed under the existing user services that bound the scope of the National ITS Architecture.

Crash Prevention and Security

Within rural transportation settings, the type, rate, and severity of crashes has been repeatedly identified as one of the most serious problems that needs to be addressed. For example, accidents per-vehicle-mile-traveled are higher in rural settings than in urban areas and tend to be more severe due to higher vehicle operating speeds and longer travel times for emergency service response. Rural ITS User Needs for Crash Prevention and Security focus on preventing crashes before they occur, reducing the severity of the crashes that do take place, and safeguarding other users of the transportation system (i.e., transit riders). These identified User Needs center around improving a driver's ability to operate a vehicle safely in rural settings. Therefore, they address the three (3) main components of vehicle crashes: the driver, the vehicle, and the roadway. These User Needs further attempt to reduce the factors that influence a crash: for example, diminishing driver alertness, roadway obstructions (e.g., animals, debris, etc.), poor roadway conditions (e.g., weather, visibility, roadway geometry, etc.).

Other Rural ITS User Needs in this category involve increasing the security (both actual and perceived) of travelers during their trip. For example, a traveler may be injured even though he or she has not been involved in a vehicular accident (i.e., transit patron assaulted while waiting for a bus). Thus, providing a secure environment through remote monitoring of key transportation sites, the presence of silent alarms, and automated vehicle location (AVL) systems are also included.

National ITS Architecture Support of Rural Crash Prevention and Security

Table A-5 shows the Market Packages that are applicable to the Crash Prevention and Security rural development track.

Table A-5: Market Packages that are Applicable to Rural Crash Prevention and Security

	Market Package	Applicability
AD1	ITS Data Mart	◗
APTS3	Demand Response Transit Operations	❍
APTS5	Transit Security	◗
APTS7	Multi-modal Coordination	❍
ATIS1	Broadcast Traveler Information	◗
ATIS2	Interactive Traveler Information	❍
ATIS3	Autonomous Route Guidance	●
ATIS4	Dynamic Route Guidance	◗
ATIS9	In Vehicle Signing	●
ATMS01	Network Surveillance	❍
ATMS06	Traffic Information Dissemination	◗
ATMS07	Regional Traffic Control	❍
ATMS08	Incident Management System	◗
ATMS12	Virtual TMC and Smart Probe Data	●
ATMS13	Standard Railroad Grade Crossing	●
ATMS14	Advanced Railroad Grade Crossing	●
ATMS15	Railroad Operations Coordination	●
ATMS18	Road Weather Information System	◗
AVSS02	Driver Safety Monitoring	●
AVSS03	Longitudinal Safety Warning	●
AVSS04	Lateral Safety Warning	●
AVSS05	Intersection Safety Warning	❍
AVSS06	Pre-Crash Restraint Deployment	●
AVSS09	Advanced Vehicle Lateral Control	●
CVO08	On-board CVO Safety	●
EM2	Emergency Routing	❍

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The National ITS Architecture currently has little or no coverage of the generic agency-to-agency real time data sharing that has been identified in the Crash Prevention and Security development track. The National ITS Architecture is built on a foundation of extensive data sharing, but does not support all of the data sharing that has been called out in the Rural User Needs. There are Rural User Needs that require a significant amount of data sharing without identified functional requirements that the specific data sharing is satisfying. This means that additional analysis is necessary to identify these functional requirements for the purposes of defining an architecture, to allow the data sharing enhancements to be added.

There are also a number of areas of Rural User Needs that are only weakly covered by the National ITS Architecture:

- Remote Monitoring (a comprehensive capability to remotely gather data from roadway and environmental sensors)
- Vehicle Alarms (other than transit alarms and personal MAYDAY)
- Road/Weather Information Systems

- Work Zone Control

These areas will be enhanced in the National ITS Architecture to ensure full coverage. These areas should all be fully addressable under the existing 31 User Services. However, a richer definition of some, such as work zone control, would be defined as part of a new User Service that fully captures the requirements.

Operations and Maintenance

The isolation, distances involved, and the large number of rural roadway miles makes the operation and maintenance of the rural transportation infrastructure both challenging and costly. Low traffic volumes on these roads also makes the detection of problems and conditions a concern. Similarly, operations and maintenance activities are difficult for rural public transportation service providers, which are frequently small, dispersed, and which lack adequate human and financial resources.

Operations and maintenance of rural roads and their associated infrastructure is typically the responsibility of public agencies at the state, county or city and township level. Their responsibilities include:

- Monitoring, maintaining, and improving the physical condition of the infrastructure
- Maintaining the condition of public vehicle fleets
- Ensuring safe operation of the system, especially under adverse travel conditions, such as winter weather, or during construction and other work zone activities
- Ensuring the efficient operation of the system, including the use and maintenance of various traffic management and traffic control devices.

In general, rural user needs in the operations and maintenance area focus on the issues of reducing costs, while maintaining or improving the efficiency and effectiveness of these activities.

National ITS Architecture Support of Rural Operations and Maintenance

Table A-6 shows the Market Packages that are applicable to the Operations and Maintenance rural development track.

Table A-6: Market Packages that are Applicable to Rural Operations and Maintenance

Market Package		Applicability
AD1	ITS Data Mart	❍
AD2	ITS Data Warehouse	❍
ATMS01	Network Surveillance	❍
ATMS03	Surface Street Control	❍

Market Package		Applicability
ATMS04	Freeway Control	❍
ATMS06	Traffic Information Dissemination	❍

Key:
❍ = applicable to rural user needs, but has limitations for the rural environment
◗ = applicable to a significant number of rural user needs, may require some augmentation for the rural environment
● = highly applicable to rural user needs and suitable for the rural environment

The National ITS Architecture currently has little or no coverage of the following Rural User Needs that have been identified in the Operations and Maintenance development track:

- Rural Addressing
- General "Operations and Maintenance"

We have previously cited "rural addressing" multiple times: this has been identified as an implementation issue that is not likely to manifest itself in the National ITS Architecture. Operations and maintenance is highly appropriate for coverage in the National ITS Architecture; however, for a full treatment a new user service is needed that defines the needs for this specific area.

There are also a number of areas of Rural User Needs that are only weakly covered by the National ITS Architecture:

- Management of O&M "Operations"
- Emergency Alarms in Fleet Vehicles other than Transit
- Managing O&M Fleet Vehicles (e.g. Snow Plows)
- Environmental Incidents (flooding, mud slides, avalanches, etc.)

These areas will be enhanced in the National ITS Architecture to ensure full coverage. Certain areas, like the management of O&M vehicle fleets, cannot be fully addressable under the existing 31 User Services.

Surface Transportation and Weather

Rural areas represent a diverse variety of terrain types ranging from mountainous areas to desert areas located below sea level. Weather conditions for rural travelers reflect this variety of characteristics. Some rural areas include such extreme differences in terrain and variability of weather within a single corridor, even within the same time frame. Weather-related crashes and delays represent a chronic problem for some rural areas prone to abrupt changes in conditions, terrain induced variability, and even seasonal occurrences such as spring and summer rainstorms creating flash flood conditions. Steep mountain grades combined with icy conditions present significant problems for commercial vehicle operators (as well as other travelers). Long response times of emergency

services in these conditions delay vitally needed medical care, and further exacerbate travel delays due to secondary incidents.

Rural user needs in the area of Weather focus on support to decision making prior to trip initiation, monitoring roadway weather conditions for trips and operations that are underway, and communicating this information to system users. Rural user needs in this area also include providing service information to travelers who are not able to continue their trips due to hazardous conditions.

ITS user needs for Weather information in rural areas involve gathering, processing and dissemination and fall into the following five general categories:

- Advisory Information
- System Operational Effectiveness
- En-Route Services Information
- Leveraging Weather Information to Cost Containment, Profitability, and Safe Operations/Travel
- Data Sharing

There are also distinctly different domains of weather information, including climatology, observations, and forecasts of the atmosphere, and of pavement/ground conditions.

Tailoring of weather information for specific users is at least regionalized or presented at local scales, which are defined climatologically. Successful use of weather information to optimize decision making depends on education of users relative to meteorology and diagnostic and forecasting capabilities, and of weather information providers relative to specific user requirements.

Evaluation of forecast accuracy, and conditioning of forecasts such as by assignment of probability, are complex issues that need attention in operational environments.

National ITS Architecture Support of Rural Surface Transportation and Weather

Table A-7 shows the Market Packages that are applicable to Rural Surface Transportation and Weather rural development track

Table A-7: Market Packages that are Applicable to Rural Surface Transportation and Weather

Market Package		Applicability
AD1	ITS Data Mart	◗
AD2	ITS Data Warehouse	◗
AD3	ITS Virtual Data Warehouse	◗
ATIS1	Broadcast Traveler Information	❍

Market Package		Applicability
ATIS9	In Vehicle Signing	❍
ATMS06	Traffic Information Dissemination	❍
ATMS18	Road Weather Information System	●

Key:

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The National ITS Architecture currently has little or no coverage of Rural User Needs in the Surface Transportation and Weather development track that fall into the following general categories:

- Natural Disaster and Shelter Information
- Dissemination of Transportation Information to Weather Services

In general, through the addition of selected user service requirements, it should be possible to meet these needs through a more robust definition of the handling of weather and environmental information in the National ITS Architecture. Disaster and shelter information are a small subset of the full view of “disaster management”, however the dissemination of this type of information, either as travel warnings or as part of incident management, falls within the scope of the existing 31 user services.

There are also a number of areas of Rural User Needs that are only weakly covered by the National ITS Architecture:

- Defined “Weather Products”
- Full information exchange between all parties that have or need weather information

These areas will be enhanced in the National ITS Architecture to ensure full coverage. While weather and environmental information products "development and dissemination" would benefit from the focus of a user service, it is probable that most of the needs can be addressed under the existing 31 User Services.