HOUSTON REGION
ITS ARCHITECTURE

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DISCLAIMER

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City of Missouri City
City of Texas City
City of Baytown
Smaller Cities
Brazoria County
Chambers County
Fort Bend County
Galveston County
Harris County
Liberty County
Montgomery County
Waller County
Air Quality
Comprehensive Planning
Environmental/Planning
Toll Roads
Private Business
H-GAC
METRO
TxDOT Beaumont District
TxDOT Houston District
TNRCC
Rural Transit
Environmental Interests
Intermodal Interests - Airports
Intermodal Interests - Bicycle & Pedestrian
Intermodal Interests - Ports
Intermodal Interests - Toll Roads
Neighborhoods/Other Citizen Interests
Other Modes, State Agencies, or Transportation Related Interests

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EXECUTIVE SUMMARY

Background

A foundation element for deploying and integrating Intelligent Transportation Systems (ITS) is the development of an ITS Architecture and Strategic Plan. The ITS Architecture defines how major elements of a comprehensive system are interrelated while the strategic plan defines how to successfully deploy and operate the ITS infrastructure. This document details the ITS architecture for the Houston region. The Strategic Plan will be discussed under a separate document.

The Houston region is comprised of eight counties including Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties (Figure ES-1). The Houston Region has been active for many years in deploying and operating ITS based systems.

Figure ES-1. Counties Included in the Regional ITS Architecture (Identified with a ★)

As part of the plan, one of the main activities undertaken was the development of a regional ITS architecture. The approach used to develop a regional ITS architecture for the Houston region ensured that the region's needs are consistent and translated into National ITS Architecture terminology and products. The architecture described in this document builds upon the defined Houston TranStar architecture and enhances it to add additional systems and services that are applicable to the entire region.

Why an ITS Architecture?

This report summarizes the development of a regional ITS architecture for the Houston region. An ITS architecture describes how various systems are connected electronically, what data is shared, and functionally how this interconnected system is used to accomplish a particular goal or a function. Without such a blueprint or architecture, the transportation system in the region would simply be a collection of isolated systems.

The Federal Highway Administration (FHWA) issued an architecture rule and policy on January 8, 2001 that required the development of a regional ITS architecture, consistent with the National ITS Architecture, as a precursor to receipt of future federal funding for ITS projects. Regions that already have ITS projects in place have up to four years from the date of this rule to develop an ITS architecture.

What's in an ITS Architecture?

The Houston region's architecture was developed using a structured process (see Figure ES-2) and sequentially "mapped" identified critical local needs and issues into the National ITS Architecture terminology and products. The steps and products identified in Figure ES-2 are described briefly below and are detailed in the rest of the document.

Identification of Functional Needs: The first step in the development of a regional ITS architecture is the identification of needs and issues faced by stakeholders in the Houston region. The project team identified these needs by conducting focus groups and interviews of key stakeholders in the region. These needs were then organized by priority and the critical needs were identified. Some of the critical needs included improved emergency management, alleviating congestion, improving safety, evacuation management, agency coordination, etc.

Mapping Needs to User Services: The next step in the process is to convert the functional needs into user services as defined by the national ITS architecture. There were two sources of input to this process. In addition to the mapping of needs to user services, all the user services listed in TranStar architecture were included as a part of the regional architecture. Twenty-six of the thirty-two national ITS architecture user services were selected as relevant to the region.

Market Packages and Equipment Packages: Market packages are bundles of functionality that are grouped together to deliver one or many user services. The market packages described for the region will include all the market packages that were identified as part of the Houston Transtar Architecture enhanced with the additional market packages identified through the new user services defined for the region. In addition to the market packages, an identification of the region's equipment packages are also included.

Physical Architecture: The physical architecture defines the Physical Entities (Centers, Subsystems) that make up an intelligent transportation system, the Architecture Flows that connect the various subsystems, and terminators into an integrated system. The subsystems or the physical entities are organized by their characteristics in four categories, namely, Center, Roadside, Vehicle, and Traveler subsystems.

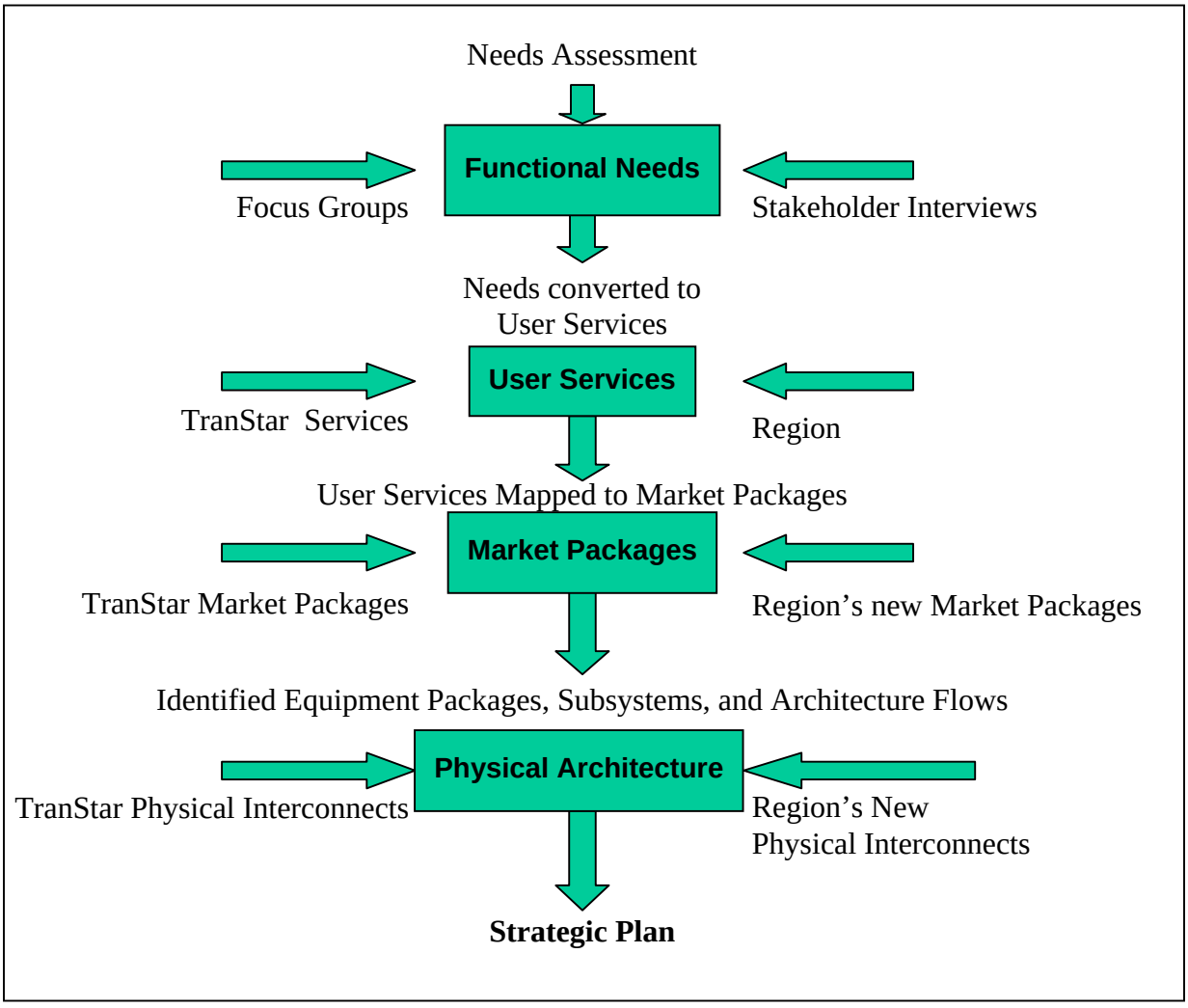

Figure ES-2: Architecture Development Process

High-Level Physical Architecture for the Houston Region

Figure ES-3 presents the high-level physical architecture for the area. This style of architectural illustration is often referred to as the "sausage diagram"--this figure presents the major subsystems as they are envisioned for the Houston region. The figure depicts the existing and planned systems and identifies them in the four main systems of centers, roadside, traveler, and vehicle. The "sausages" in this diagram represent the various communication approaches, not necessarily the exact technologies that are used to connect the subsystems. More technically detailed physical architecture diagrams for each subsystem represented in the sausage diagram are presented in Chapter 4 of the document.

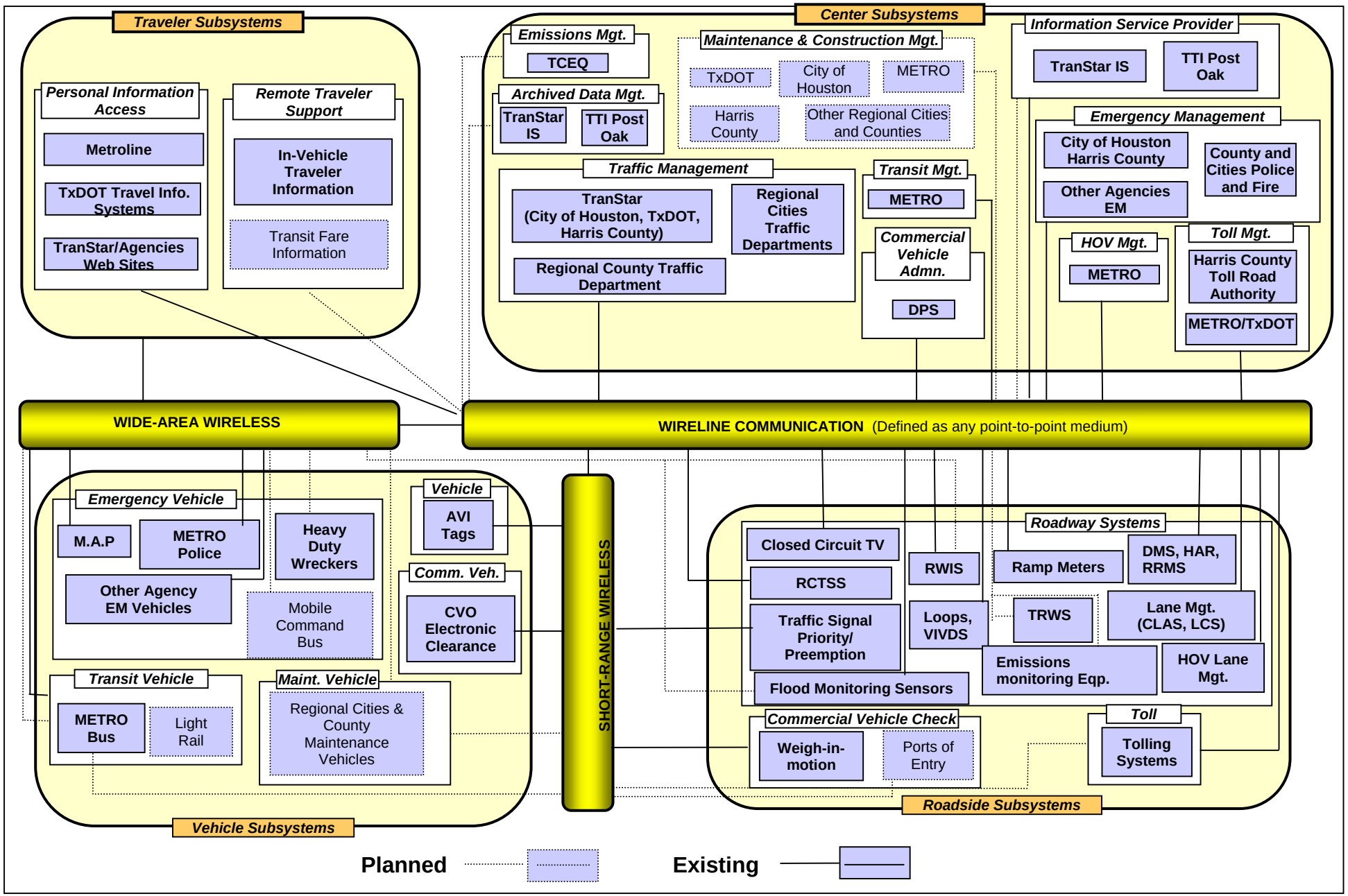

Figure ES-3: High-Level Physical Architecture for the Houston Region

1.0 INTRODUCTION

Intelligent Transportation Systems (ITS) aim to improve efficiency and safety of the transportation system in the area through deployment of advanced technologies and systems management techniques. ITS technologies offer benefits ranging from improved safety on the existing transportation infrastructure to enhanced travel information to users of the transportation facilities. ITS technologies also provide managers of the transportation systems the ability to squeeze more out of existing infrastructure by using the information provided from ITS solutions.

To ensure successful deployment, all regional stakeholders, including emergency management, transit, traveler information providers, the media, etc. must be involved and integrated. A blueprint is needed for the development of an integrated system because multiple interested stakeholders are involved -- all with different systems and technologies in place and plans for the future. An ITS architecture describes how various systems are connected electronically, what data is shared, and functionally how this interconnected system is used to accomplish a particular goal or a function (e.g., improve emergency response times to accidents/incidents). Without such a blueprint or architecture, the transportation system in the region would simply be a collection of isolated systems.

1.1 Organization of the Report

The rest of this chapter discusses the architecture development process along with the description of the Houston region and the existing ITS infrastructure in the region.

Chapter 2 discusses the needs assessment for the region including the needs identified from stakeholder interviews and focus groups and from the Houston Transtar Architecture. As a first step towards developing an architecture, this chapter also matches the regional needs to the structured National ITS Architecture User Services.

Chapter 3 maps the region's selected user services to market packages and identifies equipment packages.

Chapter 4 illustrates the physical architecture framework for major functional areas in the region and details the subsystems, interconnects, and the architecture flows.

Chapter 5 identifies the next steps to proceed from the architecture development process to the strategic plan.

Appendix A lists the selected region's customized market packages, their descriptions and diagrams.

1.2 Why an Architecture

The development of an ITS architecture is important because the cost of deploying technologies can be expensive, and is growing rapidly. Also, the decisions made in the early stages of procuring and deploying ITS technologies can have significant impacts on the costs and functionality of future deployments. Planning ahead for future regional needs and designing each system for future flexibility is the purpose of an ITS architecture.

Another important reason is to comply with the Federal Highway Administration's (FHWA) rule and the Federal Transit Administration's (FTA) policy on Intelligent Transportation Systems (ITS) Architecture and Standards. The rule and policy became effective on April 8, 2001, to implement section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21). The final rule/policy emphasizes the following:

- Regions *currently* implementing ITS projects must have a regional ITS architecture in place in four years. Regions *not currently* implementing ITS projects must develop a regional ITS architecture within four years from the date their first ITS project advances to final design.
- ITS projects funded by the Highway Trust Fund and the Mass Transit Account must conform to a regional ITS architecture.
- Major ITS projects should move forward based on a project level architecture that clearly reflects consistency with the National ITS architecture.
- Projects must use USDOT adopted ITS standards as appropriate. To date, the USDOT has not adopted any ITS standards, and a formal rulemaking process will precede any USDOT ITS standard adoption.
- Compliance with the regional ITS architecture will be in accordance with USDOT oversight and Federal-aid procedures, similar to non-ITS projects.

This policy and regulation, combined with a need for a systematic deployment of ITS systems in the Houston region, make the development of a regional ITS architecture a priority.

1.3 Architecture Development Process

The approach used to develop a regional system architecture for the Houston region ensures that the region's needs are consistent and translated into National ITS Architecture terminology and products. Figure 1-1 depicts this architecture development process and the various products of this process. These products are briefly described below and will be discussed in detail later in the document.

Functional Needs: The first step in the development of a system architecture is the identification of needs and issues faced by stakeholders in the Houston region to deploy intelligent transportation systems. The project team identified these needs by conducting focus groups and interviews of key stakeholders in the region.

User Services: The next step in the process is to convert the functional needs into user services. Simply put, user services are "**WHAT ITS should do**." They are used in the National ITS Architecture to convert the "raw" needs to useful groupings of services that can consider and address a broad range of ITS users including the traveling public as well as many different types of system operators. As shown in the Figure 1-1, the user services identified for the region will include all the user services identified as part of the Houston Transtar Architecture and the additional user services identified through the region's stakeholder needs.

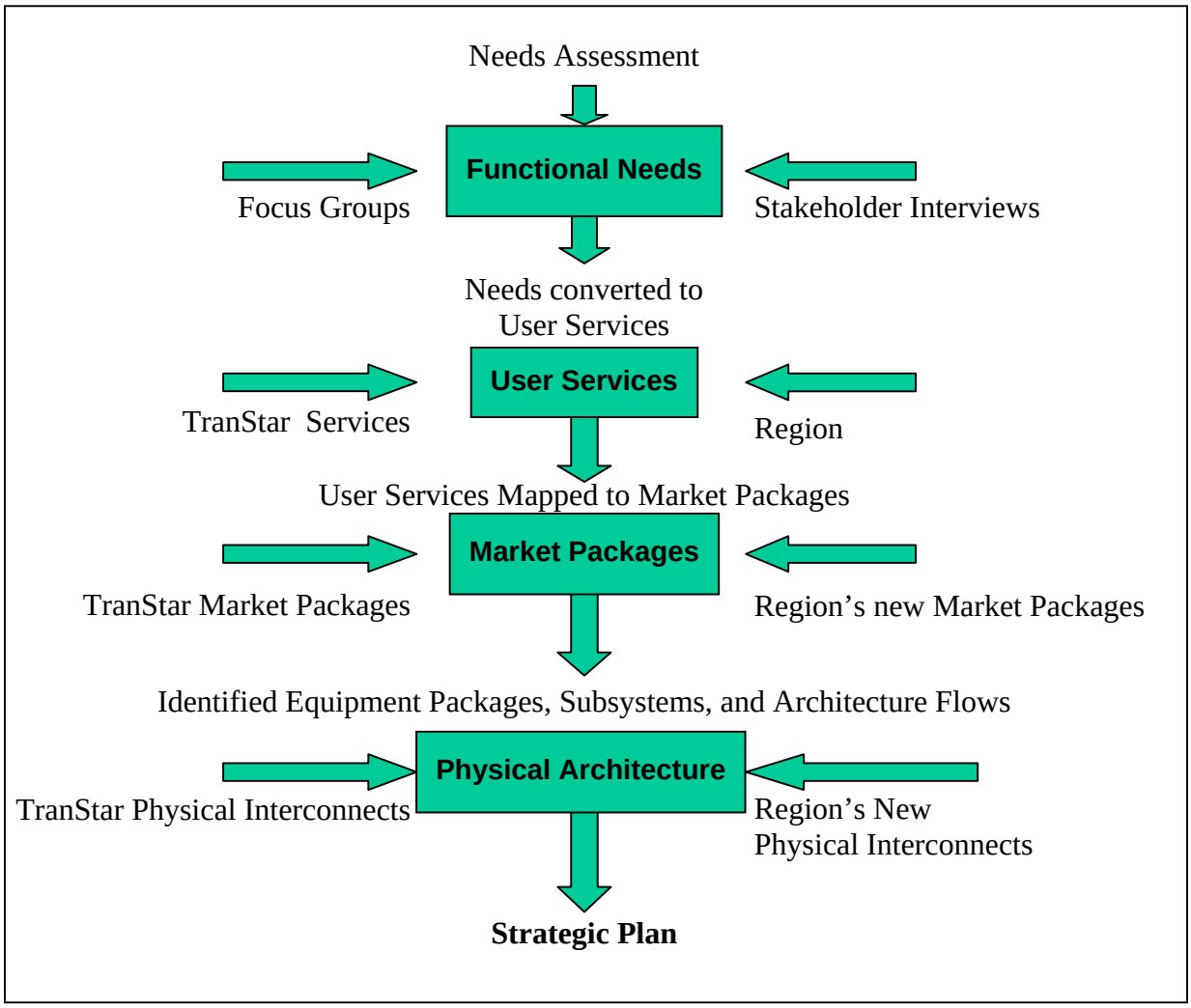

Figure 1-1. Architecture Development Process

Market Packages and Equipment Packages: Market packages are bundles of functionalities that are grouped together to deliver one or many user services. They are deployment oriented, are made up of one or more equipment packages, and relate to the physical architecture view of the system architecture. Again, as depicted in the figure, the market packages described for the region will include all the market packages that were identified as part of the Houston Transtar Architecture enhanced with the additional market packages identified through the new user services defined for the region. In addition to the market packages, an identification of the region's equipment packages are also included. Equipment packages are groups of functional hardware and software capabilities within subsystems and provide a link to the logical architecture.

Physical Architecture: The conclusion of the system architecture process will define the physical architecture, its interconnects and the architecture flows. The physical architecture provides a big picture view of the ITS activities in the region by the various stakeholders and entities. The physical architecture defines the Physical Entities (Centers, Subsystems) that make up an intelligent transportation system, the Architecture Flows that connect the various subsystems, and terminators into an integrated system.

The system architecture defined in the region through the process described above and detailed in this document will serve as a guidance document and will help define various components of the Strategic ITS plan for the Houston region.

1.4 Houston Region Background

The architecture contained in this document is comprised of eight counties in the Houston region: Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller counties (Figure 1-2).

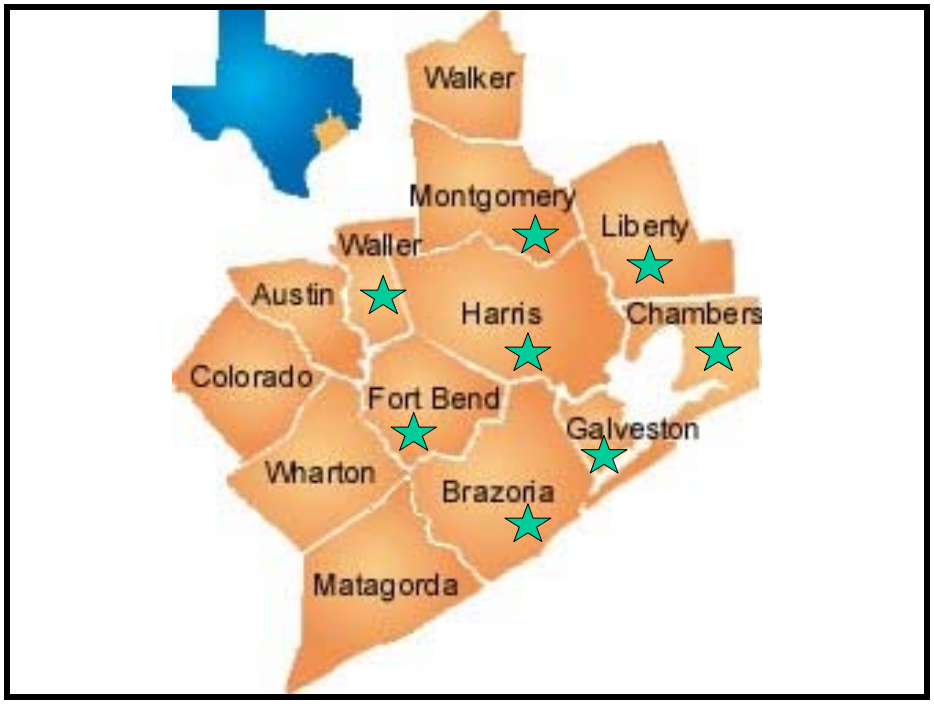

Figure 1-2. Counties Included in the Regional ITS Architecture (Identified with a ★)

The Houston region has an extensive transportation system that includes roadways, transit facilities, airports, and water ports. The development of the regional roadway and transit network is a key element of regional land use and population distribution. A few of the major elements of the transportation system (as of April 2002) are[1]:

- 25,785 centerline miles of freeways and major roadways including: IH-10, I-45, US-59, Loop 610, Beltway 8, US-225, and US-290
- 94.4 miles of barrier separated HOV lanes (additional 6.6 miles of diamond lanes on IH-10 freeway) [2]
- 133 transit routes served by 1,402 buses

[1] Houston-Galveston Area Council Website, http://www.2025plan.org/facts/facts.html
[2] Legacy Systems, ITS Strategic Plan report.

- 29 commuter transit routes
- 5 rail freight yards and 1 Amtrak station
- 26 Park & Ride lots serving 26,287 vehicles
- 7.5 Miles for METRO Rail
- 3 Commercial Airports - Ellington Field, Bush Intercontinental and Hobby serving over 40 million passengers
- 4 Ports – Port of Freeport, Port of Galveston, Port of Houston and Port of Texas City handling over 250 million tons of cargo per year.

The principal urban area is the City of Houston in Harris County with a population of over 3.0 million and an area of 1,787 square miles. In addition to the City of Houston, there are 42 other incorporated cities. The majority of the ITS developments, planned and implemented to date, are in Harris County. In addition, most of the 1,279 square miles of the service area of the transit provider -METRO of Harris County are within the county's boundaries. TxDOT is represented by the Houston District, which is composed of six of the eight counties in the TMA (Brazoria, Fort Bend, Galveston, Harris, Montgomery, and Waller). The Houston District for TxDOT does not include Liberty and Chambers counties.

Houston is home to a sophisticated Advanced Traffic Management System (ATMS) – Houston Transtar. Houston TranStar is a consortium of the transportation and emergency management functions of the following agencies:

- The Texas Department of Transportation (TxDOT),
- Metropolitan Transit Authority of Harris County (METRO),
- The City of Houston,
- Harris County

The development of the regional architecture is closely linked with the architecture definitions of Houston Transtar and this relationship is examined in the next section.

1.4.1 Relationship to Houston Transtar Architecture

Houston TranStar is responsible for the planning, design and operations of transportation systems and emergency management functions in the Greater Houston Metropolitan area and coordinates the development of ITS. Some of the functionalities of Houston Transtar are:[3]

- High Occupancy Vehicle Lane Control Systems
- Freeway Management Systems
- Regional Computerized Traffic Signal System
- METRO Bus and Police Dispatch
- Emergency Management Operations
- Incident Management / Resource Recovery

In November 2000, Southwest Research Institute developed version 3.0 of the Houston TranStar Architecture for the Texas Department of Transportation[2]. The Houston Transtar ITS

[3] Houston TranStar ITS Architecture (Version 3.0), Texas Department of Transportation, prepared by Southwest Research Institute, November 2000.

architecture described user services, market packages and some high-level subsystem architecture interconnect diagrams and flows. Houston Transtar is the guiding force and the champion for ITS in the area. Houston Transtar is one of the most comprehensive advanced traffic management centers in the country and has a role to play in almost all the user services specified in the National ITS Architecture.

In the Houston region, apart from Houston Transtar, various other cities and counties have ITS operations including interconnected signal systems which are operated independently from Houston Transtar. In addition, some agencies have emergency management centers, which are used to coordinate emergency response. These systems and facilities need to be addressed as part of the region's system architecture.

The system architecture defined in this document will address the Houston region's needs and issues, including Houston Transtar. It will include all the user services that were identified as part of the Houston Transtar architecture and enhance them to add additional user services, market packages, and subsystems to address the overall region's needs, issues, and challenges and depict an integrated and comprehensive regional system architecture.

The next section addresses some of the existing ITS systems in the region. These will be discussed in greater detail in later sections of this report.

1.4.2 Legacy Systems in the Region

As a part of the project, the legacy systems were identified. These systems include traffic management centers, traveler information systems, transit management, etc. The emphasis was to identify systems and provide information on the functional features, operational characteristics, institutional and organizational grouping, communication and coordination, extent of operations and system status.

Table 1-1 illustrates some of the key legacy systems existing in the region. Information contained here is as of April 2002.

Table 1-1. Key Subsystems in the Region

Subsystem	Local Program	Owning Stakeholder	Status
Emergency Management	City of Houston Office of Emergency Management (OEM)	City of Houston	Current
	Harris County Emergency Management	Harris County	Current
	Emergency Management Operations	Regional agencies Emergency Management	Current
	Local Police and Fire Departments	Regional Cities and Counties	Current
Emergency Vehicle	M.A.P. – Motorist Assistance Program	METRO, Harris County, TxDOT, and others	Current
	METRO Police	METRO	Current
	Heavy Duty Wreckers	TxDOT	Current
	Other agencies Emergency Vehicle	Regional agencies Emergency Management	Current
Information Service Provider	Houston Transtar IS (Webpage)	Houston TranStar	Current
	TTI Post Oak (Webpage)	Texas Transportation Institute (TTI), TxDOT	Current
Toll Collection	Quick Ride	METRO / TxDOT	Current
	Harris County Toll Road Authority (EZPASS)	Harris County	Current
Traffic Management	Houston TranStar	TxDOT (Freeways, HOV lanes)	Current
		METRO (HOV lanes)	Current
		Houston (city streets)	Current
		Harris Co. (county roads)	Current
	City and County Arterial Street Management	Regional Cities and Counties Traffic Departments	Current
Transit Management	Transit Management Applications	METRO	Current
Commercial Vehicle Check	Weigh in Motion, Electronic Clearance	Department of Public Safety (DPS)	Current
Transit Vehicle	METRO Bus	METRO	Current
Roadway (ITS Equipment)	Freeway CCTVs, Video Imaging Vehicle Detection Systems (VIVDS), Automatic Vehicle Identification (AVI), Lane Control Signs (LCS)	TxDOT	Current
	City arterial signals (RCTSS)	City of Houston	Current
	County arterials signals	Harris County	Current
	Reversible HOV lanes	TxDOT, METRO	Current
	Changeable lane signs (CLAS)	Harris County	Current
	Tolling Systems	Harris County Toll Road Authority	Current
	Loop Detectors	City of Houston, TxDOT, Harris County	Current
	Ramp Meters	TxDOT	Current
	Signal Preemption	City of Houston	Current
	HAR	TxDOT	Current
	DMS	TxDOT/METRO	Current
	Road Weather Monitoring Sensors, Flood Level Sensors	Harris County, TxDOT	Current
Toll Systems	Tolling booths, equipment	Harris County Toll Road Authority	Current

Table 1-1. Key Subsystems in the Region (Continued)

Subsystem	Local Program	Owning Stakeholder	Status
	Tolling booths, equipment	METRO Quickride program	Current
Traveler Subsystems	METROLINE	METRO	Current
	Houston Transtar Website	Houston Transtar (http://traffic.tamu.edu)	Current
	TxDOT Website	TxDOT (www.dot.state.tx.us)	Current
	HCOEM/COH Website	HCOEM, COH	Current

2.0 FUNCTIONAL NEEDS ASSESSMENT AND USER SERVICE IDENTIFICATION

One of the preliminary steps in developing an architecture is the identification of functional needs for the region. As part of the overall program, the project team conducted interviews and focus group discussions with the region's stakeholders. These needs were then compiled and prioritized to define a set of functional needs. The needs were further collaborated and documented into a requirements traceability matrix, which identified the need, the originating source, the central issue and the priority. This matrix was used as the source to decipher groupings of similar needs and issues and categorize them into technical and institutional requirements. The next two sections briefly describe the critical technical and institutional needs as identified by the stakeholders in the region. These needs are in no specific order within the section.

2.1 Critical Technical Needs

- **Ensure Air Quality Compliance**: Air quality compliance goals are particularly challenging as the vehicle miles of travel are expected to increase 36% between 1993 and the 2007, the air quality attainment year. The expressed need is to improve sensor testing and operational policies for emissions management and testing.

- **Improve Arterial Management**: Freeways have traditionally been the major area for ITS deployments and improvements. The stakeholders indicated the arterial system management, including using video cameras for traffic signal control and monitoring, is a critical need.

- **Improve Commercial Vehicle Management and Safety**: The safety and management of commercial vehicles is an important concern in the area with considerable truck traffic. The needs include the improvements in signage for routing commercial vehicles, vehicle safety inspections, truck rollover warning devices, CB Wizard (a system to provide work zone information to truckers on Citizen Band radio) and Weigh-in-Motion stations. Other moderate needs include dedicated truck lanes, on-board information, routing for over-sized trucks and automatic enforcement of commercial vehicle regulations

- **Manage Hazardous Material Transportation**: The needs include better incident verification with remote sensing capabilities, routing of hazardous materials, and incident management plans and personnel.

- **Reducing Traffic Congestion on Freeways and Arterials**: Construction costs and potential impacts increasingly limit the traditional approach for increasing capacity by building more lanes or roadways. Effective management of both transportation facilities and services is critical to maintaining system mobility, reliability, and recovery from traffic crashes, roadway repair, during special events or as a consequence of severe weather. The expressed needs are to monitor and manage the transportation system and provide information to both the transportation providers and users seeking alternative routes, travel locations or travel modes. Other priorities include reduction of single occupancy vehicle travel and reduction in vehicle miles traveled.

- **Manage Construction and Work Zones**: There is a strong need to manage traffic better and provide better information to users about construction and work zones. This need has been recognized nationally and has led to the development of a new user service "maintenance and construction operations" in the national ITS architecture.

- **Improve Data Collection and Warehousing**: The region needs to expand the ability of the systems to monitor and collect transportation data. Also, the data warehousing and the institutional arrangements required need to be explored for applications in transportation planning, transit planning etc. It is recognized that there are current efforts underway in the area of data warehousing.

- **Expand the Use of Electronic Payment**: Existing facilities for electronic payment have to be expanded and integrated. This could combine tolls, transit fare payments, parking and other services.

- **Improve Existing HOV Lane Management**: There exists a need to improve the management of the HOV system to ease travel demand and increase safety. Also, the use of HOV lane management outside the METRO service area needs to be expanded.

- **Enhance Emergency Management**: One of the very critical areas in the region, the needs include the ability to obtain and use traffic data for evacuation routing, agency coordination during evacuations, better information to the public during such emergencies, development of a regional emergency management plan, improved warnings for floods and hurricanes, provision of emergency information to other public agencies, use of roadside ITS systems during emergencies and improved coordination between Houston Transtar and other agencies.

- **Improve and Expand the Scope of Flood Monitoring Systems**: A very important issue in the Houston region, there is a need to improve flood-monitoring sensors on arterials and link the system to Houston Transtar. The sharing of data between TxDOT and other agencies needs to be explored. Weather information systems and monitoring devices are necessary to generate advance warnings to the public. There is also a need to monitor flooding in the bayous through more CCTV coverage, better lighting etc.

- **Identify ITS Applications to Homeland Security**: There exists a need to identify transportation applications to homeland security and a need to train first responders to react to hostile situations. Existing institutional and physical infrastructure should be leveraged to support homeland security.

- **Improve Incident Detection and Management**: The ability to identify and verify incidents on arterial streets is important. The deployment of ITS systems is expected to reduce crashes throughout the system. The approach to reacting to incidents can also be optimized by better coordination and technology including AVLs and wireless communications. The management of special events needs to be improved.

- **Provide Better Traveler Information**: There are various needs associated with providing traveler information to the public in the areas of content, delivery methods and modes. The needs with respect to traveler information are listed below:

    - Content
        - Improving the quality of enroute traveler information
        - Provide access to real-time traveler information
        - Use GIS based map information
        - Provide parking availability information
        - Disseminate information and data to aid incident management.
        - Provide delay and arrival time information at transit park and ride locations and bus stops
        - Provide trip itineraries to the public for trip planning and travel choices
        - Provide alternate routes for travelers and transit
        - Expand content to include other information such as parking information and special event information.

    - Delivery
        - Implement and promote the use of 511 as an outlet for information dissemination
        - Provide for cell phone, PDA and other remote access
        - Provide information kiosks and video monitors
        - Expand the use of DMS to cover more locations
        - Install DMS on arterial to support traffic operations and to support special events
        - Expand HAR by increasing the scope and the accessibility

- **Improve Traffic Signal Operations**: There exists a need to improve signal synchronization and deploy a more traffic responsive/adaptive signal system in the region in order to provide true regional control. Traffic signal pre-emption and adjustments are also desired features for emergency management activities.

- **Develop Improved Transit Management Strategies**: The need to collect ridership data and other data for transit route planning purposes is critical. The use of AVL systems needs to be expanded. High-capacity transit modes should be considered for the region. It is also vital that continued growth in vehicular travel be slowed by encouraging greater use of mass transit, ridesharing, vanpooling, tele-working and other demand-management programs.

- **Ensure Standards Compliance for All the ITS Systems**: As ITS standards are tested and approved by U.S.DOT, it is necessary to ensure standards compliance for all the ITS systems in the region. Standards are required for communications equipment and protocols, traffic signals and joint procurements.

- **Provide Redundancy to the Systems**: To ensure continuous operations of critical ITS systems such as emergency management systems and traffic control systems, it is necessary to provide adequate redundancy in the systems and staff by having appropriate backup systems and plans.

2.2 Critical Institutional Needs

The previous section identified the technical needs, which translate to the user services and the market packages directly in the National ITS Architecture. However, institutional needs are often more important to identify as they can determine the success or failure of ITS deployments. The institutional needs identified by the stakeholders are listed below:

- **Improve Agency Coordination**: The needs included developing a regional approach to ITS implementation, agency agreements, pooling of resources, maximizing the use of existing ITS systems, improving statewide center to center coordination, develop a coordination plan to specify the nature and scope of coordination required and implementing video conferencing for local agencies to allow for full participation.

- **Improve Communications Between Centers**: The needs included the implementation of high-speed communication link between Houston Transtar and other entities to share data and control. Also, the existing communication potential needs to be maximized.

- **Develop Implementation and Integration Plan**: It was felt that an implementation and integration plan would help execute future ITS projects faster. Also, an implementation plan was expected to reduce the time required for implementing improvements and services.

- **Reduce Institutional Barriers**: The resolution of institutional and funding barriers in implementing regional ITS plans is critical.

- **Identification of ITS Applications and Relationships to Legacy Systems**: Multiple applications of ITS systems (for example: different uses of video cameras) should be considered and implemented. The potential of existing systems should be maximized. Public concerns and policy considerations should be accounted for.

- **Provide for Operations and Maintenance of ITS Projects**: An integrated operations and maintenance approach was needed to ensure that ITS systems can serve their desired roles. It was felt that operations and maintenance support needed to be available from day one of the project.

- **Identify Performance Measures for Evaluating ITS Deployments**: The implementing agencies need to make sure that the ITS systems would provide benefit before the implementation process. Consequently, it is necessary to develop evaluation methodologies for measuring success and effectiveness. Also, it is necessary to communicate the results of the evaluation successfully to the general public.

- **Integrate ITS into the Transportation Planning Process**: This involves better use of ITS data and technology in the regional planning process. The agencies must identify ITS needs and opportunities even if there is no funding availability.

- **Work on Public Outreach**: The needs include improving the visibility of ITS systems, increasing public awareness and understanding of such systems, making ITS user-friendly and developing a positive image for ITS.

- **Provide ITS Training for Operators and Develop Dedicated Manpower**: The development and continued growth of skilled manpower in ITS is essential. There needs to be a coordinated training effort across all agencies to introduce ITS systems and the use of such systems. The different needs of the various agencies in the region should be addressed along with appropriate funding mechanisms for payment for these services.

- **Generate a ITS Vision for the Region**: A common vision is required for the increased deployment of ITS in the region. The vision includes connecting regional hubs to Houston Transtar, developing center to center communication links for connecting counties and cities in an integrated corridor for ITS and coordinating issues like homeland security, public safety and emergency management.

- **Develop Alternative Modes for Increased Travel Options**: In order to alleviate congestion, the region must develop alternate travel modes, which increase the occupancy of vehicles. The region also needs to provide viable travel modes to the public.

- **Reduce the Use of Proprietary Systems**: For ease of implementation, it is necessary to ensure that the ITS systems are non-proprietary and capable of plug and play.

- **Coordinate Rural and Urban ITS Deployments**: It is necessary to develop rural ITS applications while ensuring that the rural systems are compatible with the urban ITS framework.

- **Identify Funding Opportunities**: Creative financing schemes needs to be investigated for ITS projects. Agencies need to pool funds and participate in joint procurements. A realistic budget is also needed for properly executing ITS projects.

2.3 Mapping of Needs to User Services

The National ITS Architecture identifies thirty-two user services that are grouped into eight user service bundles. These user services document what "ITS" should do from the user's perspective. The rationale of mapping user needs to user services is explained in Figure 2-1. The figure illustrates the mapping from needs to the customization of market packages. However, this chapter concludes with the first step in this process, mapping local needs to user services. The market package mapping and selection is described in detail in the next chapter.

The mapping of needs to user services is an important step in architecture development. It converts the stated user needs into a National ITS Architecture compliant language that sets the stage for the subsequent steps of architecture development. Table 2-1 illustrates the mapping exercise between the identified technical and institutional needs for the region (Section 2.1 and 2.2) to the National ITS Architecture defined user services.

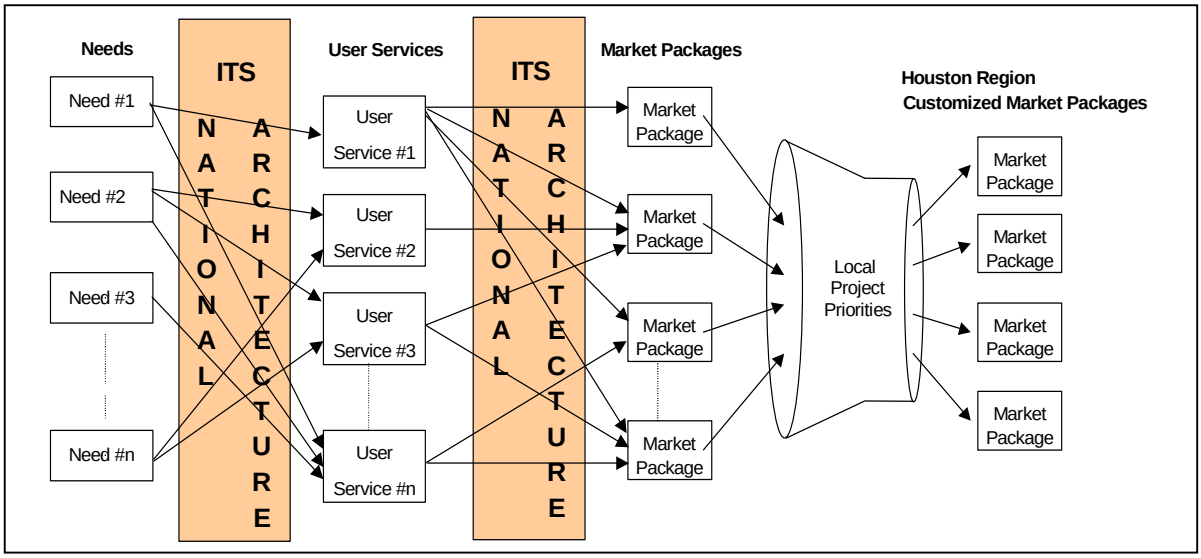

Figure 2-1. Region's Needs to User Services

Table 2-1. Mapping of Critical Needs (Technical and Institutional) to User Services

USER SERVICES	Critical Technical and Institutional Needs																														
	Improve Arterial Management	Expand the use of AVL in Transit Trips	Improve Commercial Vehicle Safety	Improve Commercial Vehicle Operations	Ensure air quality Compliance	Manage Congestion	Improve Construction and Work Zone Management	Improve Data Warehousing and Management	Enhance Emergency Evacuation	Improve Emergency Management	Improve Flood Monitoring	Enhance Hazardous Material Management	Improve Incident Management	Provide better en-route traveler information	Provide better quality of pre-trip traveler information	Provide information on routes and alternatives	Implement 511	Improve Transit Management	Provide Transit Information	Improve Traffic Signal Coordination	Expand incident management to Toll roads	Improve Traffic Management	Improve HOV Lane Management	Increase the use of Electronic Payment	Improve Agency Coordination	Identify Homeland Security ITS Applications	Improve use of Alternative Modes	Improve communications between centers	Ensure Standards Usage	Improve Safety	Enhance Statewide coordination
TRAVEL AND TRANSPORTATION MANAGEMENT																															
Provide Pre-Trip Travel Information															X		X														
Support En-Route Information														X					X												
Support Route Guidance																X															
Provide Ride Matching & Reservation																			X												
Provide Traveler Services Information														X	X		X												X		
Support Traffic Control	X					X														X		X			X			X	X		
Conduct Incident Management						X							X								X				X			X	X	X		
Support Travel Demand Management						X																	X									
Support Emissions Testing and Mitigation					X																										
Enhance Highway-Rail Crossing Safety																														X	
PUBLIC TRANSPORTATION MANAGEMENT																															
Support Public Transportation Management		X														X		X	X						X		X	X	X		
Provide En-Route Transit Information		X													X				X										X		
Enhance Personalized Public Transit																		X													
Enhance Public Travel Security																										X					
ELECTRONIC PAYMENT																															
Provide Electronic Payment Services																								X	X			X	X		
COMMERCIAL VEHICLE OPERATIONS																															
Support Commercial Vehicle Electronic Clearance				X																					X			X	X		X
Facilitate Automated Roadside Safety Inspection																															
Facilitate On-Board Safety Monitoring			X																												
Support Commercial Veh Administrative Processes																															
Enhance Hazardous Material Incident Response												X														X					
Enhance Commercial Fleet Management				X								X																			X
EMERGENCY MANAGEMENT																															
Enhance Emergency Notification & Personal Security								X	X	X															X	X		X			X
Provide Emergency Vehicle Management								X	X																						
ADVANCED VEHICLE SAFETY SYSTEMS																															
Support Longitudinal Collision Avoidance																													X		
Support Lateral Collision Avoidance																													X		
Enhance Intersection Collision Avoidance																															
Provide Vision Enhancement for Crash Avoidance																															
Provide Safety Readiness																															
Provide Pre-Crash Restraint Deployment																															
Support Automated Vehicle Operation																													X		
INFORMATION MANAGEMENT																															
Archived Data Function								X																	X			X			X
MAINT. AND CONSTRUCTION MANAGEMENT																															
Maint. and Construction Operations							X																		X				X		

2.4 Region's User Services

The user services identified for the region (Table 2-1) are selected based on two sources of inputs:

- The user services from the mapping of critical technical and institutional needs expressed by the stakeholders
- User services selected in the Houston Transtar Architecture (as identified in the Houston Transtar Architecture document)

Table 2-2 contains a comprehensive set of the selected user services for the region grouped by user service bundles. Generic descriptions of User Services are available as part of the National ITS Architecture documentation and are not included in this document.

Table 2-2. Region's User Services

User Service Bundle	User Service	
Travel and Traffic Management	1.1	Pre-trip Travel Information
	1.2	Enroute Driver Information
	1.3	Route Guidance
	1.4	Ridematching and Reservation
	1.5	Traveler Services 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
Public Transportation Management	2.1	Public Transportation Management
	2.2	Enroute Transit Information
	2.3	Personalized Public Transit
	2.4	Public Travel Security
Electronic Payment	3.1	Electronic Payment Services
Commercial Vehicle Operations	4.1	Commercial Vehicle Electronic Clearance
	4.3	On-board Safety Monitoring
	4.5	Hazardous Material Incident Response
	4.6	Commercial Fleet Management
Emergency Management	5.1	Emergency Notification and Personal Security
	5.2	Emergency Vehicle Management
Advanced Vehicle Safety Systems	6.1	Longitudinal Collision Avoidance
	6.2	Lateral Collision Avoidance
	6.7	Automated Vehicle Operation
Information Management	7.1	Archived Data Function
Maintenance and Construction Management	8.1	Maintenance and Construction Operations

3.0 IDENTIFICATION OF MARKET PACKAGES AND EQUIPMENT PACKAGES

Market packages, as defined in the National ITS Architecture are “bundles” of technology services that are often purchased together, as a group. Where a user service addresses the need or “what” the issue is, a market package addresses “how” that need or service is addressed. For example, in order to conduct traffic control activities, it is necessary to know what is happening on the traffic network. The network surveillance market package consists of several subsystems, including roadway components (detection and surveillance) and traffic management components (process surveillance data, perform traffic maintenance, freeway control, etc.), and a dissemination component for providing “real-time” traffic information to the travelers via information service provider. Market packages are made up of one or more subsystems (physical entities) and one or more equipment packages. The components of a market package can be modified to meet the specific requirements of a system.

Equipment packages are identified in market packages as part of subsystems and they are defined in the National ITS Architecture as a group of functions within a subsystem that can be “implementable.” Basically they are a package of hardware and software capabilities of a particular subsystem in the physical architecture. The equipment packages also provide a link to the logical architecture of the National ITS Architecture.

For the purpose of this document, market packages will be defined in detail along with the customization of selected market package diagrams for the region. Equipment packages for the region will be identified based on the selected market packages but detailed descriptions will not be included in this document. Descriptions of the equipment packages can be found in the National ITS Architecture documentation.

3.1 Mapping of User Services to Market Packages

A list of market packages is provided in the National ITS Architecture (version 4.0). All the market packages were examined with regard to their applicability to the Houston ITS user services. The region’s user services, as identified in Table 2-2, were mapped against the candidate market packages. The result of the mapping exercise is presented in Table 3-1.

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Table 3-1. User Services to Market Packages Mapping

	Market Packages (HOW)	Houston Region User Services (WHAT)																														
		1.1 Provide Pre-trip Travel Information	1.2 Support En-Route Driver Information	1.3 Support Route Guidance	1.4 Provide Ride Matching and Reservation	1.5 Provide Traveler Services Information	1.6 Support Traffic Control	1.7 Conduct Incident Management	1.8 Support Travel Demand Management	1.9 Support Emission Testing and Mitigation	1.10 Highway Rail Intersection	2.1 Improve Public Transportation Management	2.2 Provide En-Route Transit Information	2.3 Provide Personnalized Public Transit	2.4 Public Travel Security	3.1 Electronic Payment Services	4.1 Support Commercial Vehicle Electronic Clearance	4.3 Onboard safety monitoring	4.5 Enhance Hazardous Material Incident Response	4.6 Commercial Fleet Management	5.1 Enhance Emerg. Notification & Personal Security	5.2 Improve Emergency Vehicle Management	6.1 Support Longitudinal Collision Avoidance	6.2 Support Lateral Collision Avoidance	6.7 Support Automated Vehicle Operation	7.1 Archive Data Function	8.1 Maintenance and Construction Operations
Advanced Traffic Management Systems (ATMS)	1. Network Surveillance						X	X							X																
	2. Probe Surveillance						X																									
	3. Surface Street Control						X	X																								
	4. Freeway Control						X	X	X																							
	5. HOV Lane Management						X	X	X																							
	6. Traffic Information Dissemination		X				X		X																							
	7. Regional Traffic Control						X	X																								
	8. Incident Management System						X	X																								
	9. Traffic Forecast and Demand Management						X	X	X																							
	10. Electronic Toll Collection								X							X																
	11. Emisions Moniotring and Management									X																						
	12. Virtual TMC Smart Probe Data																															
	13. Standard Railroad Grade Crossing										X																					
	14. Advanced Railroad Grade Crossing										X																					
	15. Railroads Operations Coordination																															
	16. Parking Facility Management																															
	17. Regional Parking Management																															
	18. Reversible Lane Management						X	X	X																							
Advanced Public Transportation Systems (APTS)	1. Transit Vehicle Tracking											X	X	X	X																	
	2. Transit Fixed-Route Operations											X																				
	3. Demand Response Transit Operations				X							X		X																		
	4. Transit Passenger and Fare Management											X	X			X																
	5. Transit Security											X			X																	
	6. Transit Maintenance											X																				
	7. Multi-Modal Coordination						X		X			X																				
	8. Transit Traveler Information											X	X																			
Advanced Traveler Information Systems (ATIS)	1. Broadcast Traveler Information	X	X	X		X							X																			
	2. Interactive Traveler Information	X	X	X	X	X							X	X		X																
	3. Autonomous Route Guidance																															
	4. Dynamic Route Guidance																															
	5. ISP Based Route Guidance	X	X	X												X																
	6. Integrated Transportation Mgt/Route Guidance																															
	7. Yellow Pages and Reservation	X	X			X							X			X																
	8. Dynamic Ridesharing			X	X								X	X		X																
	9. In-Vehicle Signing																															
Advanced Vehicle Safety Systems (AVSS)	1. Vehicle Safety Monitoring														X																X	
	2. Driver Safety Monitoring																															
	3. Longitudinal Safety Warning																															
	4. Lateral Safety Warning														X															X	X	
	5. Intersection Safety Warning																															
	6. Pre-Crash Restraint Deployment																															
	7. Driver Visibility Improvement																															
	8. Advanced Vehicle Longitudinal Control														X													X		X		
	9. Advanced Vehicle Lateral Control														X														X	X		
	10. Intersection Collision Avoidance																															
	11. Automated Highway System																															
Commercial Vehicle Operations (CVO)	1. Fleet Administration																															
	2. Freight Administration																															
	3. Electronic Clearance																X															
	4. CV Administrative Processes																															
	5. International Border Electronic Clearance																															
	6. Weigh-In-Motion																X															
	7. Roadside CVO Safety																															
	8. On-Board CVO Safety																		X													
	9. CVO Fleet Maintenance																															
	10. HAZMAT Management							X												X	X											
Emergency Mgmt (EM)	1. Emergency Response																					X	X									
	2. Emergency Routing						X																X									
	3. Mayday Support																															
Archived Data (AD)	1. ITS Data Mart																													X		
	2. ITS Data Warehouse																													X		
	3. ITS Virtual Data Warehouse																															
Maintenance and Construction Managment (MC)	1. Maintenance and Construction Vehicle Tracking																															
	2. Maintenance and Construction Vehicle Maintenance																															
	3. Road Weather Data Collection	X	X				X	X														X									X
	4. Weather Information Processing and Distribution	X	X				X	X														X									X
	5. Roadway Automated Treatment																															
	6. Winter Maintenance																															
	7. Roadway Maintenance and Construction																															X
	8. Work Zone Management																															X
	9. Work Zone Safety Monitoring																															X
	10. Maintenance and Construction Activity Coordination																															X

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3.2 Region's Market Packages

The market packages selected for the Houston Region are listed in Table 3-2. The table identifies the market package category and market packages for the region.

Table 3-2. Region's Market Packages

Market Packages	
Market Package Category	**Market Packages**
Advanced Traffic Management Systems (ATMS)	ATMS01 Network Surveillance ATMS02 Probe Surveillance ATMS03 Surface Street Control ATMS04 Freeway Control ATMS05 HOV Lane Management ATMS06 Traffic Information Dissemination ATMS07 Regional Traffic Control ATMS08 Incident Management System ATMS09 Traffic Forecast and Demand Management ATMS10 Electronic Toll Collection ATMS11 Emissions Monitoring and Management ATMS13 Standard Railroad Grade Crossing ATMS 14 Advanced Railroad Grade Crossing ATMS18 Reversible Lane Management
Advanced Public Transportation Systems (APTS)	APTS1 Transit Vehicle Tracking APTS2 Fixed Route Transit Operations APTS3 Demand Responsive Transit Operations
Advanced Public Transportation Systems (APTS)	APTS4 Transit Passenger and Fare Management APTS5 Transit Security APTS6 Transit Maintenance APTS7 Multi-Modal Coordination APTS8 Transit Traveler Information
Advanced Traveler Information Systems (ATIS)	ATIS1 Broadcast Traveler Information ATIS2 Interactive Traveler Information ATIS5 ISP Route Guidance ATIS7 Yellow Pages and Reservation ATIS8 Dynamic Ridesharing
Advanced Vehicle Safety Systems (AVSS)	AVSS01 Vehicle Safety Monitoring AVSS04 Lateral Safety Warning AVSS08 Advanced Vehicle Longitudinal Control AVSS09 Advanced Vehicle Lateral Control

Market Packages		
Market Package Category	**Market Packages**	
Commercial Vehicle Operations (CVO)	CVO03	Electronic Clearance
	CVO06	Weigh in Motion
	CVO08	On board CVO Safety
	CVO10	HAZMAT Management
Emergency Management (EM)	EM1	Emergency Response
	EM2	Emergency Routing
Archived Data (AD)	AD1	ITS Data Mart
	AD2	ITS Data Warehouse
Maintenance and Construction Management (MC)	MC03	Road Weather Data Collection
	MC04	Weather Information Processing and Distribution
	MC07	Roadway Maintenance and Construction
	MC08	Work Zone Management
	MC09	Work Zone Safety Monitoring
	MC10	Maintenance and Construction Activity Coordination

In addition to the "national architecture" market packages selected Table 3-2, auxiliary market packages, which are not part of the National ITS Architecture, but identified in Houston Transtar Architecture and are applicable to the region include:

- Aux MP1 – Evacuation Transportation
- Aux MP2 - Evacuation Monitoring
- Aux MP3 – Evacuation Information Dissemination
- Aux MP4 – Flood level Reporting
- Aux MP5 – Use of Transit Vehicle as Shelter
- Aux MP6 – Truck Rollover Warning System

3.3 Customization of Market Packages

The result of mapping market packages with user services is a list of selected market packages that reflect the Houston region implementation goals. These market packages were then customized to better represent the deployment, as intended for the region (Appendix A). The market packages are intended to represent the future roles of the organizations involved. Specific information on roles, responsibilities and systems deployed can be obtained from Transtar at 713-881-3000.

The diagrams include subsystems and their associated equipment packages. Subsystems that are part of the region, but which are external to a market package are shown crosshatched. Arrows are used to depict architecture flows (information content and direction). Terminators are entities on the periphery of the architecture, not part of it, but interacting with it, and are shown as ovals. An example of a generic market package diagram is shown in Figure 3-1.

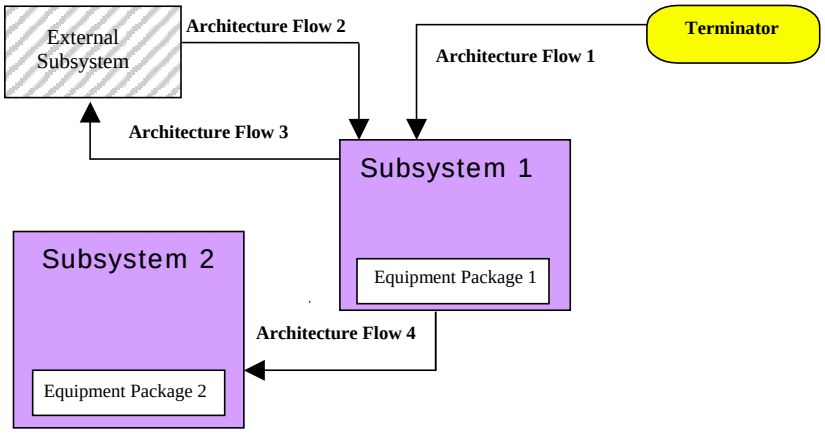

Figure 3-1. Generic Market Package Diagram

3.4 Identification of Region's Equipment Packages

As described earlier, equipment packages are part of subsystems and are defined in the National ITS Architecture as a group of functions within a subsystem that can be "implementable." Basically they are a package of hardware and software capabilities of a particular subsystem in the physical architecture. Similar to the user services mapping and the market package mapping, the National ITS Architecture provides a guide on linking generic market packages to associated subsystems and equipment packages. Using this information and the selected region's market packages, a list of the region's equipment packages are identified. This list is illustrated in Table 3-3 along with associated market packages and subsystems.

Table 3-3. Region's Equipment Packages

Houston Region Market Packages	Subsystems	Equipment Packages
ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS) MARKET PACKAGES		
Network Surveillance (ATMS01)	Roadway	Roadway Basic Surveillance
	Traffic Management	Collect Traffic Surveillance Traffic Maintenance
Probe Surveillance (ATMS02)	Roadway	Roadway Probe Beacons
	Traffic Management	TMC Probe Information Collection
	Vehicle	Vehicle Location Determination Vehicle Probe Support
Surface Street Control (ATMS03)	Roadway	Roadway Signal Control
	Traffic Management	TMC Signal Control Traffic Maintenance
Freeway Control (ATMS04)	Roadway	Roadway Freeway Control
	Traffic Management	TMC Based Freeway Management Traffic Maintenance
HOV Lane Management (ATMS05)	Roadway	Roadway HOV Lanes
	Traffic Management	TMC HOV Lane Management
Traffic Information Dissemination (ATMS06)	Roadway	Roadway Traffic Information Dissemination
	Traffic Management	TMC Traffic Information Dissemination
Regional Traffic Control (ATMS07)	Traffic Management	TMC Regional Traffic Control
Incident Management (ATMS08)	Emergency Management	Emergency Response Management
	Roadway	Roadway Incident Detection
	Traffic Management	TMC Incident Detection TMC Incident Dispatch, Coordination and Communication
Traffic Forecast and Demand Management (ATMS09)	Traffic Management	TMC Traffic Network/Performance Evaluation
Electronic Toll Collection (ATMS10)	Vehicle	Vehicle Toll/Parking Interface
Emissions Monitoring and Management (ATMS11)	Emissions Management	Emissions Data Management
	Roadway	Roadway Emissions
Standard Railroad Crossing (ATMS13)	Traffic Management	HRI Traffic Management
	Roadway	Standard Rail Crossing
Advanced Railroad Crossing (ATMS14)	Traffic Management	HRI Traffic Management
	Roadway	Advanced Rail Crossing
Reversible Lane Management (ATMS18)	Traffic Management	TMC Reversible Lanes Management
	Roadway	Reversible Lanes
ADVANCED PUBLIC TRANSPORTATION SYSTEMS (APTS) MARKET PACKAGES		
Transit Vehicle Tracking (APTS1)	Transit Management	Transit Center Tracking and Dispatch
	Transit Vehicle	On-Board Transit Trip Monitoring

Table 3-3. Region's Equipment Packages (Continued)

Houston Region Market Packages	Subsystems	Equipment Packages
Transit Fixed Route Operations (APTS2)	Transit Management	Transit Center Fixed Route Operations
	Transit Vehicle	On-board Fixed Route Schedule Management
Demand Response Transit Operations (APTS3)	Transit Management	Transit Center Paratransit Operations Transit Garage Operations
	Transit Vehicle	On-board Paratransit Operations
Transit Passenger and Fare Management (APTS4)	Transit Management	Transit Center Fare and Load Management
	Transit Vehicle	On-board Transit Fare and Load Management
	Remote Traveler Support	Remote Transit Fare Management
Transit Security (APTS5)	Transit Management	Transit Center Security
	Transit Vehicle	On-board Transit Security
Transit Maintenance (APTS6)	Transit Management	Transit Garage Maintenance
	Transit Vehicle	On-board Maintenance
Multi-Modal Coordination (APTS7)	Roadway	Roadside Signal Priority
	Traffic Management	TMC Multi-modal Coordination
	Transit Management	Transit Center Multi-modal Coordination
	Transit Vehicle	On-board Transit Signal Priority
Transit Traveler Information (APTS8)	Transit Management	Transit Center Information Services
	Transit Vehicle	On-Board Transit Information Services
	Remote Traveler Support	Remote Transit Information Services
	Personal Information Access	Personal Interactive Information Reception
	Information Service Provider	Interactive Infrastructure Information
ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS) MARKET PACKAGES		
Broadcast Traveler Information (ATIS1)	Information Service Provider	Basic Information Broadcast
	Personal Information Access	Personal Basic Information Reception
	Remote Traveler Support	Remote Basic Information Broadcast
Interactive Traveler Information (ATIS2)	Information Service Provider	Remote Interactive Information Reception
	Personal Information Access	Personal Interactive Information Reception

Table 3-3. Region's Equipment Packages (Continued)

Houston Region Market Packages	Subsystems	Equipment Packages
ISP Based Route Guidance (ATIS5)	Information Service Provider	Infrastructure Provided Route Selection
	Personal Information Access	Personal Location Determination Personal Provider-Based Route Guidance
	Remote Traveler Support	Remote Interactive Information Reception
	Vehicle	Vehicle Location Determination Vehicle Provider-Based Route Guidance
Yellow Pages and Reservation (ATIS7)	Information Service Provider	Infrastructure Provided Yellow Pages & Reservation
	Personal Information Access	Personal Interactive Information Reception
	Remote Traveler Support	Remote Interactive Information Reception
	Vehicle	Interactive Vehicle Reception
Dynamic Ride Sharing (ATIS8)	Information Service Provider	Infrastructure-based dynamic ride sharing
	Personal Information Access	Personal Interactive Information Reception
	Remote Traveler Support	Remote Interactive Information Reception
	Vehicle	Interactive vehicle reception
ADVANCED VEHICLE SAFETY SYSTEMS (AVSS) MARKET PACKAGES		
Vehicle Safety Monitoring (AVSS01)	Vehicle	Vehicle Safety Monitoring System
Lateral Safety Warning (AVSS04)	Vehicle	Vehicle Lateral Warning System
Advanced Vehicle Longitudinal Control (AVSS08)	Vehicle	Vehicle Longitudinal Control
Advanced Vehicle Lateral Control (AVSS09)	Vehicle	Vehicle Lateral Control
COMMERCIAL VEHICLE OPERATIONS (CVO) MARKET PACKAGES		
Electronic Clearance (CVO3)	Commercial Vehicle Administration	CV Information Exchange
	Commercial Vehicle	On-board CV Electronic Data
	Commercial Vehicle Check	Roadside Electronic Screening
Weigh in Motion (CVO6)	Commercial Vehicle Check	Roadside Weigh in Motion
Onboard CVO Safety (CVO8)	Commercial Vehicle	On-board CV Safety
HAZMAT Management (CVO10)	Fleet and Freight Management	Fleet HAZMAT Management

Table 3-3. Region's Equipment Packages (Continued)

Houston Region Market Packages	Subsystems	Equipment Packages
EMERGENCY MANAGEMENT (EM) MARKET PACKAGES		
Emergency Response (EM1)	Emergency Management	Emergency Call Taking Emergency Response Management
	Emergency Vehicle	On-board EV Incident Management Communicator
Emergency Routing (EM2)	Emergency Management	Emergency Dispatch
	Emergency Vehicle	On-board EV Enroute Support
	Roadway	Roadside Signal Priority
ARCHIVED DATA MANAGEMENT (AD) MARKET PACKAGES		
ITS Data Mart (AD1)	Archived Data Management Subsystem	Government Reporting Systems Support ITS Data Repository Traffic and Roadside Data Archival
	Commercial Vehicle Administration	CV Data Collection
	Emergency Management	Emergency Data Collection
	Emissions Management	Emissions Data Collection
	Information Service Provider	ISP Data Collection
	Maintenance and Construction Management	MCM Data Collection
	Roadway Subsystem	Roadside Data Collection
	Toll Administration	Toll Data Collection
	Traffic Management	Traffic Data Collection
	Transit Management	Transit Data Collection
ITS Data Warehouse (AD2)	Archived Data Management Subsystem	Government Reporting Systems Support ITS Data Repository Traffic and Roadside Data Archival Online Analysis and Mining
	Commercial Vehicle Administration	CV Data Collection
	Emergency Management	Emergency Data Collection
	Emissions Management	Emissions Data Collection
	Information Service Provider	ISP Data Collection
	Maintenance and Construction Management	MCM Data Collection
	Roadway Subsystem	Roadside Data Collection
	Toll Administration	Toll Data Collection
	Traffic Management	Traffic Data Collection
	Transit Management	Transit Data Collection

Table 3-3. Region's Equipment Packages (Continued)

Houston Region Market Packages	Subsystems	Equipment Packages
MAINTENANCE AND CONSTRUCTION MANAGEMENT (MC) MARKET PACKAGES		
Road Weather Data Collection (MC03)	Emergency Management	Emergency Environmental Monitoring
	Emergency Vehicle Subsystem	On-Board EV Environmental Monitoring
	Information Service Provider	ISP Probe Information Collection
	Maintenance and Construction Management	MCM Environmental Information Collection
	Maintenance and Construction Vehicle	MCV Environmental Monitoring
	Roadway Subsystem	Roadway Environmental Monitoring Roadway Probe Beacons
	Traffic Management	TMC Environmental Monitoring TMC Probe Information Collection
	Transit Management	Transit Environmental Monitoring
	Transit Vehicle Subsystem	On-Board Environmental Monitoring
	Vehicle	Smart Probe
Weather Information Processing and Dissemination (MC04)	Emergency Management	Emergency Environmental Monitoring
	Information Service Provider	Basic Information Broadcast
	Information Service Provider	Interactive Infrastructure Information
	Maintenance and Construction Management	MCM Environmental Information Processing
	Traffic Management	TMC Environmental Monitoring
	Transit Management	Transit Environmental Monitoring
Roadway Maintenance and Construction (MC07)	Maintenance and Construction Management	MCM Maintenance Decision Support MCM Roadway Maintenance and Construction
	Maintenance and Construction Vehicle	MCV Infrastructure Monitoring MCV Roadway Maintenance and Construction
	Roadway Subsystem	Roadway Infrastructure Monitoring
	Traffic Management	Traffic Maintenance
Work Zone Management (MC08)	Maintenance and Construction Management	MCM Work Zone Management
	Maintenance and Construction Vehicle	MCV Work Zone Support
	Roadway Subsystem	Roadway Work Zone Traffic Control
	Traffic Management	TMC Work Zone Traffic Management
Work Zone Safety Monitoring (MC09)	Maintenance and Construction Management	MCM Work Zone Safety Management
	Maintenance and Construction Vehicle	MCV Vehicle Safety Monitoring
	Roadway Subsystem	Roadway Work Zone Safety
Maintenance and Construction Activity Coordination (MC10)	Maintenance and Construction Management	MCM Work Activity Coordination

Table 3-3. Region's Equipment Packages (Continued)

Houston Region Market Packages	Subsystems	Equipment Packages
	Traffic Management	TMC Work Activity Coordination
	Transit Management	Transit Center Multi-Modal Coordination
	Emergency Management	Emergency Response Management

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4.0 ARCHITECTURE FRAMEWORK

4.1 Overview

This section describes the physical architecture of the Houston region based on the conventions set forth by the National ITS Architecture. The generic form of the highest level of architecture is presented in Figure 4-1 using a "Sausage Diagram" that depicts the physical entities involved in the operations of a fully integrated regional ITS system. The subsystems or the physical entities are organized by their characteristics in four categories, namely, Center, Roadside, Vehicle, and Traveler subsystems.

The Center Subsystems represent operational entities such as a traffic management system or transit management system. The Roadside Subsystems represent devices or systems deployed on the transportation infrastructure. The Vehicle Subsystems represent vehicles or mobile entities that utilize the ITS technology in support of their respective operations. The Traveler Subsystems represent traveler information services provided to the traveling public as well as the commercial operators for improving their safety and travel experiences.

These subsystems are connected with each other via three general types of communications to facilitate data and information exchange, including Wire-line, Wide Area Wireless, and Short-Range Wireless communications. The wire-line communications include an array of known "wired" communication methods including telephone lines, copper cables, high-capacity fiber optics, and includes wireless point-to-point media. The Wide-Area Wireless communications provide wireless data and voice communications over a long distance. The examples of Wide Area Communications include microwave, Mobile Radio, and commercially available wireless data services such as the Cellular Digital Packet Data (CDPD). The Short-Range Wireless is typically used to provide data exchange between a mobile unit (e.g., vehicle) and a roadside device. Examples of Short-Range Wireless communication include: emergency vehicle signal pre-emption, electronic tolling, and commercial vehicle electronic clearance.

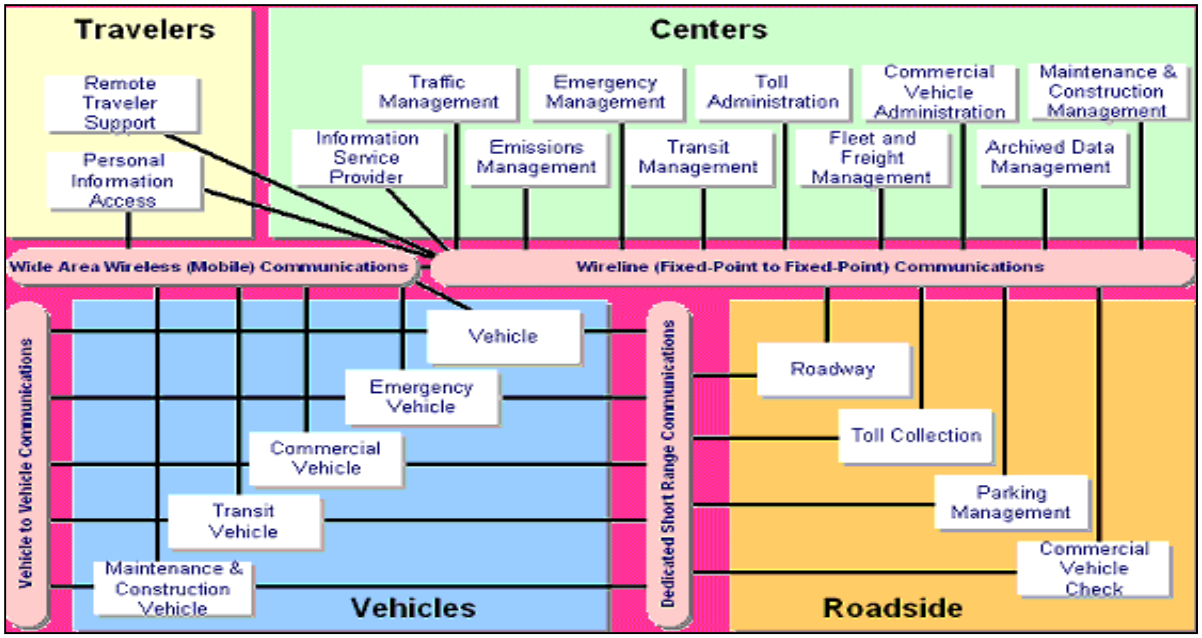

Figure 4-1. National ITS Architecture "Sausage" Diagram

4.2 Houston Region High Level Architecture

Using the generic "sausage" diagram and an inventory of the existing systems by major stakeholders in the region, a customized high-level framework for the Houston region is illustrated in Figure 4-2. The major subsystems depicted in this figure include:

- **Centers Subsystems**
  - Traffic Management Center Subsystems
    - Houston Transtar (City of Houston, Harris County, TxDOT)
    - Regional Cities Traffic Management Centers
    - Regional County Traffic Management
    - METRO HOV Lane Management
  - Transit Management Center Subsystems
    - METRO
  - Emergency Management Center Subsystems
    - City of Houston (COH) Office of Emergency Management (located in Houston Transtar)
    - Harris County Office of Emergency Management -HCOEM (located in Houston Transtar)
    - Other Agencies Emergency Management Centers
    - Local Police and Fire
  - Commercial Vehicle Center Subsystems
    - TxDOT Commercial Vehicle Administration Systems
  - Archived Data Management Center Subsystems
    - Texas Transportation Institute (TTI) Post Oak
    - Houston Transtar Information Service (IS)
  - Information Service Provider
    - Houston Transtar IS - Traffic Website (www.houstontranstar.org)
    - TTI Post Oak
  - Toll Administration
    - Harris County Toll Road Authority
    - METRO/TxDOT
  - Maintenance and Construction Management
    - Harris County
    - City of Houston
    - TxDOT
    - METRO
    - Regional Cities and Counties
  - Emissions Management
    - Texas Commission on Environmental Quality (TCEQ)

- **Roadside Subsystems**
  - Roadway
    - Closed-Circuit Television (CCTV)
    - Loop Detectors
    - Video Imaging and Vehicle Detection Systems (VIVDS)
    - Ramp Meters
    - Changeable Lane Assignment Signs (CLAS)
    - Lane Control Signs (LCS)
    - HOV Lane Management
    - Traffic signal network for signal coordination (RCTSS)

        - Emergency vehicle pre-emption
        - Dynamic Message Signs (DMS)
        - Highway Advisory Radio
        - Weather, pavement and environmental sensors
        - Emissions Monitoring Equipment
        - Flood Monitoring Sensors
        - Truck Rollover Warning Systems (TRWS)
        - Railroad Message Signs (RRMS)
    - Toll Collection systems
    - Commercial vehicle operation implementations
        - Weigh-in-motion and electronic clearance
        - Ports of Entry

- **Vehicle Subsystems**
    - Transit vehicle
        - METRO Bus (IVOMS Bus, Automated Bus)
        - Light Rail
    - Emergency vehicle
        - M.A.P
        - METRO Police
        - Other Agencies Emergency Vehicles
        - Heavy Duty Wreckers
        - Mobile Command Bus
    - Commercial vehicle
        - Electronic clearance (onboard device)
    - Maintenance vehicle
        - Regional cities and counties maintenance vehicles
    - Vehicle
        - AVI tags

- **Traveler Subsystems**
    - Real-time enroute traffic information service on major freeway
    - Personal information access via Internet (Houston Transtar) and personal communication devices like cellphones, PDAs
    - Texas Travel Information System (TxDOT website)
    - METROLINE (Transit Traveler information system)
    - HCOEM/COH websites

4.2.1 Relationship of Transtar to Other TMCs

Transtar is envisioned to be the primary transportation management center in the Houston region, but it shall be supplemented with surrounding regional city and county TMCs. Transtar will also link to other statewide traffic management centers. Figure 4.3 depicts these links and connections.

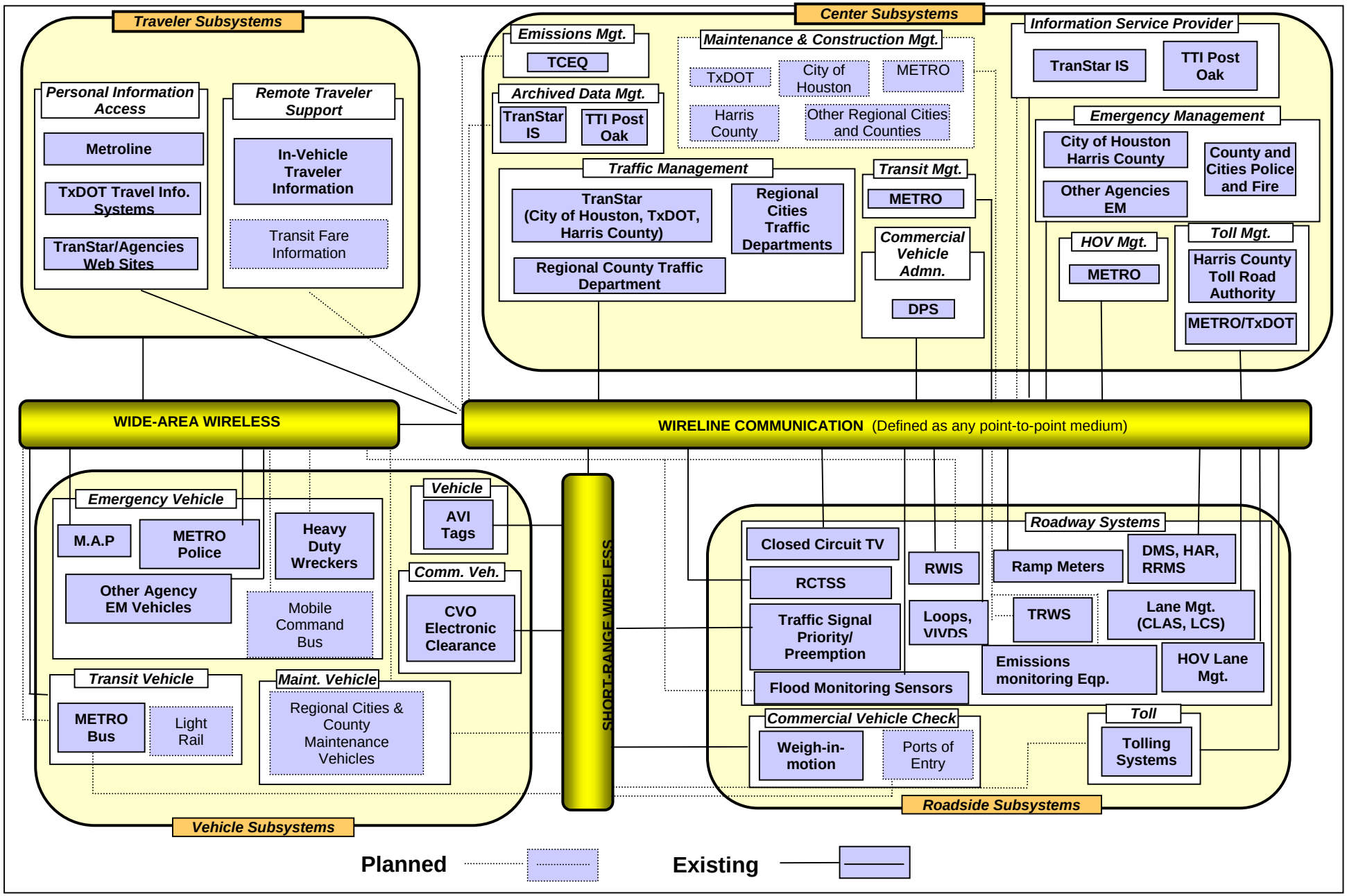

Figure 4-2. High-Level Architecture Framework for the Houston Region

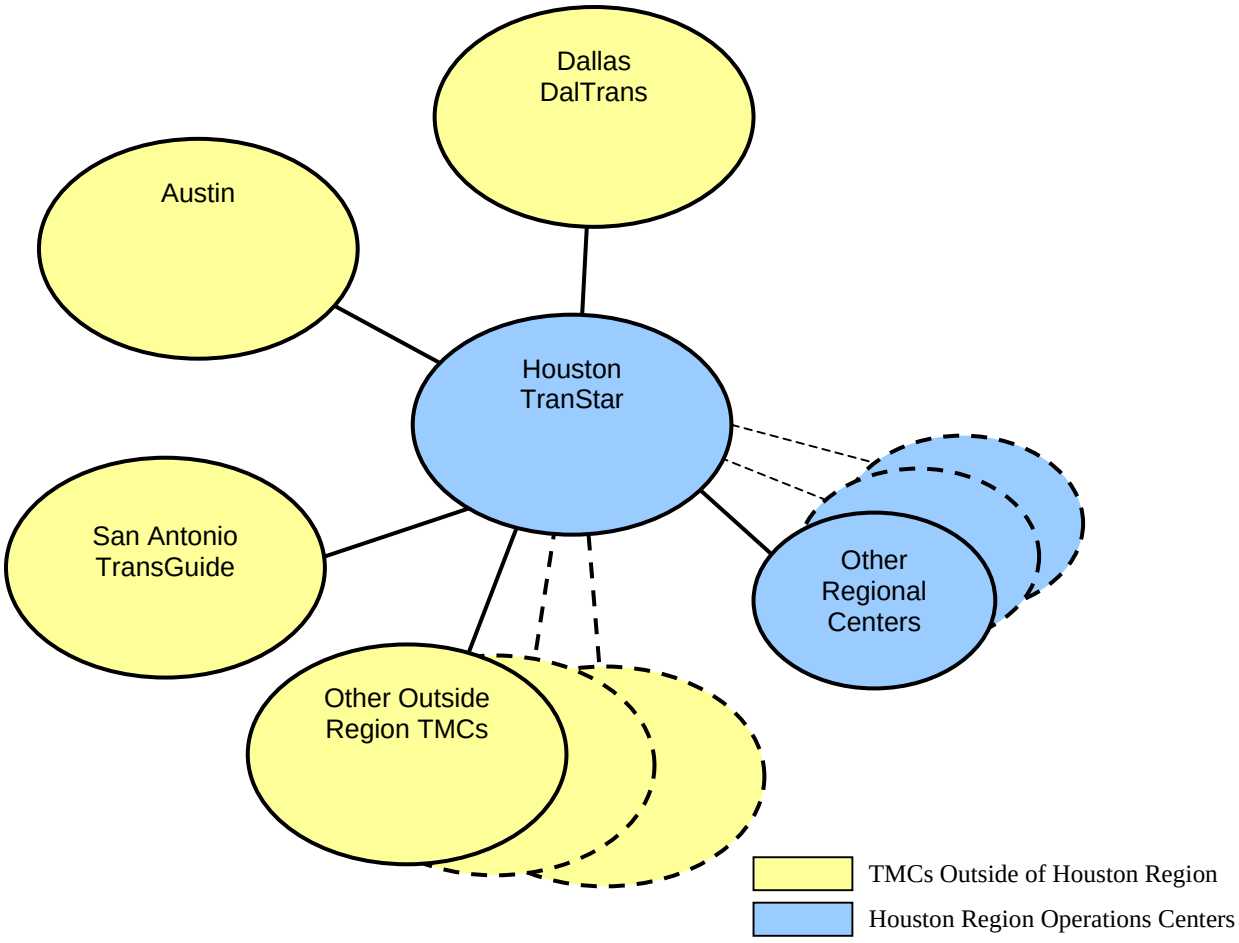

Figure 4-3. Houston Transtar Relationships

4.3 Physical Architectures of Major Functional Areas

The high level architecture framework described and illustrated in the earlier section provides a big picture view of all the systems and equipment talking to each other through the communication channels. The National ITS Architecture provides a detailed physical interconnect diagram of each of the 19 subsystems to identify the information that is exchanged between them and the major stakeholders that operate and provide the intended ITS functions. Using these interconnect diagrams as a guide and by identifying the major functional areas for the Houston region, the section below describes these major functional areas and illustrates a simplified version of the physical interconnect diagrams along with architecture flows (information exchanged).

The major functional areas identified for the Houston region include those that were identified in Houston Transtar Architecture and are enhanced to include new areas that are applicable for the whole region. The region's physical architecture interconnect diagrams have two components:

- Functions performed by Houston Transtar
- Functions performed by other regional cities and counties

In some cases, physical architecture interconnect diagrams are duplicated to distinguish Houston Transtar operations and the regional cities and counties operations. Major functional areas identified, described and illustrated for the whole region include:

- Traffic Management
- Transit Management
- Traveler Information
- Toll Management
- Emissions Management
- Emergency Management
- Archived Data Management
- Maintenance and Construction Management

4.3.1 Traffic Management

The traffic management function is provided through the traffic management subsystem in the physical architecture and includes operations within a traffic management center or other fixed location. This subsystem provides functions that communicate with the roadway subsystem to monitor and manage traffic flow. Incidents are detected and verified and incident information is provided to the emergency management subsystem, to travelers (through roadway subsystem highway advisory radio and dynamic message signs), and to third party providers. This subsystem supports HOV lane management and coordination, road pricing, and other demand management policies that can alleviate congestion and influence mode selection. Functions also include monitoring and management of maintenance work and dissemination of maintenance work schedules and road closures. The subsystem also manages reversible lane facilities, and processes probe vehicle information. The subsystem communicates with other Traffic Management Subsystems to coordinate traffic information and control strategies in neighboring jurisdictions. It also coordinates with rail operations to support safer and more efficient highway traffic management at highway-rail intersections. Finally, the Traffic Management Subsystem provides the capabilities to exercise control over those devices utilized for AHS traffic and vehicle control.

Houston Transtar is the main traffic management center in the region. There are four major stakeholders involved in the traffic management operations in Houston Transtar:

- TxDOT (Freeway Management)
- City of Houston (City Arterial Streets)
- Harris County (County Arterial Streets)
- METRO (HOV Lane Management)

The data sharing between subsystems associated with Houston Transtar is shown in Figure 4-4.

In addition, various cities and counties have traffic management departments, which operate independently of Houston Transtar. The interconnects for these regional traffic management departments is shown in Figure 4-5.

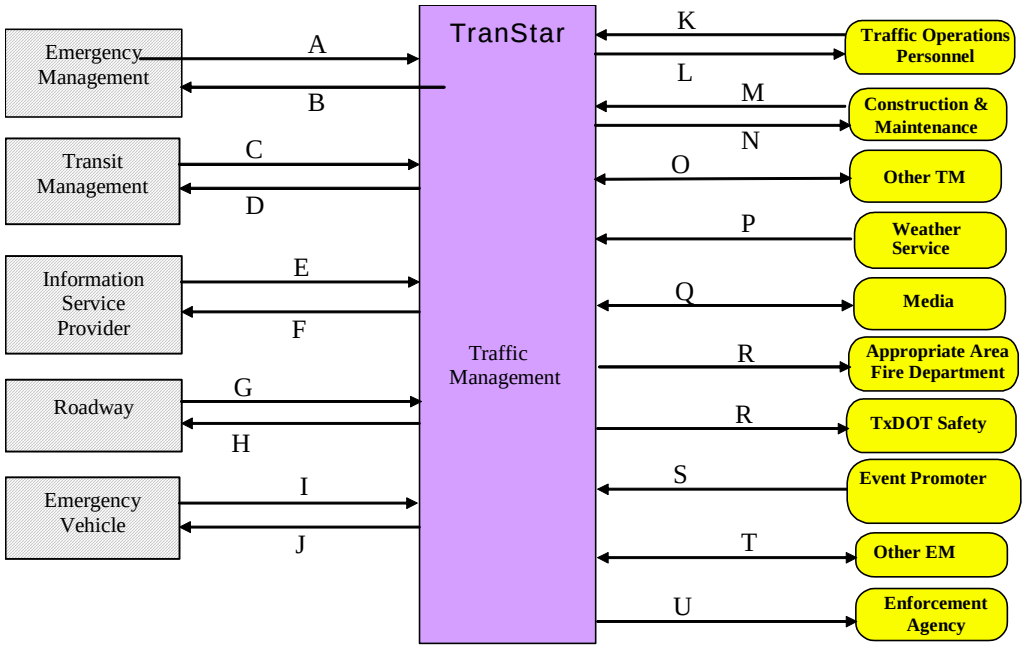

Figure 4-4. Houston Transtar Traffic Management Interconnections

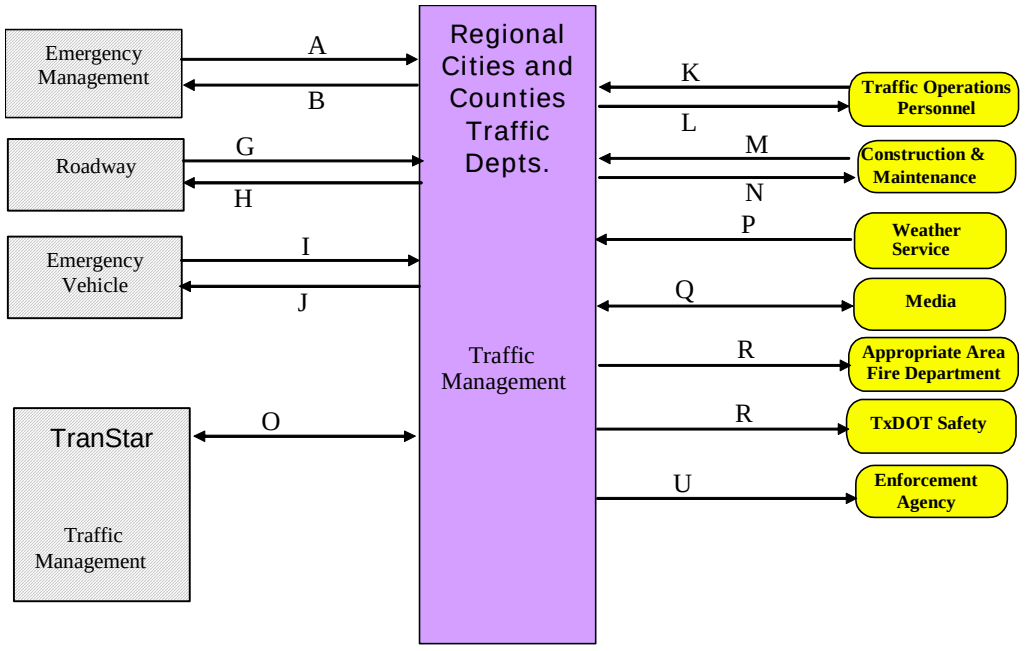

Figure 4-5. Regional Cities and Counties Traffic Management Interconnections

Architecture Flow Names

A: incident information, resource request, remote surveillance control, request evac assist, emergency information, environmental conditions
B: current network conditions, incident information, assistance offer, evacuation status, environmental conditions, closure coordination
C: transit system data, traffic control priority request, transit demand management response
D: traffic information for transit, traffic control priority status, transit demand management request
E: request for traffic information, vehicle probe data
F: traffic information, fault report, freeway control data, roadway information system data, work zone status, incident information, signal control status, roadway environmental information
G: traffic flow, traffic images, vehicle probe data, signal control status, fault report, freeway control status, HOV data, roadway information system status, hri status, reversible lane status, environmental conditions
H: sensor and surveillance control, signal control data, freeway control data, roadway information system data
I: incident command information, traffic control coordination, traffic information coordination
J: incident status, traffic control coordination, traffic information coordination
K: traffic operator inputs
L: traffic operator data
M: maintenance resource response, work zone status
N: maintenance resource request, closure coordination
O: traffic information coordination, traffic control coordination
P: weather information
Q: traffic information
R: incident information
S: event plans
T: incident response coordination, incident report, road closure information
U: violation trend data notification

4.3.2 Transit Management

The transit management functions are provided through the transit management subsystem of the physical architecture and manages transit vehicle fleets and coordinates with other modes and transportation services. It provides operations, maintenance, customer information, planning, and management functions for the transit property. It spans distinct central dispatch and garage management systems and supports the spectrum of fixed route, flexible route and paratransit services.

The subsystem's interfaces allow for communication between transit departments and with other operating entities such as emergency response services and traffic management systems. This subsystem receives special event and real-time incident data from the traffic management subsystem. It provides current transit operations data to other center subsystems.

The Transit Management Subsystem collects and stores accurate ridership levels and implements corresponding fare structures. It collects operational and maintenance data from transit vehicles, manages vehicle service histories, and assigns drivers and maintenance personnel to vehicles and routes. The Transit Management Subsystem also provides the capability for automated planning and scheduling of public transit operations. It furnishes travelers with real-time travel information, continuously updated schedules, schedule adherence

information, transfer options, and transit routes and fares. In addition, the monitoring of key transit locations with both video and audio systems is provided with automatic alerting of operators and police of potential incidents including support for traveler activated alarms.

The region has one major Transit provider (METRO), which is a part of the Houston Transtar Architecture and the interconnects for this area is illustrated in Figure 4-6.

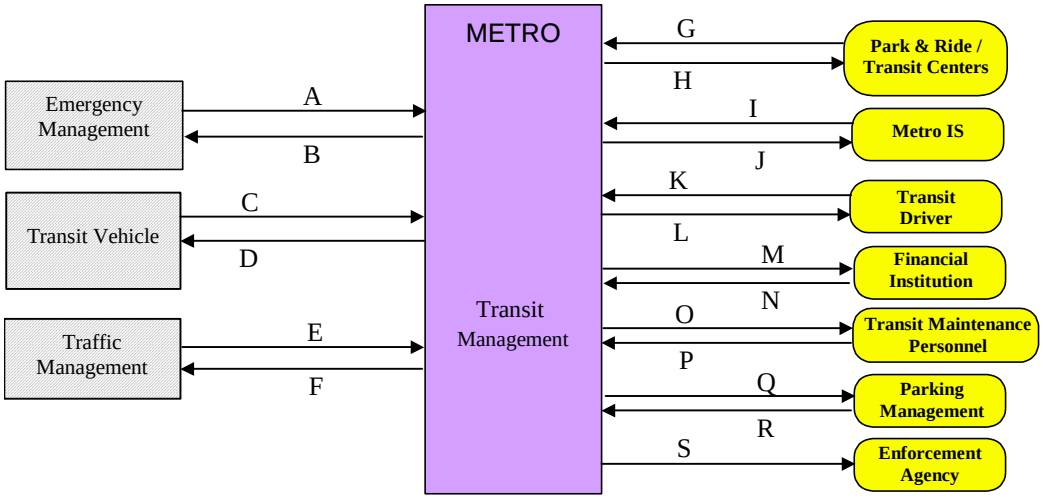

Figure 4-6. METRO Transit Management Interconnections

Architecture Flow Names

A: request evacuation assist emergency information
B: assistance offer
C: transit vehicle location data, transit vehicle schedule performance, transit vehicle passenger and use data, fare and payment status, emergency notification, transit vehicle conditions
D: driver instructions, bad tag list, emergency acknowledge
E: traffic information for transit, traffic control priority status, transit demand management request
F: transit system data, traffic control priority request, transit demand management response
G: emergency notification, secure area surveillance data
H: secure area monitoring support, emergency acknowledge
I: transit information request
J: transit and fare schedules, transit request confirmation, transit incident notification
K: transit driver availability
L: route assignment, driver instructions
M: payment request
N: transaction status
O: transit work schedule
P: maintenance status
Q: transit parking lot response
R: transit parking coordination
S: violation notification

4.3.3 Traveler Information

The traveler information functions are provided through the Information Service Provider (ISP) subsystem and the personal information access subsystem of the physical architecture.

Information Service Provider: This subsystem collects, processes, stores, and disseminates transportation information to system operators and the traveling public. The subsystem can play several different roles in an integrated ITS. In one role, the ISP provides a general data warehousing function, collecting information from transportation system operators and redistributing this information to other system operators in the region and other ISPs. In this information redistribution role, the ISP provides a bridge between the various transportation systems that produce the information and the other ISPs and their subscribers that use the information.

The second role of an ISP is focused on delivery of traveler information to subscribers and the public at large. Information provided includes basic advisories, traffic and road conditions, transit schedule information, yellow pages information, ridematching information, and parking information. The subsystem also provides the capability to provide specific directions to travelers by receiving origin and destination requests from travelers, generating route plans, and returning the calculated plans to the users.

In addition to general route planning for travelers, the ISP also supports specialized route planning for vehicle fleets. In this third role, the ISP function may be dedicated to, or even embedded within, the dispatch system. Reservation services are also provided in advanced implementations. The information is provided to the traveler through the Personal Information Access Subsystem, Remote Traveler Support Subsystem, and various Vehicle Subsystems through available communications links. Both basic one-way (broadcast) and personalized two-way information provision is supported. The subsystem provides the capability for an informational infrastructure to connect providers and consumers, and gather that market information needed to assist in the planning of service improvements and in maintenance of operations.

Houston Transtar houses two ISPs including TTI Post Oak, which provides traffic information using probe surveillance. The interconnects for these ISPs are shown in Figures 4-7 and 4-8. One of the expressed needs was the ability for regional ISPs in cities and counties not part of Houston Transtar to be involved in ISP coordination. The interconnects for regional ISPs and their relationship to Houston Transtar are shown in Figure 4-9.

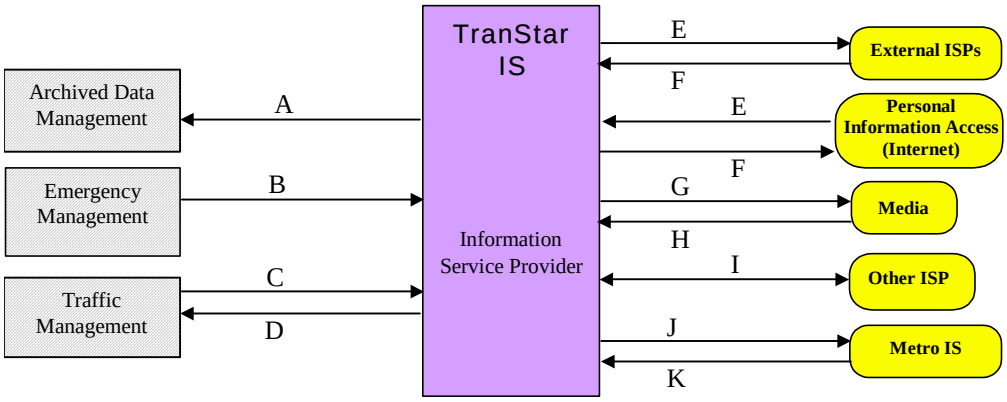

Figure 4-7. Traveler Information (Information Service Provider) Houston Transtar IS Interconnections

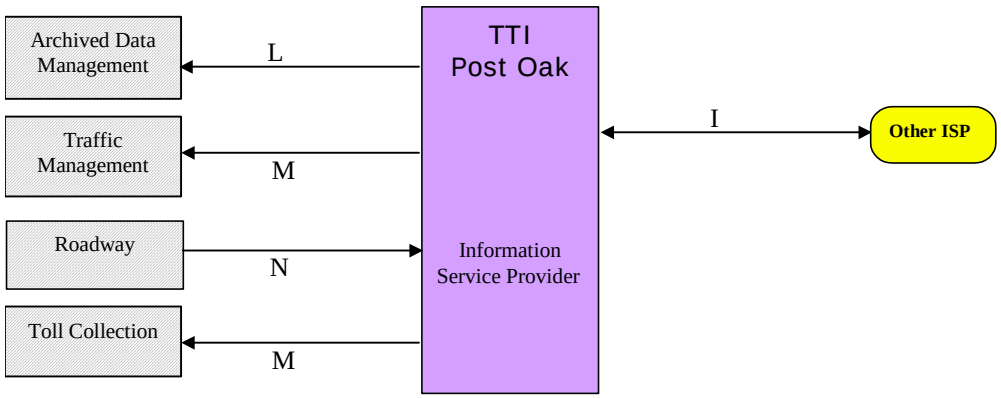

Figure 4-8. Traveler Information (Information Service Provider) TTI at Post Oak Interconnections

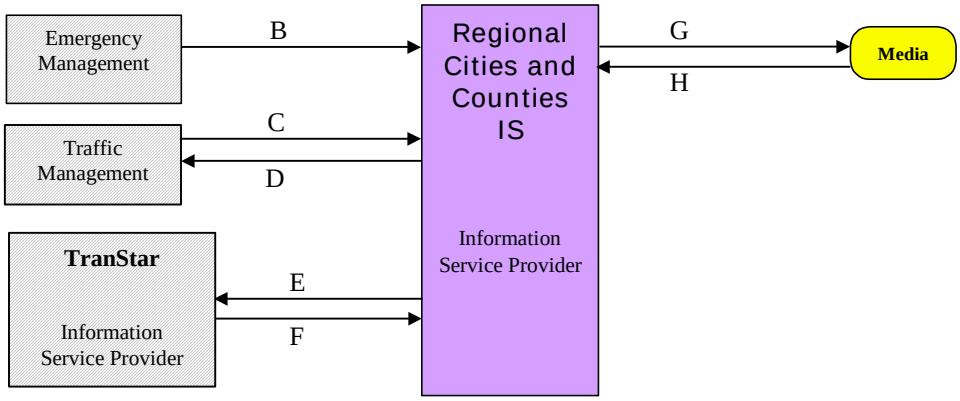

Figure 4-9. Traveler Information (Information Service Provider) Regional Cities and Counties Interconnections

Architecture Flow Names

A: freeway control data, traffic information, work zone status, fault report
B: environmental conditions, emergency information
C: traffic information, fault report, freeway control data, roadway information system data, work zone status, incident information, signal control status
D: request for traffic information
E: traveler request
F: broadcast information, traveler information, emergency information
G: traffic information for media
H: request for traffic information
I: traffic information
J: transit and fare schedules
K: transit information request
L: vehicle probe data
M: vehicle probe data
N: traffic information, vehicle probe data

Personal Information Access: This subsystem provides the capability for travelers to receive formatted traffic advisories from their homes, place of work, major trip generation sites, personal portable devices, and over multiple types of electronic media. These capabilities shall also provide basic routing information and allow users to select those transportation modes that allow them to avoid congestion, or more advanced capabilities to allow users to specify those transportation parameters that are unique to their individual needs and receive travel information.

This subsystem shall provide capabilities to receive route planning from the infrastructure at fixed locations such as in their homes, their place of work, and at mobile locations such as from personal portable devices and in the vehicle or perform the route planning process at a mobile information access location. In addition to end user devices, this subsystem may also represent a device that is used by a merchant or other service provider to receive traveler information and relay important information to their customers. This subsystem shall also provide the capability to initiate a distress signal and cancel a prior issued manual request for help.

There are three major sources of personal information access in the region:

- Houston Transtar/Agencies website
- METROLINE
- TxDOT Travel Information System

The interconnects for personal information access subsystems are shown in Figure 4-10.

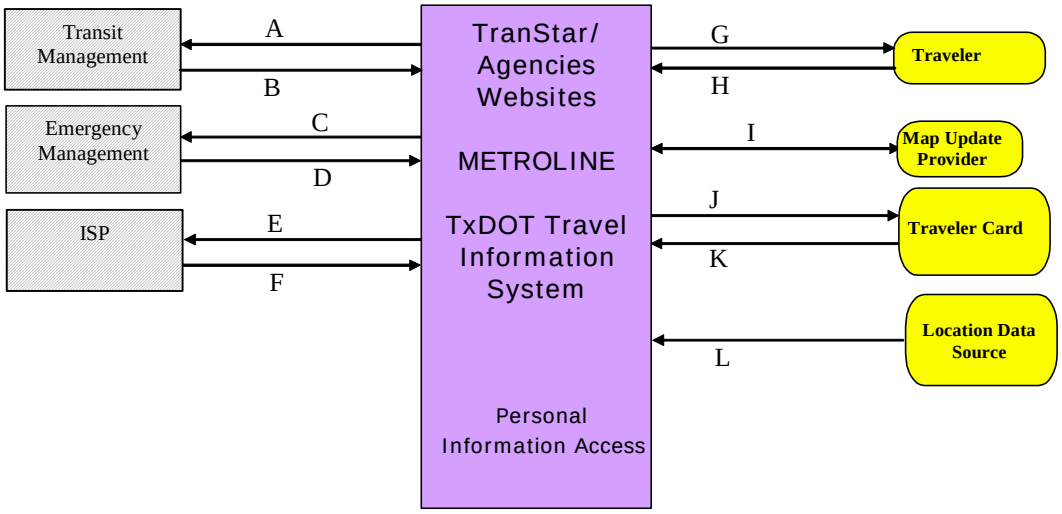

Figure 4-10. Traveler Information (Personal Information Access) Interconnections

Architecture Flow Names

A: transit information user request
B: personal transit information
C: emergency notification
D: emergency acknowledge
E: traveler profile, traveler request, trip confirmation, trip request, yellow pages request
F: broadcast information, traveler information, trip plan, yellow pages information
G: traveler interface updates
H: traveler inputs
I: map updates requests and map updates
J: request for payment, traveler card update
K: payment, traveler card information
L: position Fix

4.3.4 Toll Management

The toll management functions are provided through the toll administration subsystem and provides general payment administration capabilities and supports the electronic transfer of authenticated funds from the customer to the transportation system operator. This subsystem supports traveler enrollment and collection of both pre-payment and post-payment transportation fees in coordination with the existing, and evolving financial infrastructure supporting electronic payment transactions. The system may establish and administer escrow accounts depending on the clearinghouse scheme and the type of payments involved. This subsystem posts a transaction to the customer account and generates a bill (for post-payment accounts), debits an escrow account, or interfaces to the financial infrastructure to debit a customer designated account. It supports communications with the Toll Collection Subsystem to support fee collection operations. The subsystem also sets and administers the pricing structures and includes the capability to implement road pricing policies in coordination with the Traffic Management Subsystem. The electronic financial transactions in which this subsystem is an intermediary between the customer and the financial infrastructure shall be cryptographically protected and authenticated to preserve privacy and ensure authenticity and auditability.

Harris County Toll Road Authority (HCTRA) is the organization responsible for toll collection and administration in Harris County. The EZPASS program allows for electronic toll collection. In addition, the AVI tags are used as probes by TTI Post Oak to collect and provide traffic information. METRO also has a program called Quickride, administered independently of HCTRA, which allows vehicles with two onboard passengers to drive in the 3+ carpool lanes for an extra charge. This is done by providing the commuters with a trip tag, which can be read by the tolling systems on the roadway and a rearview mirror hang-on tag, which is visually verified to determine enrolment in the program. The interconnects for toll administration in the region are given in Figure 4-11.

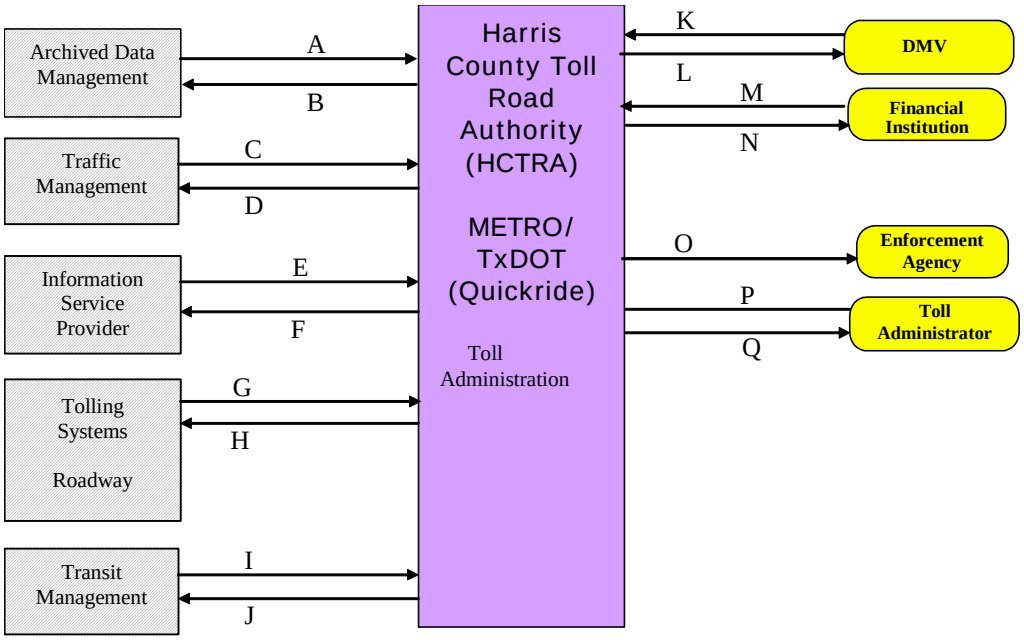

Figure 4-11. Toll Management Interconnections

Architecture Flow Names

A: archive requests, archive status
B: toll archive data
C: toll demand management request
D: probe data, toll demand management response
E: toll data request
F: toll data, probe data
G: toll transactions
H: toll instructions
I: toll demand management request
J: toll demand management response
K: registration
L: license request
M: transaction status
N: payment request
O: payment violation notification
P: toll administration requests
Q: toll revenues and summaries

4.3.5 Emissions Management

The emissions management functions are provided by the emissions management subsystem and operates at a fixed location and may co-reside with the Traffic Management Subsystem or may operate in its own distinct location depending on regional preferences and priorities. This subsystem provides the capabilities for air quality managers to monitor and manage air quality. These capabilities include collecting emissions data from distributed emissions sensors within the roadway subsystem. These sensors monitor general air quality within each sector of the area and also monitor the emissions of individual vehicles on the roadway. The sector emissions measures are collected, processed, and used to identify sectors exceeding safe pollution levels. This information is provided to toll administration, traffic management, and transit management systems and used to implement strategies intended to reduce emissions in and around the problem areas. Emissions data associated with individual vehicles, supplied by the Roadway Subsystem, is also processed and monitored to identify vehicles that exceed standards. This subsystem provides any functions necessary to inform the violators and otherwise ensure timely compliance with the emissions standards.

Texas Commission on Environmental Quality (TCEQ) the major agency responsible for air quality monitoring with the cities and the counties are involved to a lesser extent. The interconnects for the region are shown in Figure 4-12.

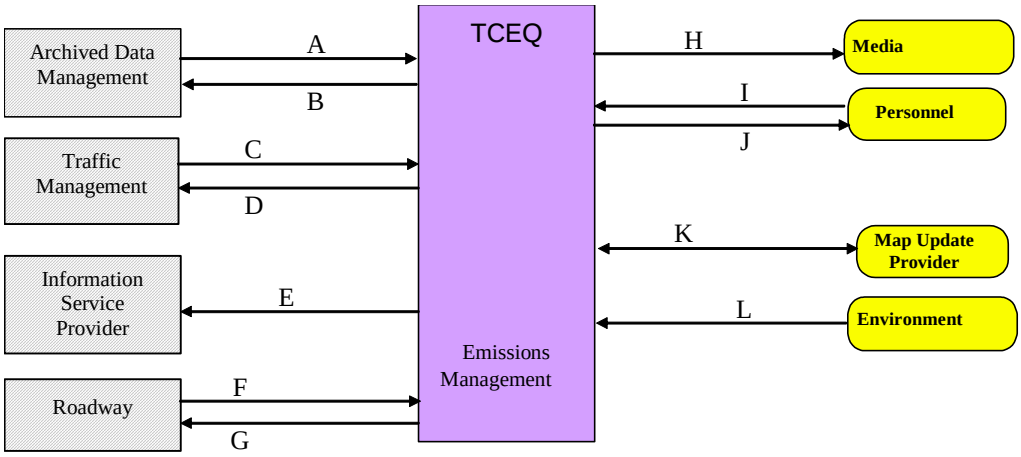

Figure 4-12. Emissions Management Interconnections

Architecture Flow Names

A: archive requests, archive status
B: emissions archive data
C: pollution state data request
D: wide area statistical pollution information
E: air quality information
F: pollution data
G: vehicle pollution criteria
H: air quality information
I: pollution data parameters
J: pollution data display
K: map update requests, map updates
L: pollution levels

4.3.6 Emergency Management

The emergency management functions are provided through the emergency management subsystem and represents public safety and other allied agency systems that support coordinated traffic incident management and emergency response. The subsystem includes the functions associated with fixed and mobile public safety communications centers and includes various public safety call taker and dispatch centers operated by police, fire, and emergency medical services. This subsystem also represents other allied systems including centers associated with towing and recovery, freeway service patrols, HAZMAT response teams, mayday service providers, and security/surveillance services that improve traveler security in public areas.

This subsystem interfaces with other Emergency Management Subsystems to support coordinated emergency response involving multiple agencies. The subsystem creates, stores, and utilizes emergency response plans to facilitate coordinated response. The subsystem tracks and manages emergency vehicle fleets using automated vehicle location technology and two-way communications with the vehicle fleet. Real-time traffic information received from the other center subsystems is used to further aide the emergency dispatcher in selecting the

emergency vehicle(s) and routes that will provide the timely response. Interface with the Traffic Management Subsystem allows strategic coordination in tailoring traffic control to support en-route emergency vehicles. Interface with the Transit Management Subsystem allows coordinated use of transit vehicles to facilitate response to major emergencies.

The emergency management centers in the region are:

- City of Houston Office of Emergency Management (OEM)
- Harris County OEM
- Other Agencies' Emergency Management Centers

The Harris County OEM, housed in Houston Transtar and the City of Houston OEM operate independently according to their jurisdictions. Other regional cities and counties operate their emergency management centers independently. The interconnects for the three entities are shown in Figures 4-13 to 4-15.

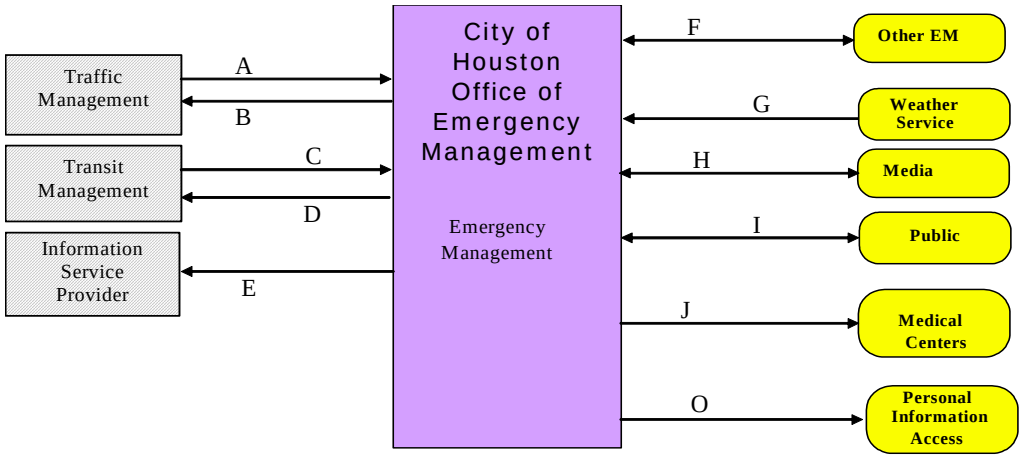

Figure 4-13. Houston OEM Interconnections

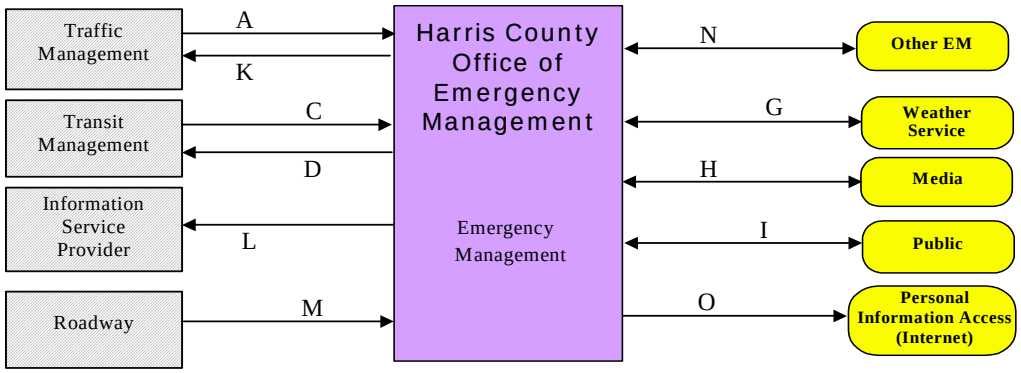

Figure 4-14. Harris County OEM Interconnections

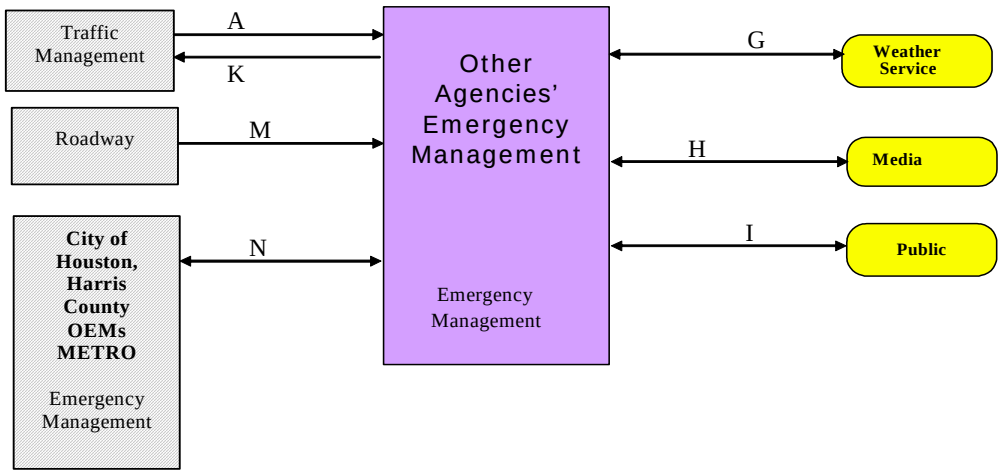

Figure 4-15. Other Agencies' Emergency Management

Architecture Flow Names

A: current network conditions, incident information, assistance offer, evacuation status, environmental conditions, closure coordination
B: incident information, resource request, remote surveillance control, request evacuation assist, emergency information, road closure information
C: assistance offer
D: request evac assist emergency information
E: emergency information
F: incident report, incident response coordination, closure coordination
G: weather information
H: emergency information, evacuation status
I: emergency information, environmental conditions
J: closure coordination
K: incident information, resource request, remote surveillance control, request evac assist, emergency information, environmental conditions
L: emergency information, environmental conditions
M: environmental conditions
N: incident report, incident response coordination, planned closure coordination, environmental conditions
O: environmental conditions

4.3.7 Information Management

The functions of information management are provided through the archived data management subsystem which collects, archives, manages, and distributes data generated from ITS sources for use in transportation administration, policy evaluation, safety, planning, performance monitoring, program assessment, operations, and research applications. The data received is formatted, tagged with attributes that define the data source, conditions under which it was collected, data transformations, and other information (i.e. meta data) necessary to interpret the data.

The subsystem can fuse ITS generated data with data from non-ITS sources and other archives to generate information products utilizing data from multiple functional areas, modes, and jurisdictions. The subsystem prepares data products that can serve as inputs to Federal, State, and local data reporting systems.

This subsystem may be implemented in many different ways. It may reside within an operational center and provide focused access to a particular agency's data archives. Alternatively, it may operate as a distinct center that collects data from multiple agencies and sources and provides a general data warehouse service for a region.

TxDOT has two archived data management systems: Houston Transtar IS and TTI Post Oak. Both of these entities serve a dual role as ISPs also. The data sharing for the two archived data management systems are shown in Figures 4-16 and 4-17. In addition, there are regional sources of data including emergency and traffic management centers in cities and counties not part of Houston Transtar (Figure 4-18).

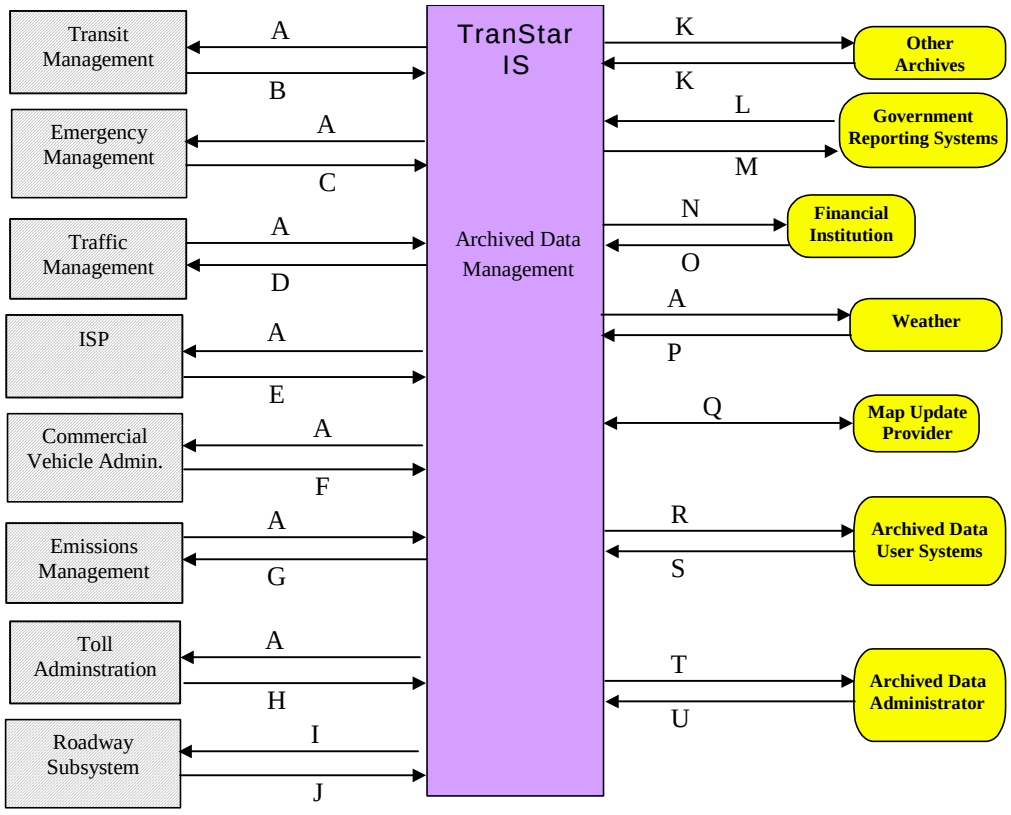

Figure 4-16. Houston Transtar IS Information Management (Archived Data Management) Interconnections

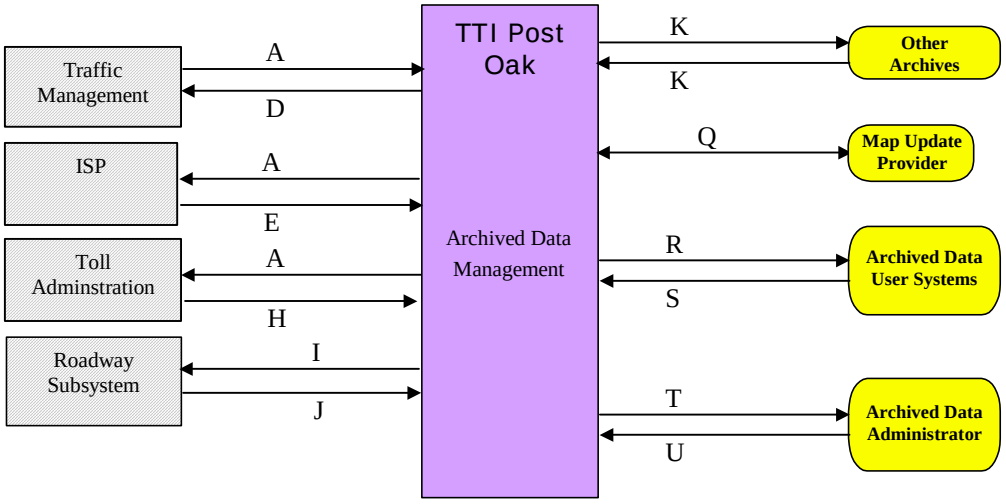

Figure 4-17. TTI Post Oak Information Management (Archived Data Management) Interconnections

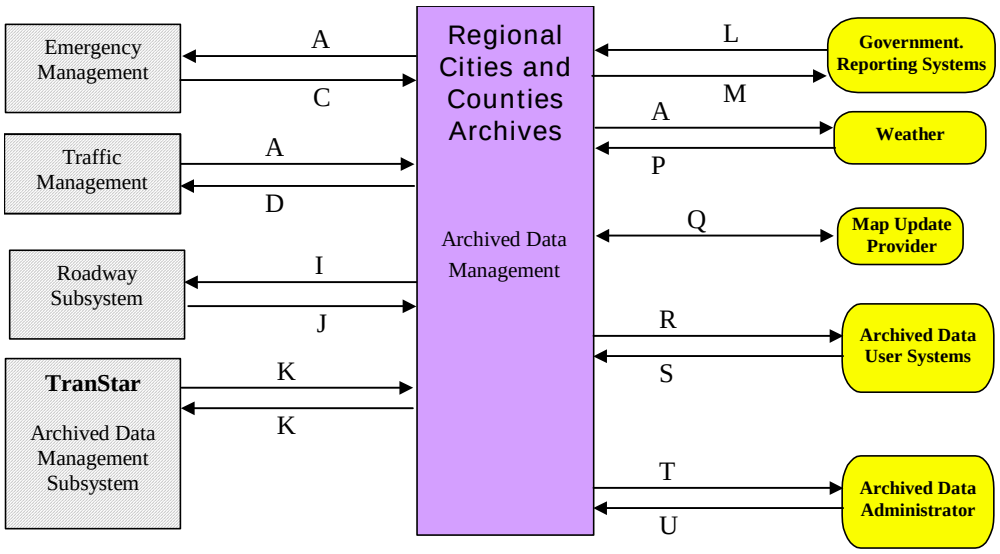

Figure 4-18. Regional Cities Information Management (Archived Data Management) Interconnections

Architecture Flow Names

A: archive request and archive status, (roadside)
B: transit archive data
C: emergency archive data
D: traffic archive data
E: traveler archive data
F: commercial vehicle archive data

G: emissions archive data
H: toll archive data
I: data collection and monitoring control
J: roadside archive data
K: archive coordination
L: government reporting systems receipt
M: government reporting systems data
N: payment request
O: transaction status
P: weather information
Q: map update requests and map updates
R: archive analysis requests, archive product requests
S: archive analysis results, archive data products, archive request confirmation
T: archive management data
U: archive management requests

4.3.8 Maintenance and Construction Operations

The functions of maintenance and construction management are provided through the maintenance and construction management subsystem, which monitors and manages roadway infrastructure construction and maintenance activities. Representing both public agencies and private contractors that provide these functions, this subsystem manages fleets of maintenance, construction, or special service vehicles (e.g., snow and ice control equipment, high water, rescue vehicles etc).

The subsystem receives a wide range of status information from these vehicles and performs vehicle dispatch, routing, and resource management for the vehicle fleets and associated equipment. The subsystem participates in incident response by deploying maintenance and construction resources to an incident scene, in coordination with other center subsystems.

The subsystem manages the repair and maintenance of both non-ITS and ITS equipment including the traffic controllers, detectors, dynamic message signs, signals, and other equipment associated with the roadway infrastructure. Additional interfaces to weather information providers (the weather service and surface transportation weather service providers) provide current and forecast weather information that can be fused with other data sources and used to support advanced decision support systems that increase the efficiency and effectiveness of maintenance and construction operations.

The subsystem remotely monitors and manages ITS capabilities in work zones, gathering, storing, and disseminating work zone information to other systems. It manages traffic in the vicinity of the work zone and advises drivers of work zone status (either directly at the roadside or through an interface with the Information Service Provider or Traffic Management subsystems). Construction and maintenance activities are tracked and coordinated with other systems, improving the quality and accuracy of information available regarding closures and other roadway construction and maintenance activities.

While there is no single coordinated maintenance and construction management center, the following stakeholders are involved in maintenance and construction operations in the region:

- TxDOT
- City of Houston
- Harris County
- METRO
- Other Regional Cities and Counties

The interconnects for the region are shown in Figure 4-19.

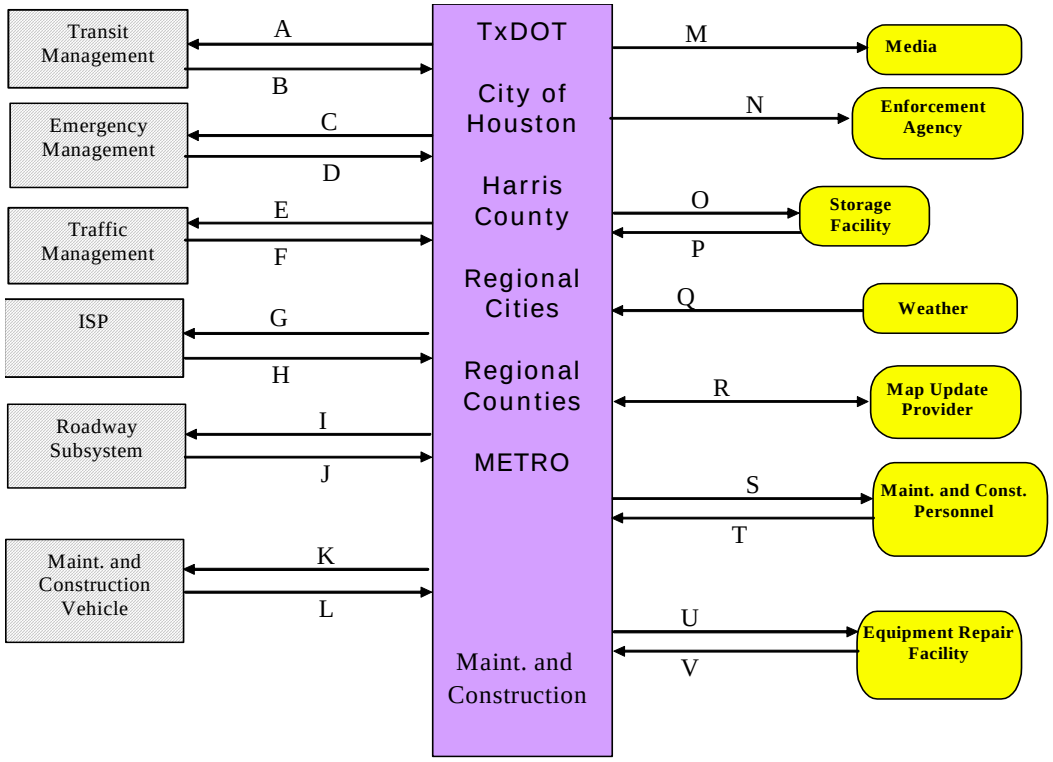

Figure 4-19. Maintenance and Construction Operations Interconnections

Architecture Flow Names

A: maintenance and construction work plans, roadway maintenance status, work zone information
B: work plan feedback
C: incident information, maintenance and construction work plans, roadway maintenance status, work zone information
D: incident response, work plan feedback
E: field equipment maintenance status, incident information, maintenance and construction work plans, roadway maintenance status, work zone information
F: incident information, maintenance and construction resource request, work plan feedback

G: maintenance and construction work plans, roadway maintenance status, work zone information
H: road network probe information
I: environmental sensors control, infrastructure monitoring control, roadway information system data, work zone warning device control
J: environmental conditions data, field device status, infrastructure monitoring sensor data, work zone warning status
K: maintenance and construction dispatch information
L: maintenance and construction dispatch status, location data, operational data, work zone status
M: maintenance and construction plans, roadway maintenance status, work zone information
N: request for enforcement
O: storage facility request
P: equipment availability, maintenance material storage status
Q: weather Information
R: map update requests and map updates
S: maintenance and construction information presentation
T: maintenance and construction personnel inputs
U: maintenance and construction information
V: maintenance and construction repair status

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5.0 NEXT STEPS

The system architecture that was described in this document will serve as a guide and assist the project team in developing a regional Strategic ITS Plan, which will address the needs and issues and provide strategies and recommendations for implementing and deploying successful ITS Systems in the Houston region.

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APPENDIX A

Customized Market Package Diagram

Legend

The result of mapping market packages with user services is a list of selected market packages that reflect the Houston region implementation goals. These market packages were then customized to better represent the deployment, as intended for the region. The market packages are intended to represent the future or the ultimate roles of the organizations involved. Specific information on existing roles, responsibilities and systems deployed can be obtained from Houston Transtar at 713-881-3000.

The diagrams include subsystems and their associated equipment packages. Subsystems that are part of the region, but which are external to a market package are shown crosshatched. Arrows are used to depict architecture flows (information content and direction). Terminators are entities on the periphery of the architecture, not part of it, but interacting with it, and are shown as ovals. An example of a generic market package diagram is shown in Figure A.

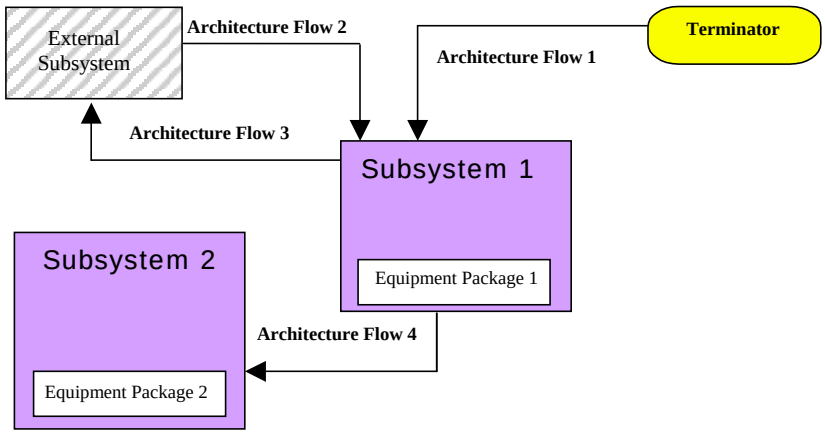

Figure A. Generic Market Package Diagram

ATMS1 – Network Surveillance

The ATMS1 market package includes the monitoring and some control functions between the Houston TranStar center and the roadway equipment. The Houston TranStar operations monitor the freeways via TxDOT's field equipment such as roadway closed circuit television cameras, loop detectors, and Video Imaging and Vehicle Detection (VIVDS). The Collect Traffic Surveillance equipment package is involved with retrieving this information from the roadway equipment. If field equipment problems are encountered, then the Traffic Maintenance equipment package is used to address these problems. The traffic information that is collected is then transferred to the Information Service Provider subsystem, in this case, the Houston Transtar website.

The Media terminator here represents those cases where traffic information is first learned by external reporters; for example via Media owned traffic-monitoring helicopters.

Automated Vehicle Identification (AVI) technology is also used, but this is covered in the enhanced market package "ATMS2 – Probe Surveillance."

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management
- 2.4 – Public Travel Security

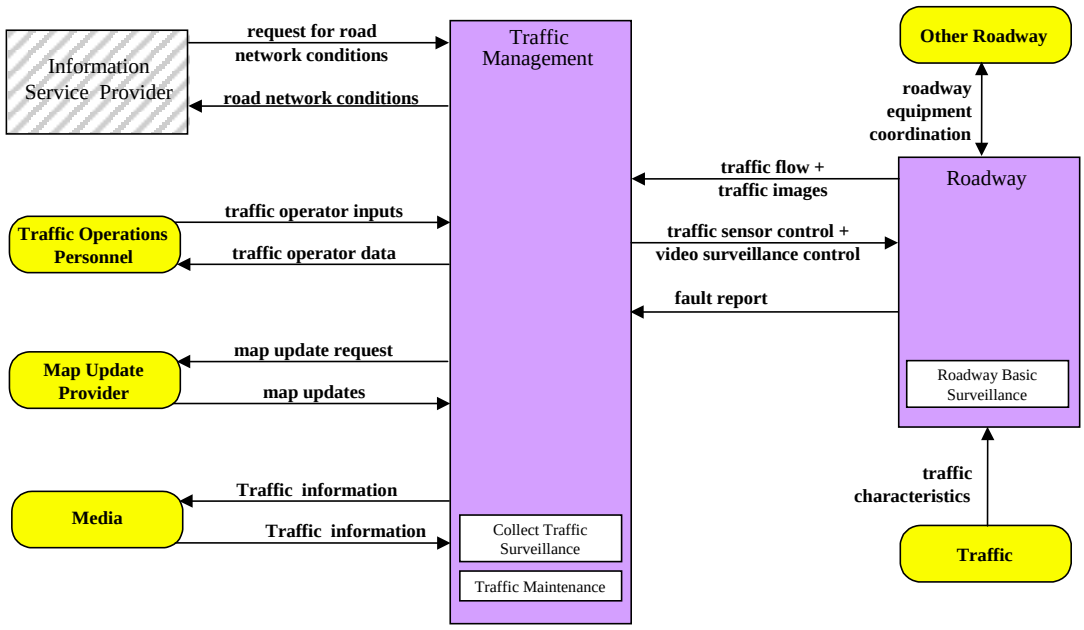

Figure A-1. ATMS1 Network Surveillance

ATMS2 – Probe Surveillance

The ATMS2 market package includes the functionality to retrieve AVI tag data from vehicles along the roadway.

Automatic vehicle identification is used to collect real-time information on current travel conditions on freeways and HOV lanes. The main sources of AVI data in Houston are vehicles using the "EZ Tag" automatic toll collection tags from the Harris County Toll Road Authority (HCTRA). AVI deployments include antennas and tag readers installed on structures along freeways and HOV lanes spaced at one to five mile intervals. The antennas and readers monitor the passage of probe vehicles that are equipped with transponder tags. The tags are powered by a small battery, which enables them to reflect signals transmitted from the AVI antennas. The time, identification, and location stamp of the probes collected at the AVI reader station are transmitted to a central computer over a telephone line. Probe vehicle data from successive AVI readers are used to calculate average travel times and speeds for a roadway segment. The speed on a link is calculated using the time it takes a vehicle equipped with an AVI tag to travel the predetermined distance between the two AVI tag readers. Average vehicle speeds on various links are displayed in real-time on a speed map on the Houston TranStar website and are also used for the route builder and speed tables on the website.

Currently AVI technology is being used to determine travel speeds on Houston area freeways and HOV lanes. AVI is also deployed on Hempstead Road, which parallels U.S. 290. AVI deployments include AVI reader stations, mobile readers and AVI toll tags (transponders).

The basic vehicle is the single terminator that exists for this market package. The basic vehicle is capable of deploying an AVI tag for use within this system.

Houston TranStar also makes use of other forms of vehicle detection; see "ATMS1 – Network Surveillance," and "ATMS4 – Freeway Control."

Primary User Service(s) Implemented:

- 1.6 – Traffic Control

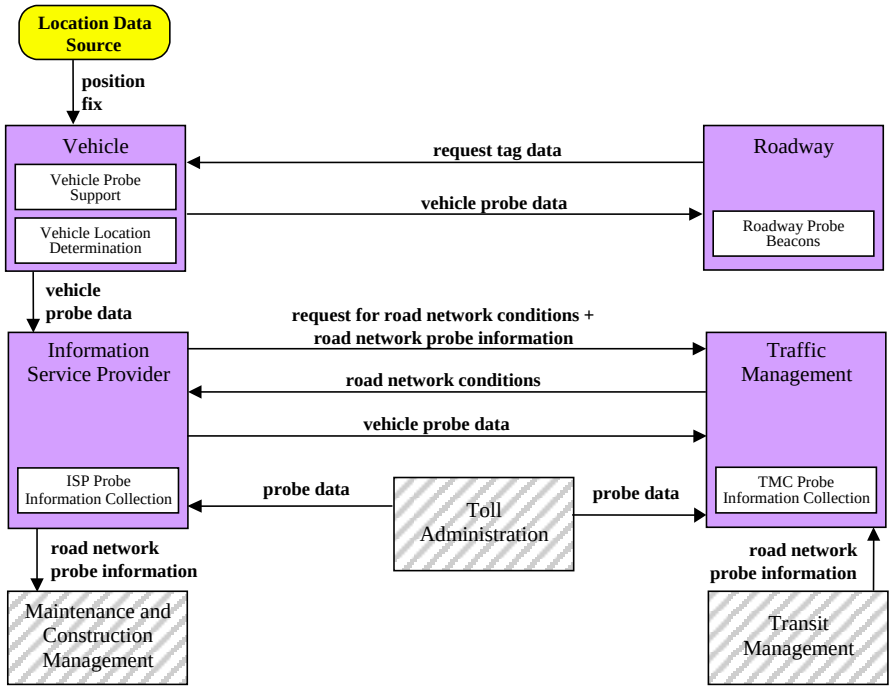

Figure A-2. ATMS2 Probe Surveillance

ATMS3 – Surface Street Control

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.

City of Houston, Harris County, and TxDOT operations within Houston TranStar will include support for RCTSS installations being designed and deployed by METRO. The City of Houston and Harris County operations will also include Changeable Lane Assignment Signals (CLAS) system. Transit Priority is shown in APTS7 market package.

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management

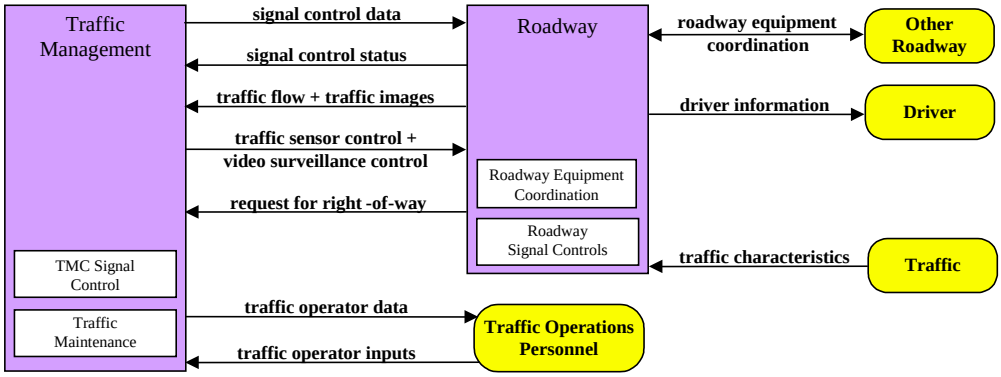

Figure A-3. ATMS3 Surface Street Control

ATMS4 – Freeway Control

This market package accounts for many of TxDOT's control functions performed between the Houston TranStar operations center and the freeway equipment. It includes monitoring traffic flow (see ATMS1 and ATMS2) through loop and VIVDS, retrieving CCTV images, retrieving the status of equipment on the roadway, and sending control and configuration information out to the freeway equipment such as Dynamic Message Signs, the Flow Signals at freeway entrance ramps, and Lane Control Signals.

AVI technology is also used, but this is covered in "ATMS2 – Probe Surveillance."

The driver is the single terminator in this market package. The driver receives the control information sent from the traffic operations center in the form of DMS messages, Lane Control Signal (LCS) indications, and entrance ramp Flow Signals.

Both TxDOT and METRO perform a Traffic Management function on the operations floor at TranStar. Generally TxDOT is responsible for all the freeways.

See also "ATMS2 – Probe Surveillance," "ATMS5 – HOV Lane Management," and "ATMS17 – Reversible Lane Management."

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management
- 1.8 – Travel Demand Management

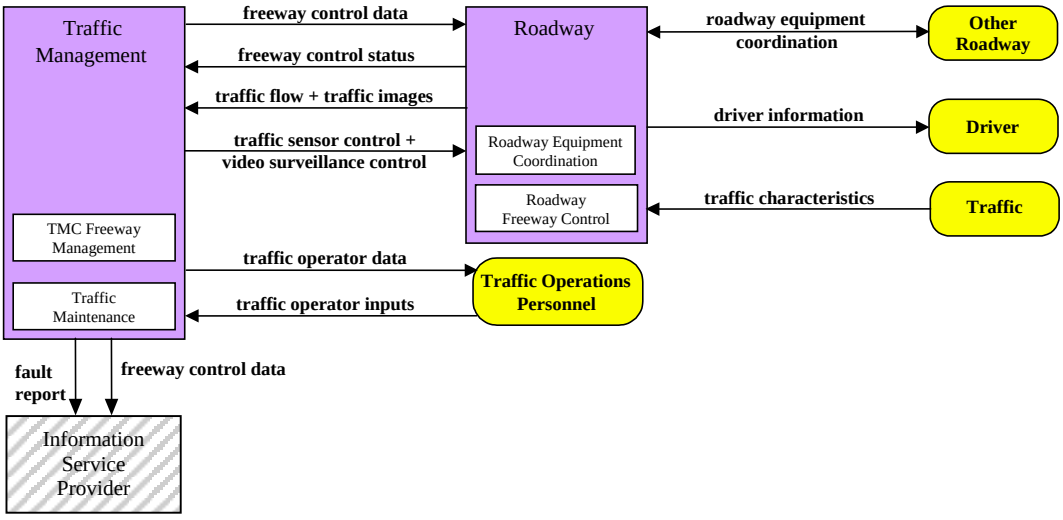

Figure A-4. ATMS4 Freeway Control

ATMS5 – HOV Lane Management

This market package manages METRO's HOV lanes via HOV lane use signals and other roadway equipment. METRO manages these lanes from the TranStar Traffic Management Center. Existing HOV lanes are reversible, so reversible lane management is required. The future may add standard HOV lanes as well.

AVI technology is also used, but this is covered in "ATMS2 – Probe Surveillance."

See also "ATMS2 – Probe Surveillance," "ATMS4 – Freeway Control," and "ATMS17 – Reversible Lane Management."

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management
- 1.8 – Travel Demand Management

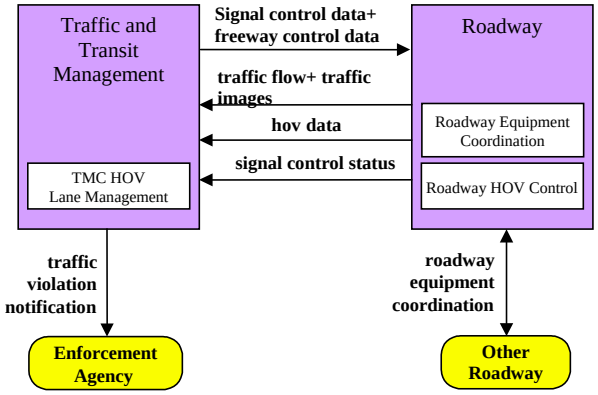

Figure A-5. ATMS5 HOV Lane Management

ATMS6 – Traffic Information Dissemination

This market package contains the functionality necessary to disseminate traffic information to the public. It includes the communication functionality of TxDOT freeway equipment and future Highway Advisory Radio (HAR).

Five terminators to the Houston TranStar architecture are shown in this market package: the Media, the Basic Vehicle, Other Roadway Equipment, Traffic Operations Personnel, and the Driver. Four Houston TranStar subsystems act as additional subsystems to this market package: the METRO dispatchers, the OEMs, maintenance and construction management system, and the Information Service Providers (ISPs).

The Basic Vehicle terminator is used to represent the radio in most vehicles receiving the advisories from the HAR system.

Houston TranStar also supports more advanced digital information services such as Internet and Remote Traveler Support. These are covered in market packages ATIS1 and ATIS2.

Primary User Service(s) Implemented:

- 1.2 – Support Enroute Driver Information
- 1.6 – Traffic Control
- 1.8 – Support Travel Demand Management

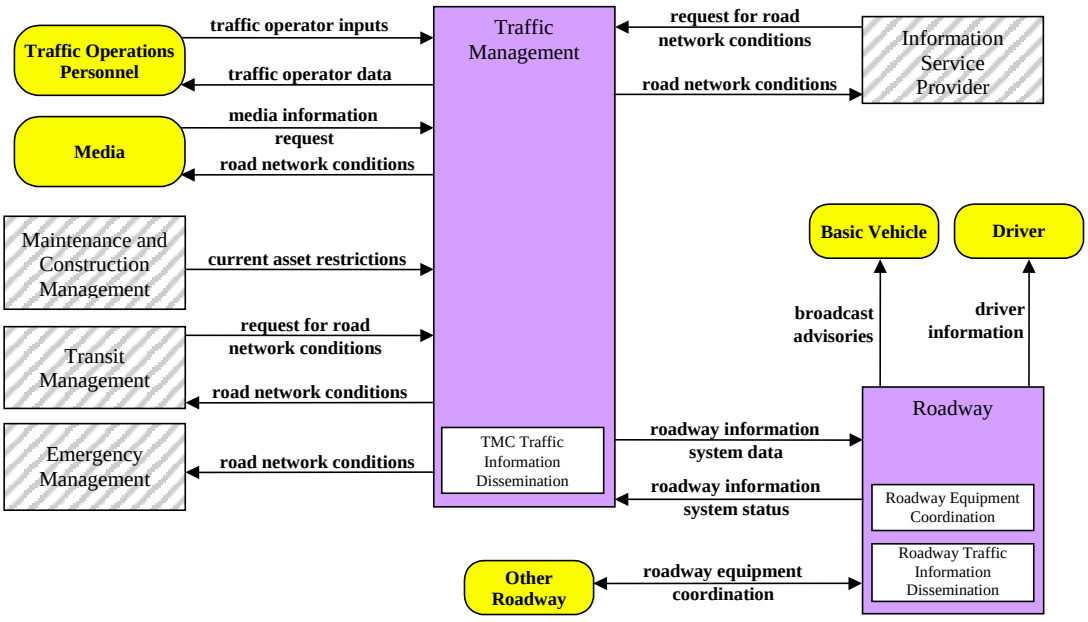

Figure A-6. ATMS6 Traffic Information Dissemination

ATMS7 – Regional Traffic Control

This package advances the "ATMS3 – Surface Street Control" and "ATMS4 – Freeway Control" market packages by adding the communications links and integrated control strategies that enable integrated inter-jurisdictional 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 suburban areas of Clear Lake, Conroe, Humble, Sugarland, and Webster are likely to deploy traffic management centers, which will need to inter-operate with Houston TranStar. The nature of optimization and extent of information and control sharing will be determined through working arrangements between jurisdictions.

Plans call for ITS roadway equipment along the I-10 corridor west to San Antonio. Operation of this equipment will be coordinated with San Antonio's TransGuide traffic management center.

In addition, an "Uptown Center" is being planned to specialize in traffic management for the older core of the City of Houston. This will include the area most affected by the plans for Light Rail.

The "Other Traffic Management (TM)" terminator in this market package represents all of these cases. The "Roadway" subsystem refers to ITS equipment on certain roadways of mutual importance to TMCs, which would be specific to each case. See also "ATMS1 – Network Surveillance," "ATMS3 – Surface Street Control," "ATMS4 – Freeway Control," and "ATMS6 – Traffic Information Dissemination."

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management

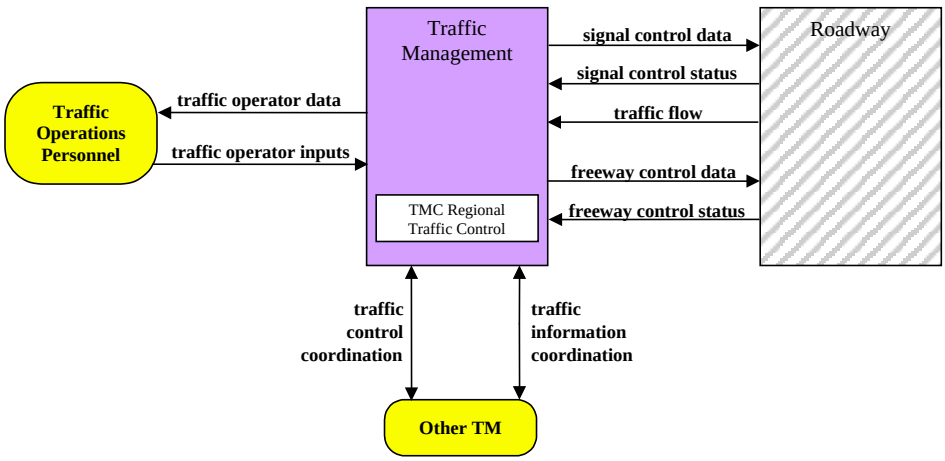

Figure A-7. ATMS7 Regional Traffic Control

ATMS8 – Incident Management System

This market package contains the functionality necessary to manage incidents within the freeway system. It includes the capability to detect incidents and respond to the point of closing portions of the freeway, if necessary. Additionally, it includes the capability to coordinate with event promoters to manage the traffic due to a planned event.

Houston TranStar detects incidents via a Computerized Transportation Management System (CTMS), and responds in a variety of ways, including the dispatch of service vehicles from the Motorist Assistance Program. TranStar personnel will often coordinate with local law enforcement agencies, or may dispatch other emergency vehicles directly such as METRO Police; TxDOT's Heavy Wreckers, or the planned Mobile Command Bus.

The term "Emergency Management" is used in the National ITS Architecture for subsystems such as the Motorist Assistance Program, but within TranStar the term more often refers to the Houston and Harris County Offices of Emergency Management. These agencies are not usually involved in traffic incident response, unless the incident poses a significant risk to public safety.

The incident management for other cities and counties in the region is performed by the respective traffic and emergency management centers in the jurisdiction. The market package also indicates the expected coordination between TranStar for traffic management, emergency management and information.

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management

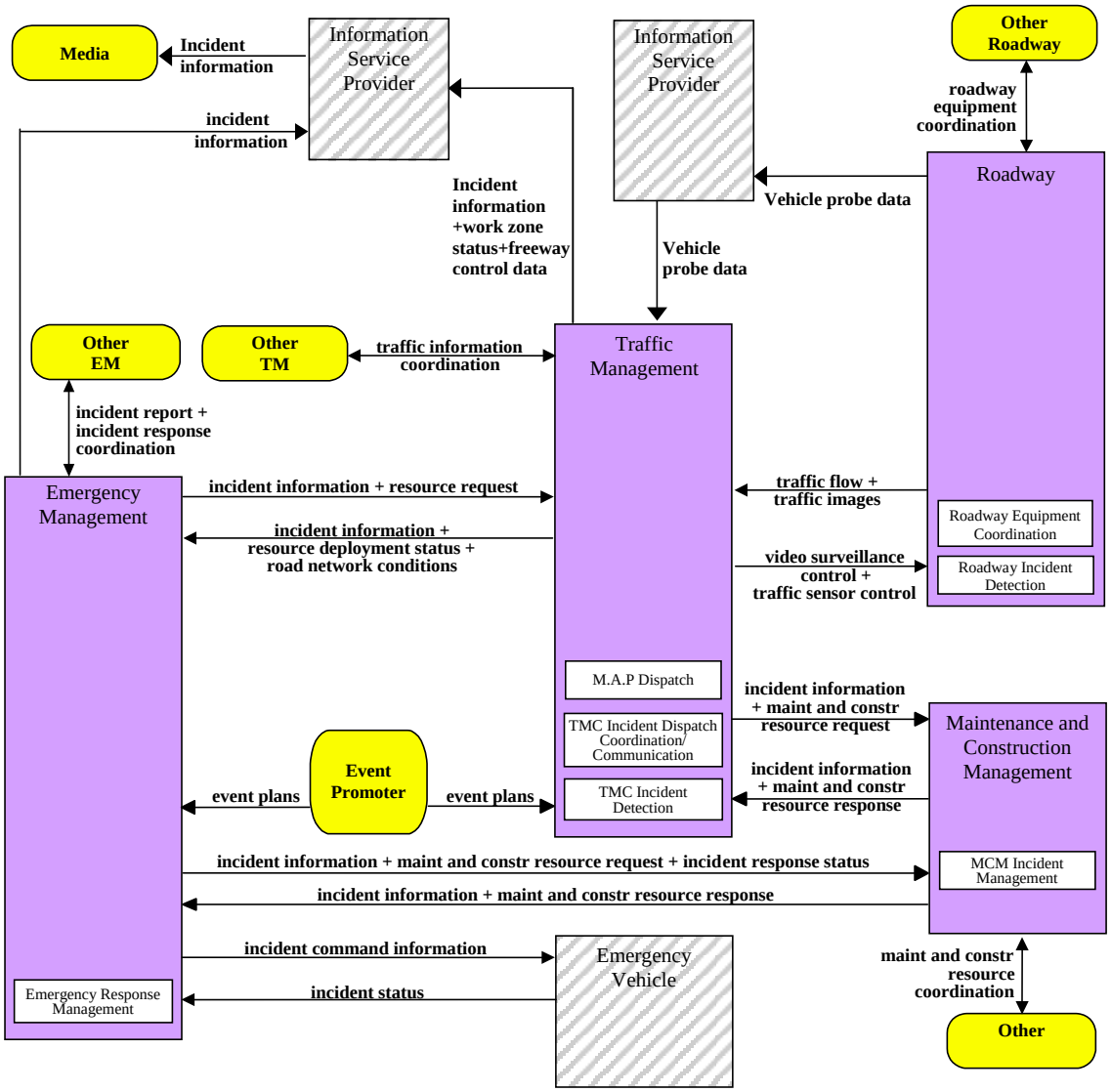

Figure A-8. ATMS8 Incident Management System

ATMS9 – Traffic Forecast and Demand Management

This market package includes the long-term forecasting of transportation demands. It includes the planning and forecasting performed by members of the Metropolitan Planning Organization (MPO).

Other traffic management centers in the region are expected to coordinate more with TranStar. Other traffic management centers may alter the demand on Houston TranStar's resources as they make modifications and additions to their systems.

Event promoters are terminators for this market package. Event promoters may impact the long-term needs of the transportation infrastructure with their planned events and expansions.

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management
- 1.8 – Travel Demand Management

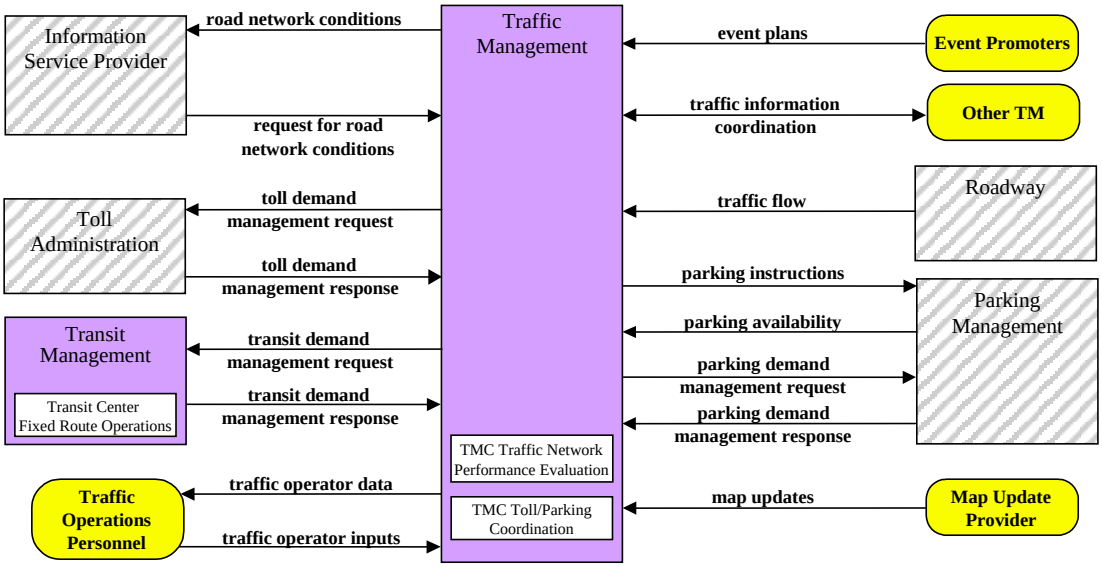

Figure A-9. ATMS9 Traffic Forecast and Demand Management

ATMS10 – Electronic Toll Collection

This market package provides toll operators with the ability to collect tolls electronically and detect violators. This includes the toll operations of Harris County Toll Road Authority (HCTRA), which administers the EZPASS program in the Harris County region. Houston TranStar's operations include METRO's HOV value pricing program, "Quick Ride," which uses the existing AVI detection system.

Primary User Service(s) Implemented:

- 1.8 – Travel Demand Management
- 3.1 – Electronic Payment Services

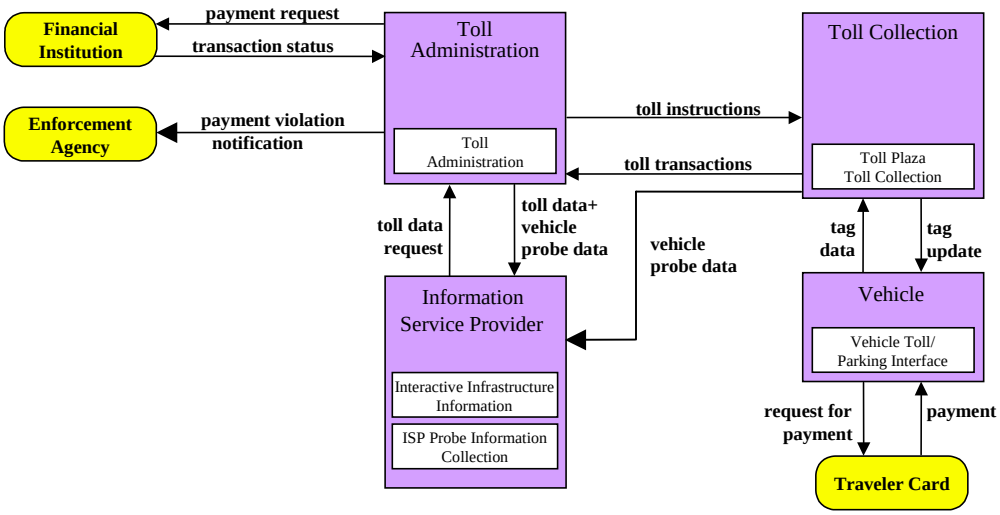

Figure A-10. ATMS10 Electronic Toll Collection

ATMS11 – Emissions Monitoring and Management

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 area wide air quality monitoring and point emissions monitoring 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. TCEQ also provides ozone alert information to TranStar.

Primary User Service(s) Implemented:

- 1.9 – Emissions Policy and Mitigation

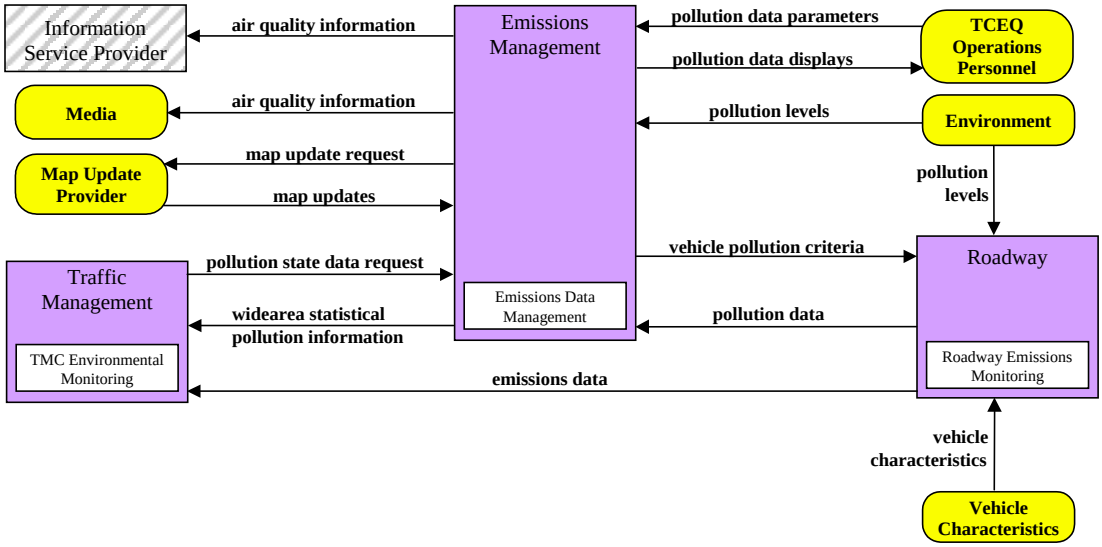

Figure A-11. ATMS11 Emissions Monitoring and Management

ATMS13 – Standard Railroad Grade Crossing

Where operational speeds do not mandate more advanced features, this market package manages highway traffic at highway-rail intersections. AVI technology may be used to detect oncoming rail cars, or a detection technology may be used that does not require a transponder on the train, such as Doppler radar.

Primary User Service(s) Implemented:

- 1.10 – Highway-rail Intersections

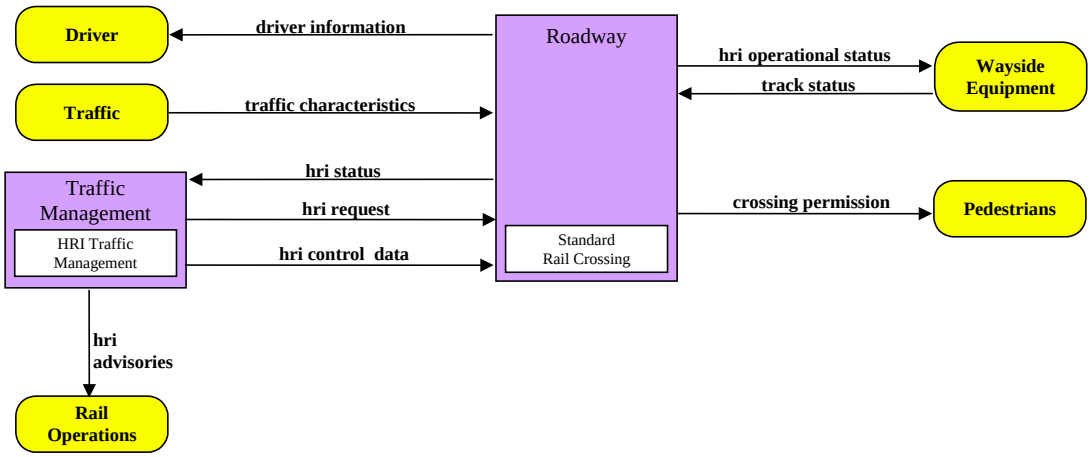

Figure A-12. ATMS13 Standard Railroad Grade Crossing

ATMS14 – Advanced Railroad Grade Crossing

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 that preclude entrance into the intersection when the barriers are activated.

Like the Standard Package (ATMS 13), the HRI equipment is activated on notification by wayside interface equipment, which detects, or communicates with the approaching train. In this market package, the wayside equipment provides additional information about the arriving train so that the train's direction of travel, estimated time of arrival, and 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 that enable it to detect an entrapped or otherwise immobilized vehicle within the HRI and provide an immediate notification to highway and railroad officials.

Primary User Service(s) Implemented:

- 1.10 – Highway-rail Intersections

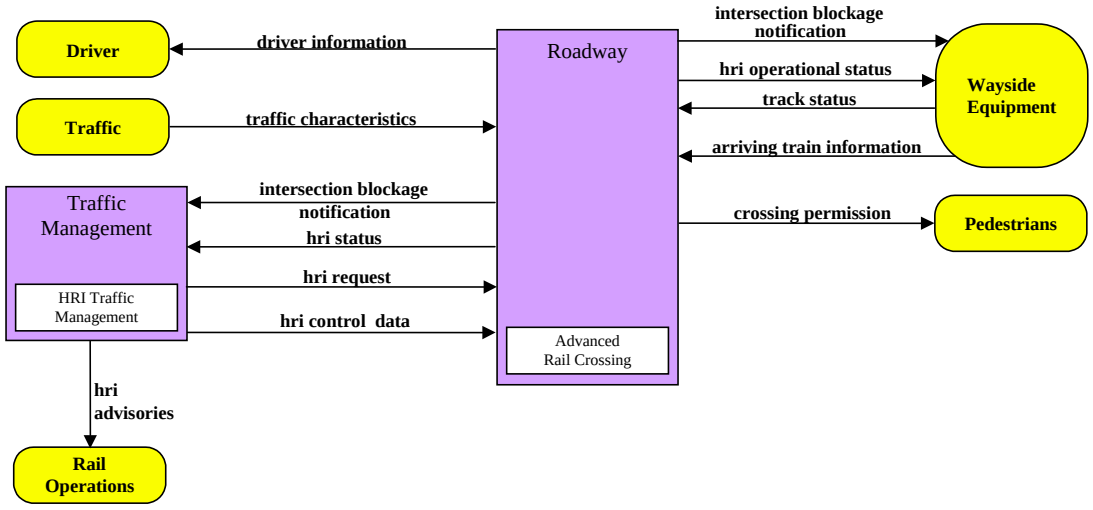

Figure A-13. ATMS14 Advanced Railroad Grade Crossing

ATMS18 – Reversible Lane Management

This provides for METRO's management of reversible HOV lane facilities. It includes surveillance and various signals to mitigate safety hazards associated with reversible lanes.

In this market package, the terminator "Traffic Operations Personnel" refers to METRO personnel performing a traffic management function from the TranStar operations floor.

AVI technology is also used, but this is covered in "ATMS2 – Probe Surveillance."

See also "ATMS2 – Probe Surveillance," "ATMS4 – Freeway Control," and "ATMS5 – HOV Lane Management."

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 1.7 – Incident Management
- 1.8 – Travel Demand Management

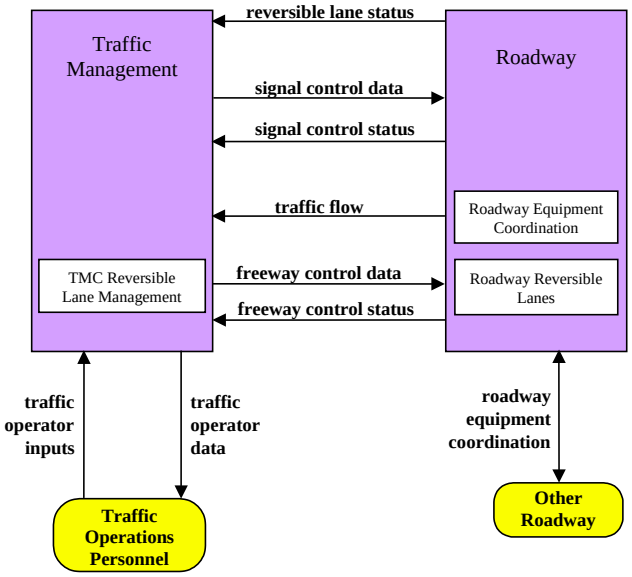

Figure A-14. ATMS18 Reversible Lane Management

APTS1 – Transit Vehicle Tracking

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. METRO's In-Vehicle Operations and Maintenance System (IVOMS) will add the required equipment packages to buses, and the real-time location of the planned Light Rail vehicles will also be tracked.

Primary User Service(s) Implemented:

- 2.1 – Public Transportation Management
- 2.2 – Provide Enroute Transit Information
- 2.3 – Provide Personalized Public Transit
- 2.4 – Public Travel Safety

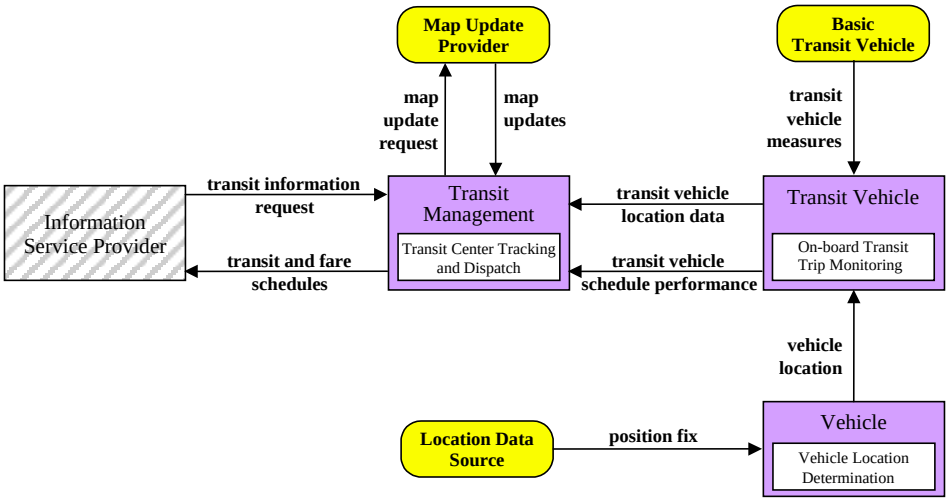

Figure A-15. APTS1 Transit Vehicle Tracking

APTS2 – Transit Fixed Route Operations

This market package performs automatic driver assignment and monitoring, as well as vehicle routing and scheduling for fixed-route services. It also includes the planned Light Rail transit vehicles.

Primary User Service(s) Implemented:

- 2.1 – Public Transportation Management

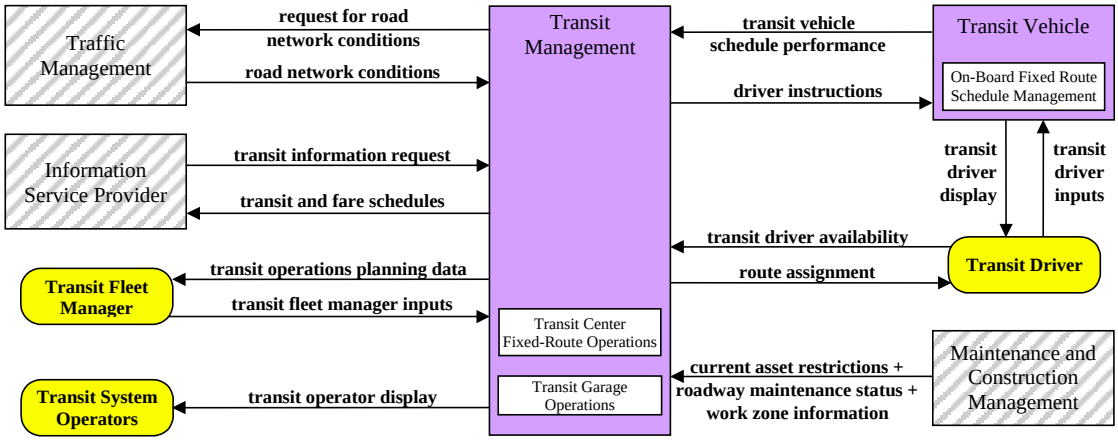

Figure A-16. APTS2 Transit Fixed Route Operations

APTS3 – Demand Response Transit Operations

This market package performs vehicle routing and scheduling as well as automatic driver assignment and monitoring for demand responsive transit services. This package monitors the 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. This service includes the capability for a traveler request for personalized transit services to be made through the Information Service Provider (ISP) Subsystem. The ISP may 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 makes a reservation for the traveler.

Primary User Service(s) Implemented:

- 2.1 – Public Transportation Management
- 2.3 – Personalized Public Transit
- 1.4 – Ride Matching & Reservation

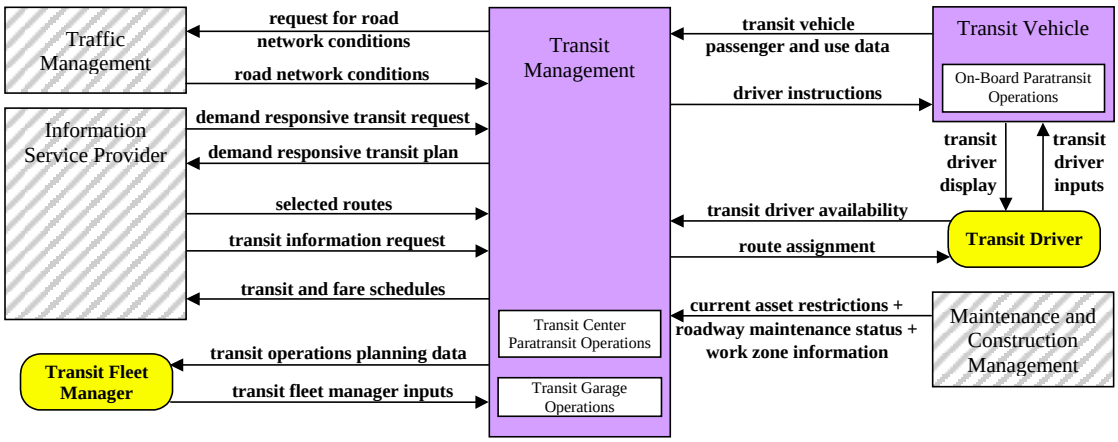

Figure A-17. APTS3 Demand Response Transit Operations

APTS4 – Transit Passenger and Fare Management

This market package manages passenger loading and fare payments on-board vehicles using electronic means. It allows transit users to use a traveler card or other electronic payment device. Sensors mounted on the vehicle permit the driver and central operations to determine vehicle loads, and readers located either in the infrastructure or on-board the transit vehicles allow electronic fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem. This is expected to occur on the IVOMS bus.

Primary User Service(s) Implemented:

- 2.1 – Public Transportation Management
- 2.2 – Provide Enroute Transit Information
- 3.1 – Electronic Payment Services

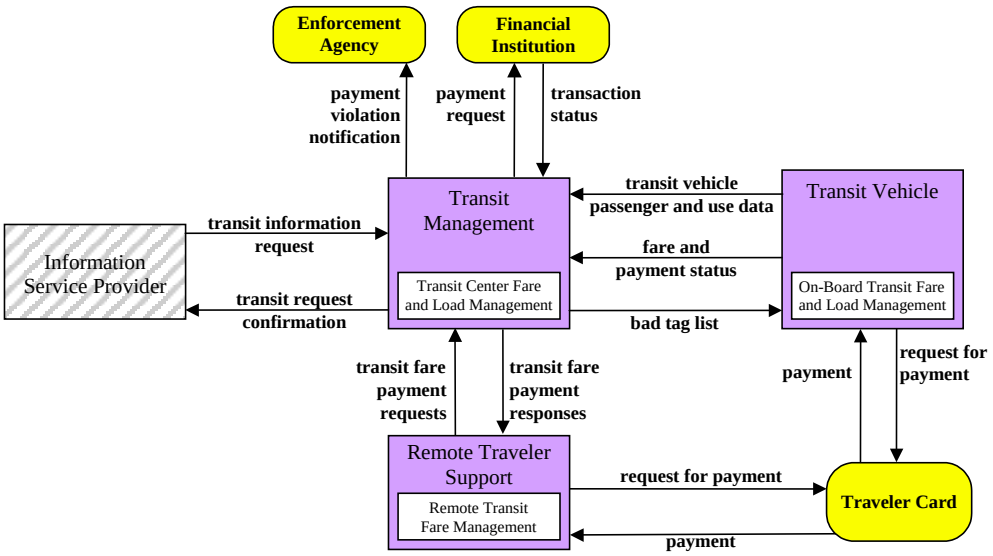

Figure A-18. APTS4 Transit Passenger and Fare Management

APTS5 – Transit Security

This provides for the physical security of transit passengers via on-board security systems. Covered transit vehicles include all buses and the planned Light Rail.

It also includes the potential to monitor the "Park & Ride" and future "Transit Center" public areas.

Primary User Service(s) Implemented:

- 2.1 – Public Transportation Management
- 2.4 – Provide Travel Security

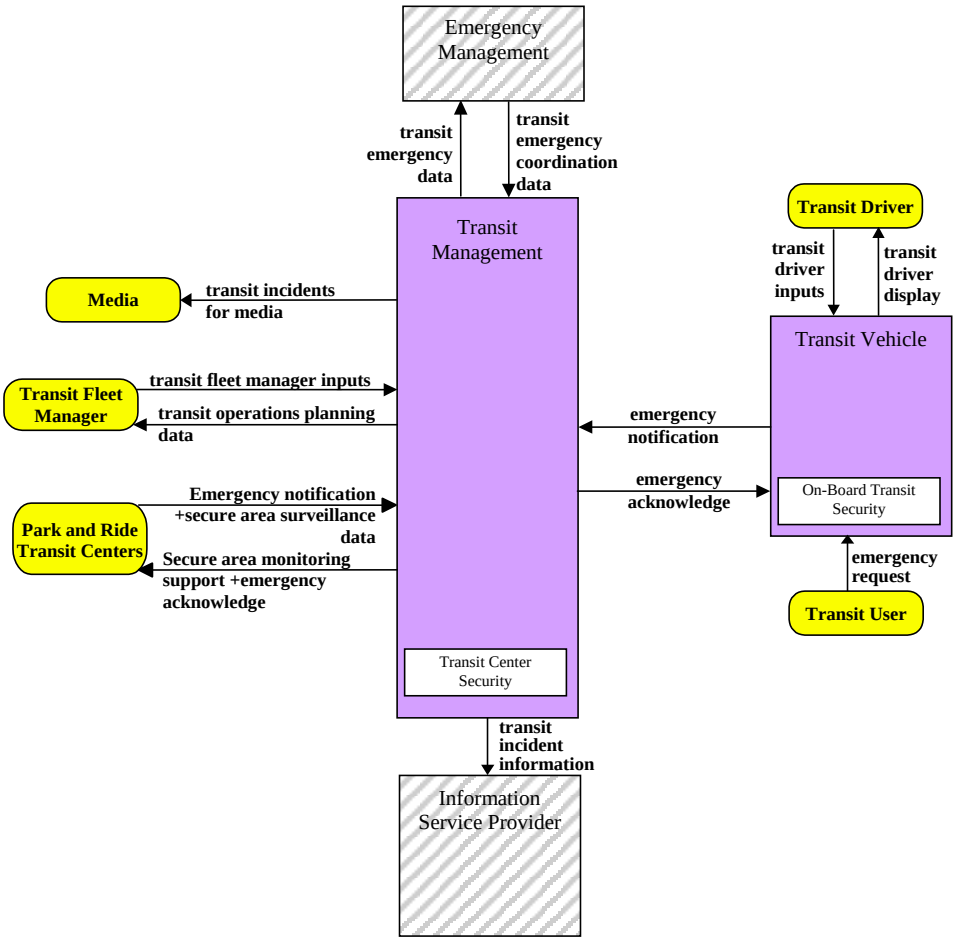

Figure A-19. APTS5 Transit Security

APTS6 – Transit Maintenance

This market package supports automatic transit maintenance scheduling and monitoring. On-board condition sensors monitor 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 preventative and corrective maintenance.

Primary User Service(s) Implemented:

- 2.1 – Public Transportation Management

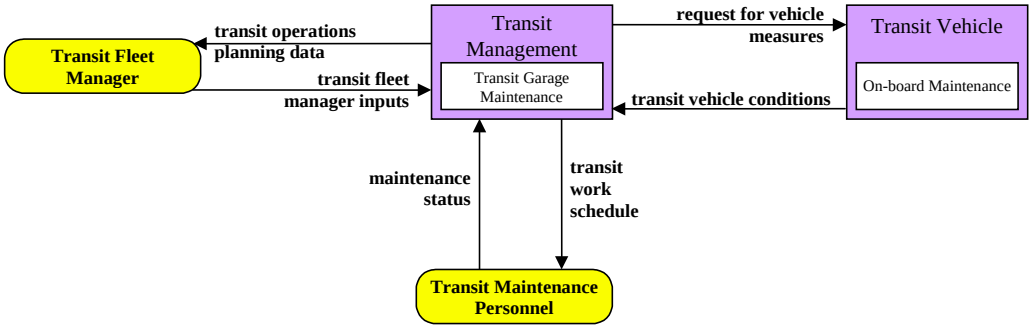

Figure A-20. APTS6 Transit Maintenance

APTS7 – Multi-Modal Coordination

The market package establishes two-way communications between multiple transit and traffic agencies to improve service coordination.

Local coordination between transit vehicles and signal priority at roadway intersections will be supported by enhanced Regional Computerized Traffic Signal Systems (RCTSS), so that signal priority may be given to buses that are behind schedule.

Parking Management functions are used for special events, such as the Houston Live Stock Show and Rodeo.

Primary User Service(s) Implemented:

- 2.1 – Public Transportation Management
- 1.6 – Traffic Control
- 1.8 – Travel Demand Management

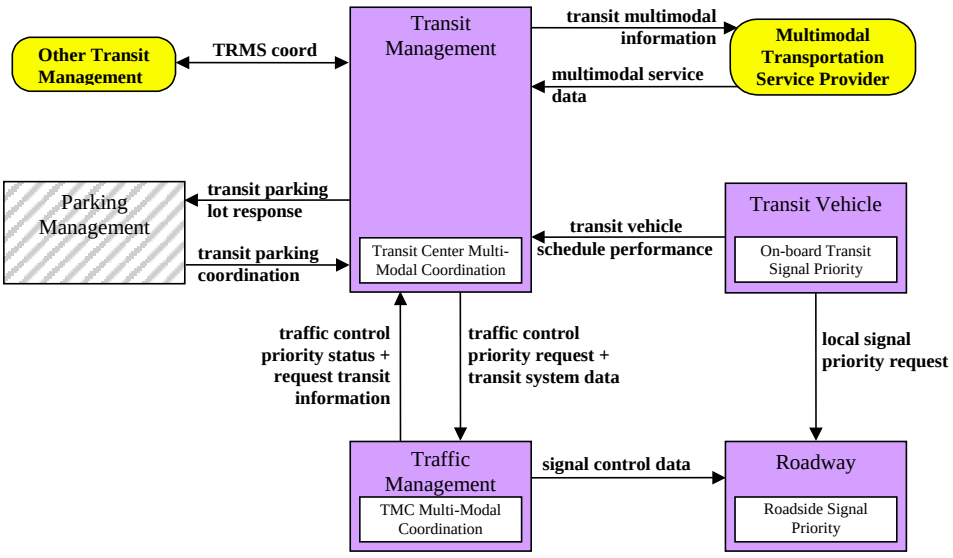

Figure A-21. APTS7 Multi-Modal Coordination

APTS8 – Transit Traveler Information

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.

Primary User Service(s) Implemented:

- 2.1 – Improve Public Transportation Management
- 2.2 – Enroute Transit Information

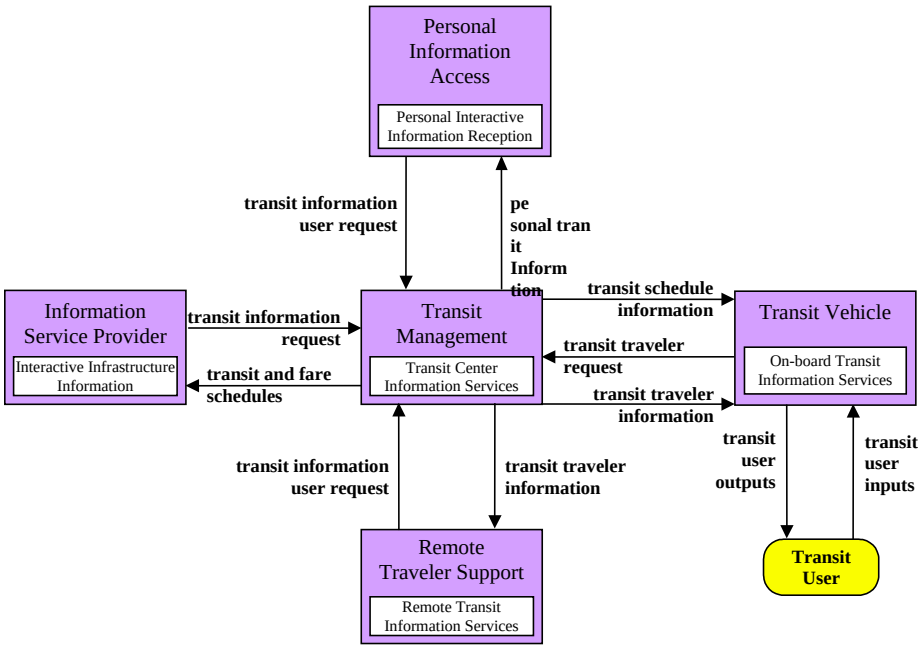

Figure A-22. APTS8 Transit Traveler Information

ATIS1 – Broadcast Traveler Information

This market package provides the user with a basic set of Advanced Traveler Information Systems (ATIS) services. This refers to more advanced digital information than market package "ATMS6 – Traffic Information Dissemination," which covers DMS signs and future Highway Advisory Radio.

Primary User Service(s) Implemented:

- 1.1 – Pre-Trip Travel Information
- 1.2 – Enroute Driver Information
- 1.3 – Route Guidance
- 1.5 – Traveler Services Information

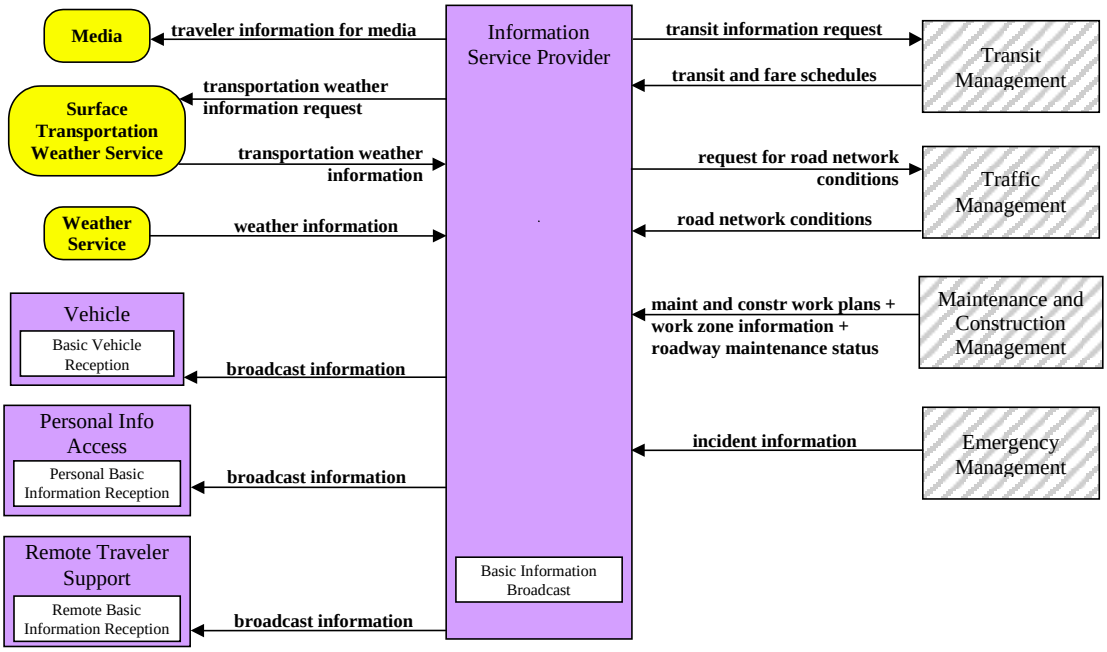

Figure A-23. ATIS1 Broadcast Traveler Information

ATIS2 – Interactive Traveler Information

This market package tailors information in response to a traveler request. TxDOT makes current highway speed information available via Houston TranStar's Internet web site. METRO's Rideshare Matching program is also a form of interactive traveler information.

In addition, the OEMs from other counties in the region also provide information to the TranStar IS.

Primary User Service(s) Implemented:

- 1.1 – Pre-Trip Travel Information
- 1.2 – Enroute Driver Information
- 1.3 – Route Guidance
- 1.4 – Provide Ride Matching and Reservation
- 1.5 – Traveler Services Information
- 2.3 – Provide Personalized Public Transit

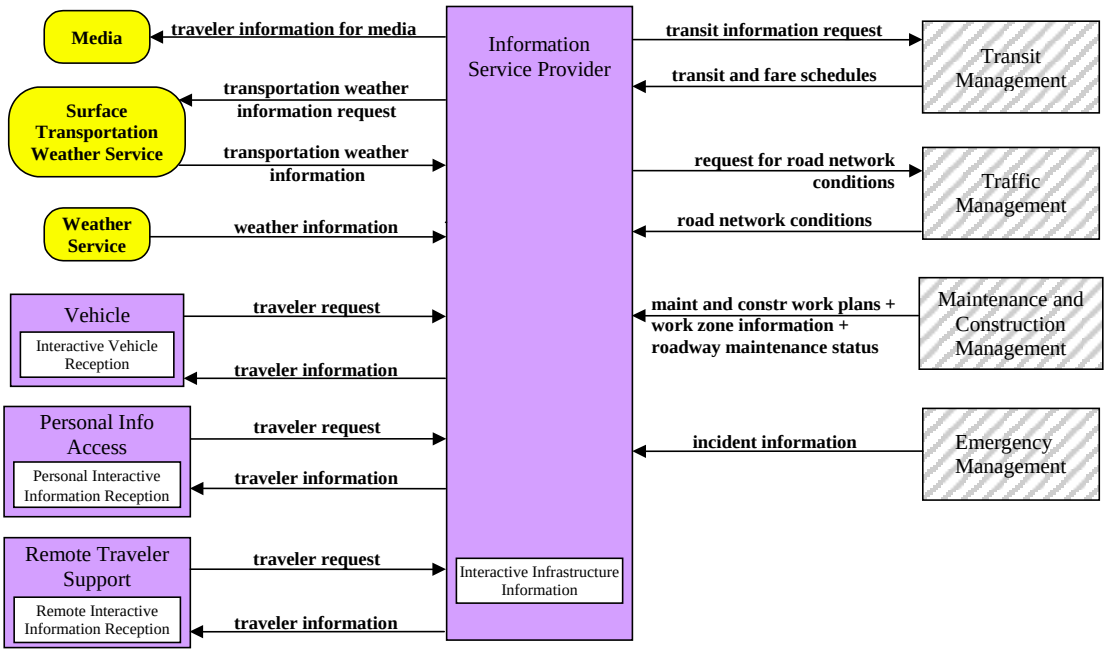

Figure A-24. ATIS2 Interactive Traveler Information

ATIS5 – ISP Based Route Guidance

This market package offers the user pre-trip route planning and turn-by-turn route guidance services. Routes may be based on static information or reflect conditions. 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.

Primary User service(s) Implemented:

- 1.1 – Provide Pre-trip Travel Information
- 1.2 – Support Enroute Driver Information
- 1.3 – Support Route Guidance
- 3.1 – Electronic Payment Services

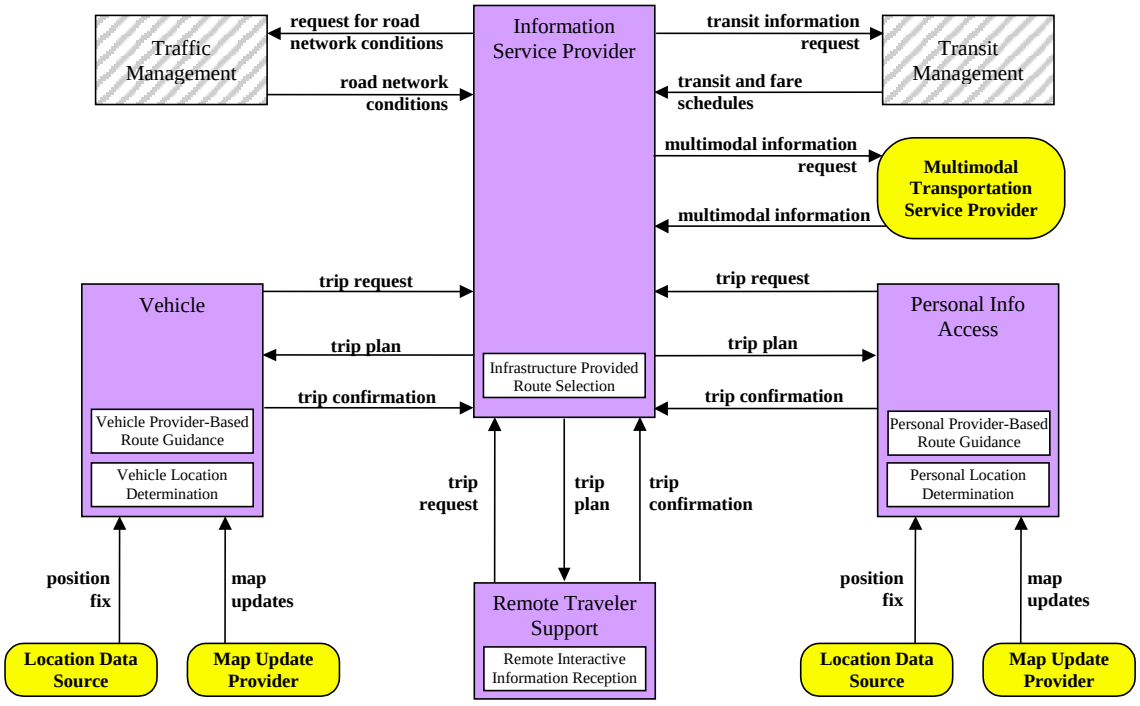

Figure A-25. ATIS5 ISP Based Route Guidance

ATIS7 – Yellow Pages and Reservation

This market package provides yellow pages and reservation services to the user. These additional traveler services may be provided using the same equipment used for interactive traveler information. This market package provides multiple ways for accessing information either while enroute in a vehicle using wide area wireless communications or pre-trip via wireline connections.

Primary user service(s) Implemented:

- 1.1 – Provide Pre-trip Traveler Information
- 1.2 – Support Enroute Driver Information
- 1.5 – Provide Traveler Services Information
- 2.2 – Provide Enroute Transit Information
- 3.1 – Electronic Payment Services

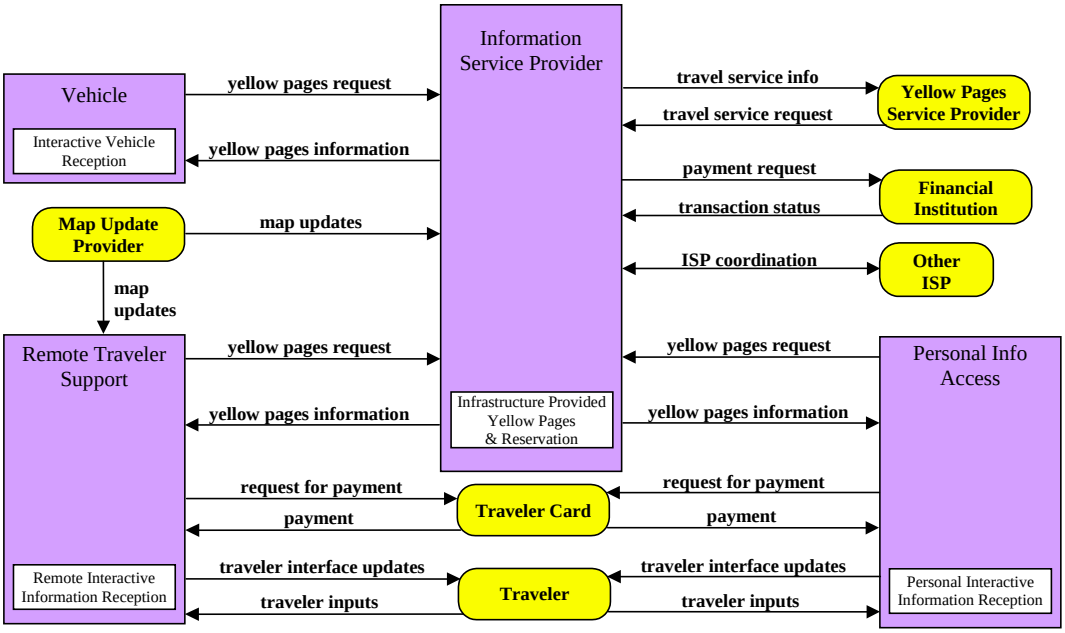

Figure A-26. ATIS7 Yellow Pages and Reservation

ATIS8 – Dynamic Ridesharing

This market package provides dynamic ridesharing/ride matching services to travelers. This service could allow near real time ridesharing reservations to be made through the same basic user equipment used for Interactive Traveler Information. This ridesharing/ride matching capability also includes arranging connections to transit or other multimodal services. METROLIFT service, a personalized transit service for persons with disabilities uses this market package.

Primary User Service(s) Implemented:

- 1.3 – Support Route Guidance
- 1.4 – Ride Matching and Reservation
- 2.2 – Provide Enroute Transit Information
- 2.3 – Personalized Public Transit
- 3.1 – Electronic Payment Services

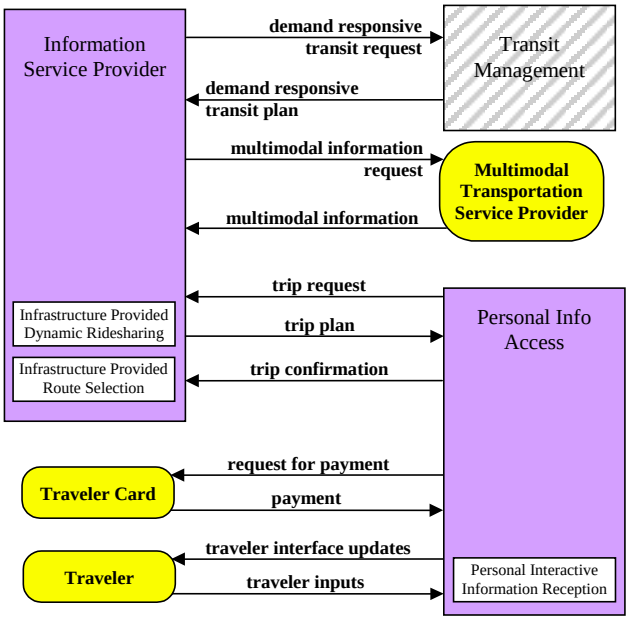

Figure A-27. ATIS8 Dynamic Ride Sharing

AVSS1 – Vehicle Safety Monitoring

The Regional ITS Strategic Plan for the Houston region includes support for an "Automated Bus" program for METRO buses, which has already demonstrated impressive technology. Although not expected to be in actual deployment for some time, this market package accommodates the plans to diagnose critical components of the vehicle and warn the driver of potential dangers, such as straying out of the traffic lane.

Primary User Service(s) Implemented:

- 2.4 – Public Travel Safety
- 6.7 – Automated Vehicle Operation

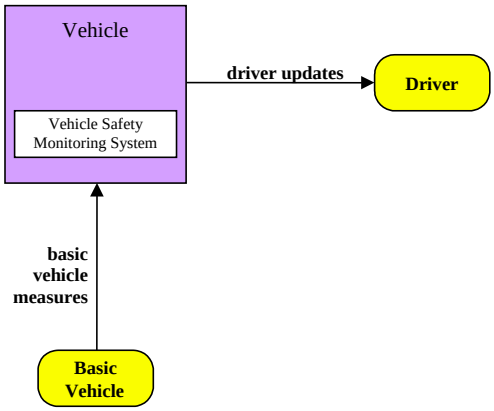

Figure A-28. AVSS1 Vehicle Safety Monitoring

AVSS4 – Lateral Safety Warning

The general architecture for sounding a warning when straying out of the traffic lane is in this market package.

Although not expected to be deployed for some time, this market package architects interoperability with future potential deployment of an “Automated Bus” program, which has already demonstrated impressive technology.

Primary User Service(s) Implemented:

- 2.4 – Public Travel Safety
- 6.2 – Lateral Collision Avoidance

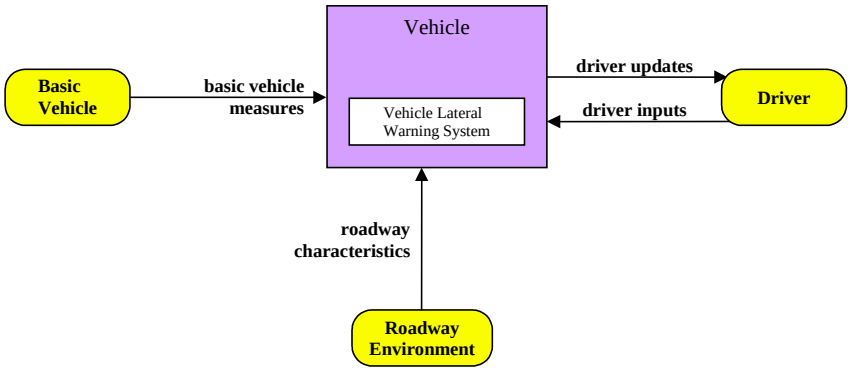

Figure A-29. AVSS4 Lateral Safety Warning

AVSS8 – Advanced Vehicle Longitudinal Control

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.

Although not expected to be deployed for several years, this market package architects interoperability with future potential deployment of an "Automated Bus" program, which has already demonstrated impressive technology.

Primary User Service(s) Implemented:

- 2.4 – Public Travel Safety
- 6.1 – Longitudinal Collision Avoidance
- 6.7 – Automated Vehicle Operation

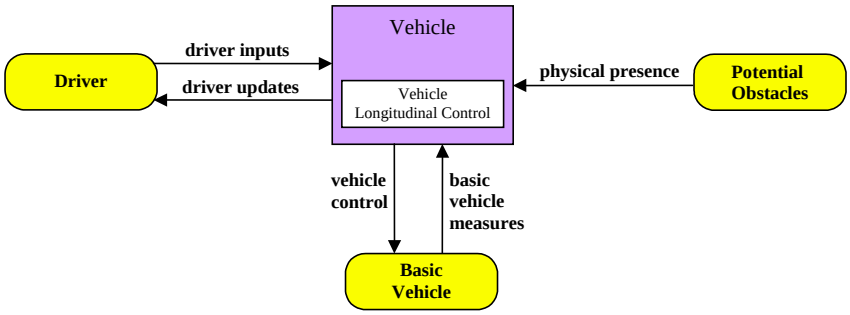

Figure A-30. AVSS8 Advanced Vehicle Longitudinal Control

AVSS9 – Advanced Vehicle Lateral Control

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.

Although not expected to be deployed for several years, this market package architects interoperability with future potential deployment of an "Automated Bus" program, which has already demonstrated impressive technology.

Primary User Service(s) Implemented:

- 2.4 – Public Travel Safety
- 6.2 – Lateral Collision Avoidance
- 6.7 – Automated Vehicle Operation

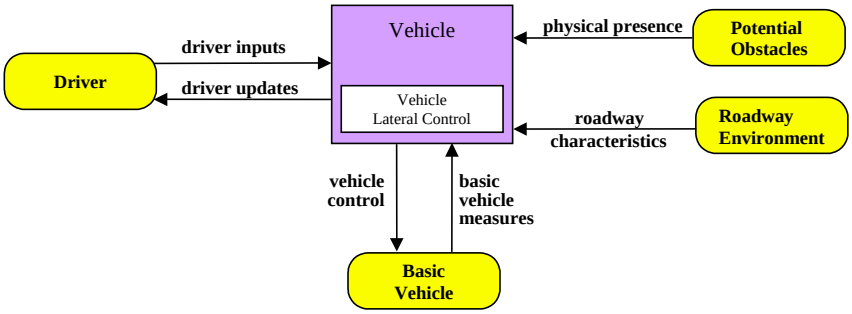

Figure A-31. AVSS9 Advanced Vehicle Lateral Control

CVO03 – Electronic Clearance

This market package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This allows a good driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated short-range communications to the roadside. Results of roadside clearance activities will be passed on to the Commercial Vehicle Administration. The roadside check facility may be equipped with Automated Vehicle Identification (AVI), weighing sensors, transponder read/write devices and computer workstations.
TxDOT is currently developing a CVO Architecture for the entire state as a part of the CVISN project and it is expected that this market package will be updated based on inputs from the state CVO architecture.

Primary User Service(s) Implemented:

- 3.1 – Electronic Payment Services
- 4.1 – Support Commercial Vehicle Electronic Clearance

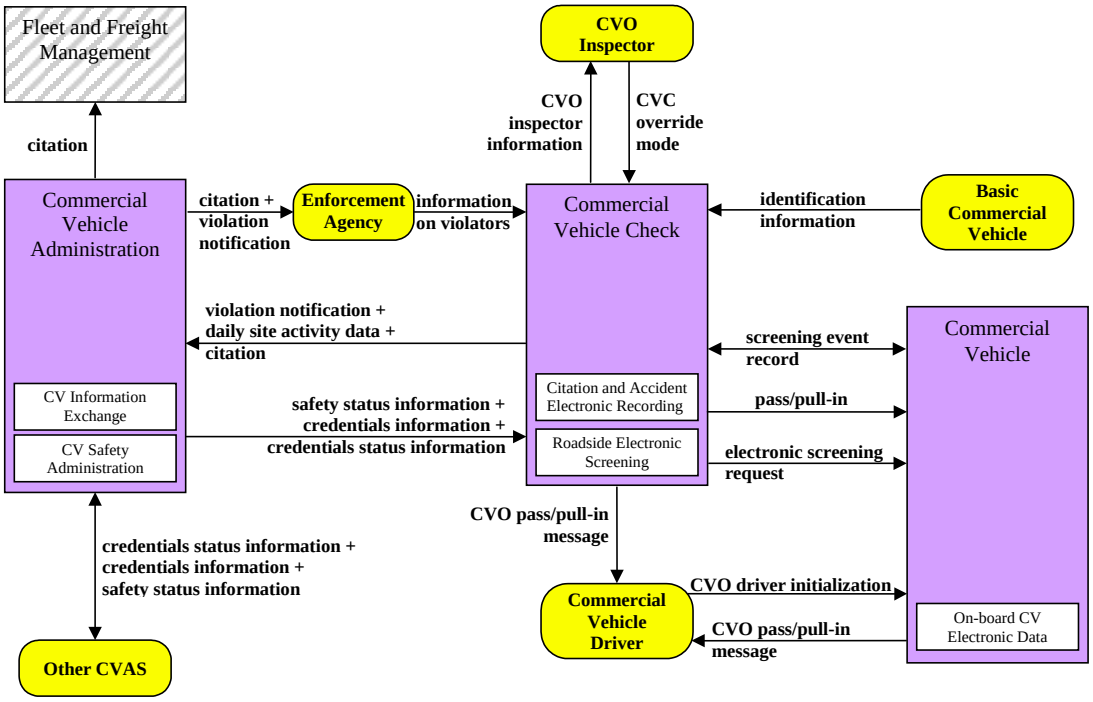

Figure A-32. CVO03 Commercial Vehicle Electronic Clearance

CVO06 – Weigh-In-Motion

This market package provides for high speed weigh-in-motion with or without Automated Vehicle Identification (AVI) capabilities. This market package provides the roadside equipment that could be used as a stand-alone system or to augment the Electronic Clearance (CVO03) market package.

TxDOT is currently developing a CVO Architecture for the entire state as a part of the CVISN project and it is expected that this market package will be updated based on inputs from the state CVO architecture.

Primary User Service(s) Implemented:

- 3.1 – Electronic Payment Services
- 4.1 – Support Commercial Vehicle Electronic Clearance

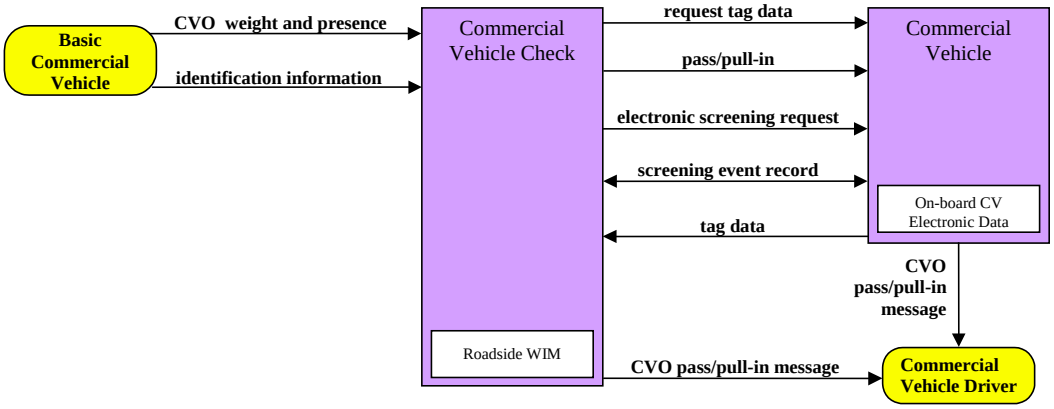

Figure A-33. CVO06 Weigh-In-Motion

CVO08 – On-board CVO Safety

This market package provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety (CVO08) Market Package and includes roadside support for reading on-board safety data via tags. Safety warnings are provided to the driver as a priority with secondary requirements to notify the Commercial Vehicle Check roadside elements. This market package allows for the Fleet and Freight Management subsystem to have access to the on-board safety data. This is a long-term market package.

TxDOT is currently developing a CVO Architecture for the entire state as a part of the CVISN project and it is expected that this market package will be updated based on inputs from the state CVO architecture.

Primary User Service(s) Implemented:

- 4.3 – Provide onboard safety monitoring

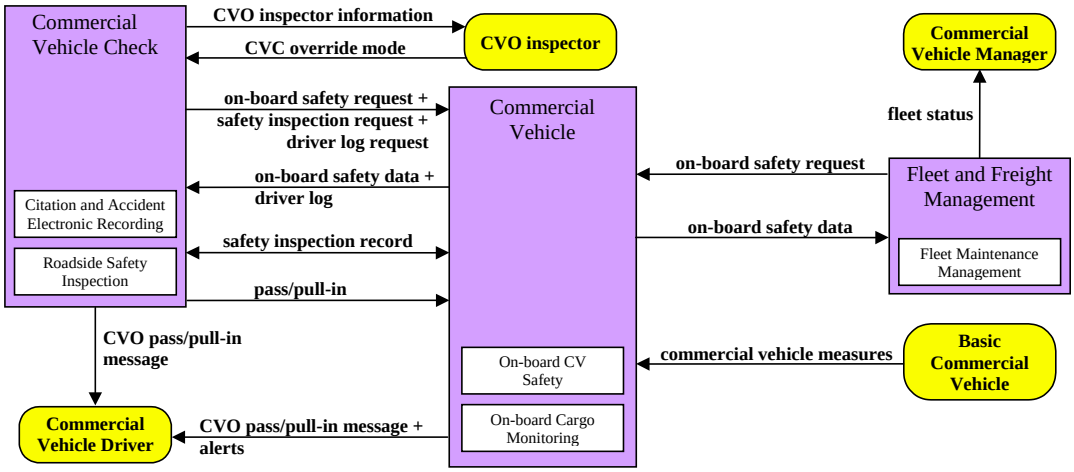

Figure A-34. CVO08 On Board Safety Monitoring

CVO10 – HAZMAT Management

In the event of a release of "hazardous materials," a "HAZMAT incident," local Fire Departments are called. On Freeways, TxDOT Safety is also called.

The City of Houston and Harris County Offices of Emergency Management at Houston TranStar are involved with sufficiently serious HAZMAT incidents, to coordinate the response and recovery with city departments, TxDOT, METRO, state and federal government, and other agencies. This is the kind of incident that might involve TranStar's planned Mobile Command Bus as well. The Regional cities and counties are also involved in HAZMAT management in the region.

The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response along with the incident management market package (ATMS 08). Refer the ATMS 08 market package for details on how the incident is handled in the region. 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. See also "Aux-mp5 – Use of Transit Vehicle as Shelter."

Primary User Service(s) Implemented:

- 1.6 – Conduct Incident Management
- 4.5 – Hazardous Material Incident Response
- 4.6 – Commercial Fleet Management

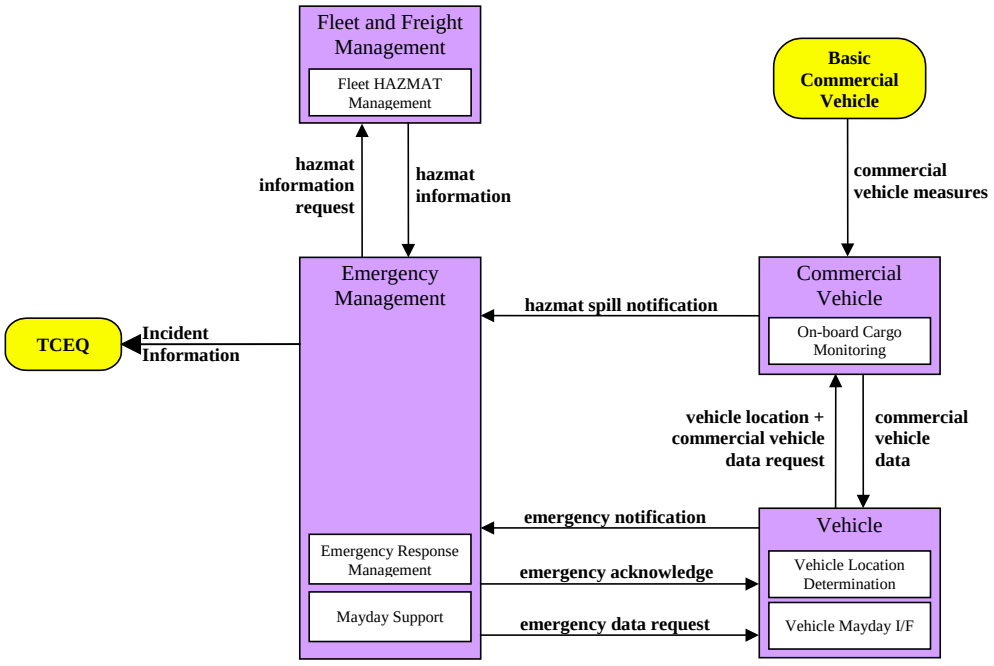

Figure A-35. CVO10 HAZMAT Management

EM1 – Emergency Response

Two Offices of Emergency Management are functions of Houston TranStar: The City of Houston Office of Emergency Management (OEM), and the Harris County OEM. Coordination between Emergency Management Subsystems supports emergency notification and coordinated response between agencies.

Water level and rainfall sensors deployed throughout the region provide data to the Harris County OEM, (see "ATMS18 – Road Weather Information System").

The market package for the other regional cities and counties is also shown.

Primary User Service(s) Implemented:

- 5.1 – Emergency Notification and Personal Security
- 5.2 – Improve Emergency Vehicle Management

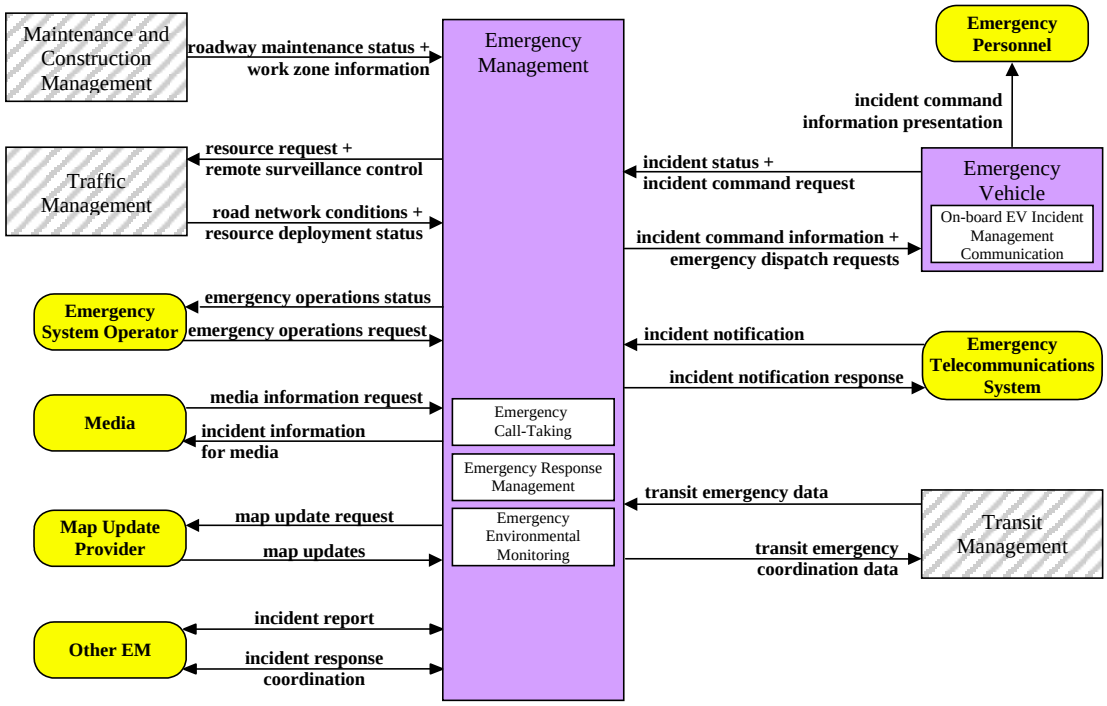

Figure A-36. EM1 Emergency Response

EM2 – Emergency Routing

Plans call for tracking some emergency vehicles to optimize deployment. In addition, dynamic routing of emergency vehicles and coordination with future RCTSS traffic signals will provide priority for emergency vehicles on their selected route.

Primary User Service(s) Implemented:

- 1.6 – Support Traffic Control
- 5.2 – Emergency Vehicle Management

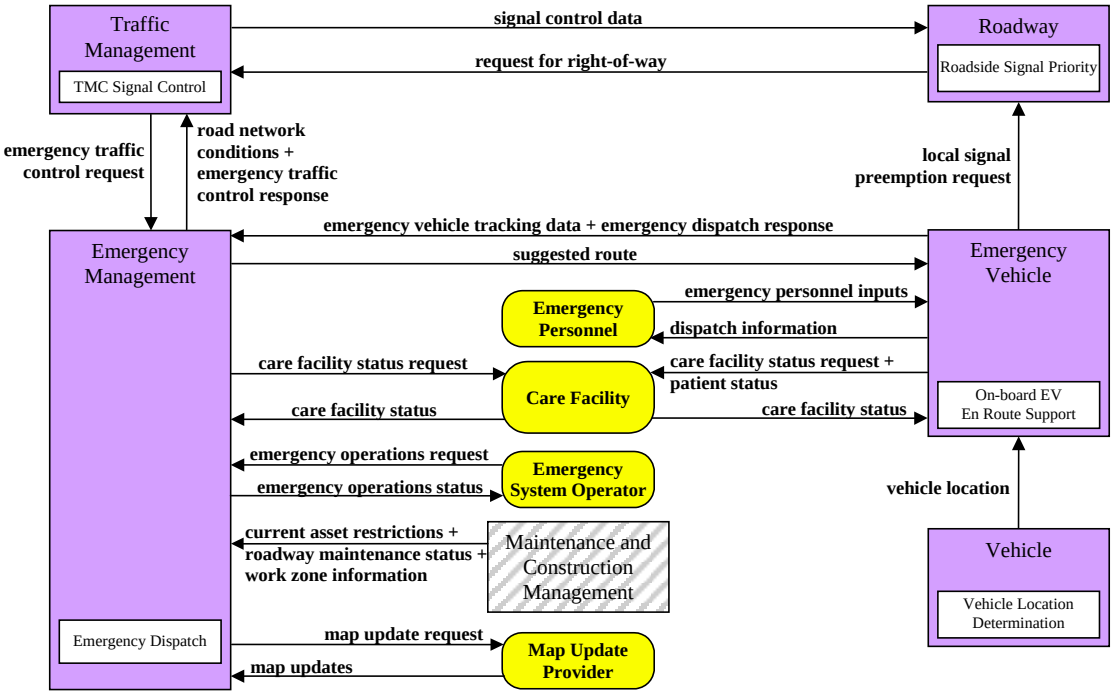

Figure A-37. EM2 Emergency Routing

AD1 – ITS Data Mart

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.

Primary User Service(s) Implemented:

- 7.1 – Archived Data Function

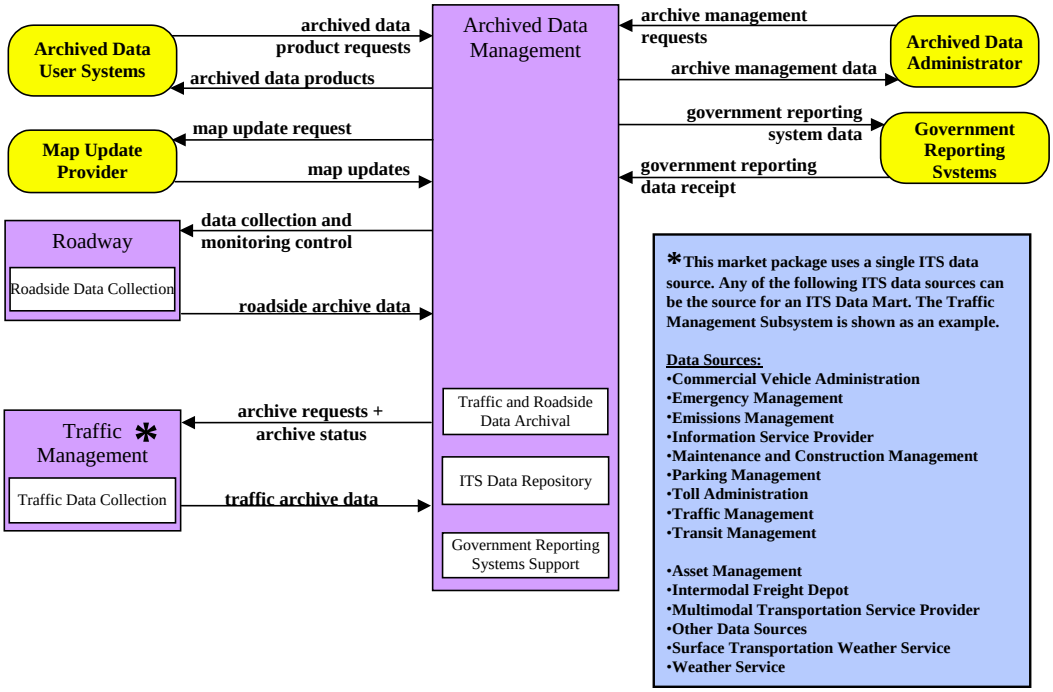

Figure A-38. AD1 ITS Data Mart

AD2 – ITS Data Warehouse

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.

The architecture flow "traffic archive data" includes road and weather conditions such as flooding or icing notices, incident information including snapshots from closed circuit television (CCTV) cameras, and occupancy metrics from various traffic detection devices. The flow "signal control status" includes both reports of errors and signal timing changes, as available. Both Dynamic Message Sign (DMS) message history and ramp signal controls are included in "freeway control data," and "work zone status" in this market package refers to construction and closure information.

Primary User Service(s) Implemented:

- 7.1 – Archived Data Function

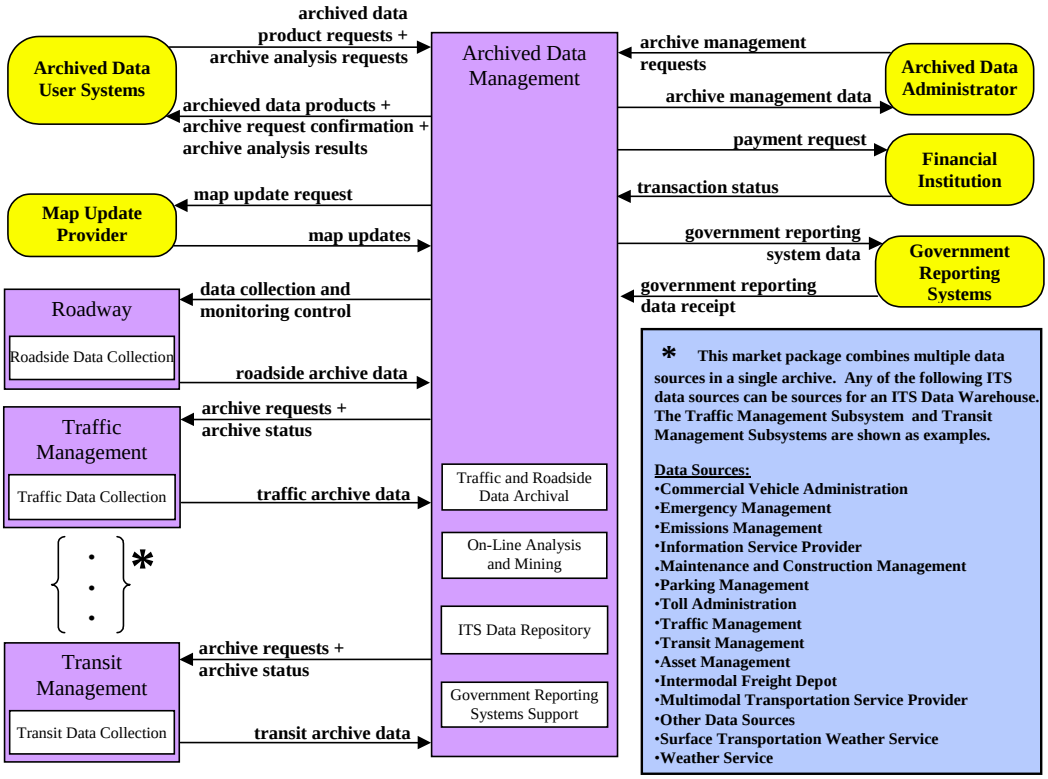

Figure A-39. AD2 ITS Data Warehouse

MC03 – Road Weather Data Collection

This market package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway (or guideway in the case of transit related rail systems). In addition to fixed sensor stations at the roadside, sensing of the roadway environment can also occur from sensor systems located on Maintenance and Construction Vehicles and on-board sensors provided by auto manufacturers. The collected environmental data is used by the Weather Information Processing and Distribution Market Package (MC04) to process the information and make decisions on operations.

Primary User Service(s) Implemented:

- 1.1 – Provide Pre-Trip Traveler information
- 1.2 – Support Enroute Driver information
- 1.6 – Traffic Control
- 1.7 – Incident Management
- 5.1 – Emergency Notification and Personal Security
- 8.1 – Maintenance and Construction Operation

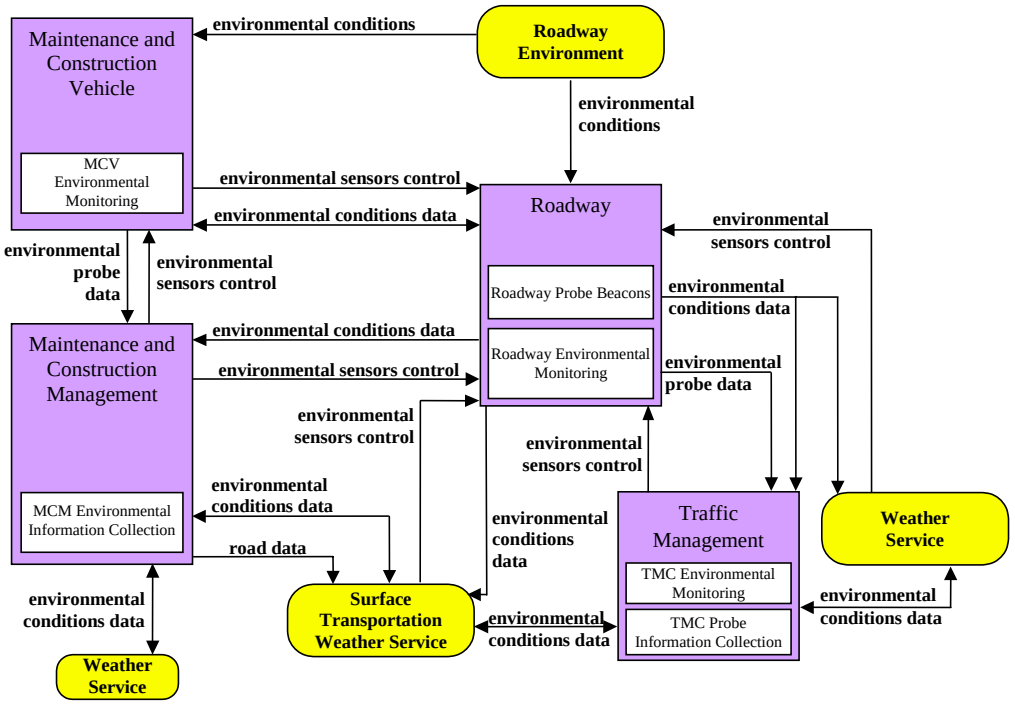

Figure A-40. MC03 Road Weather Data Collection

MC04 – Weather Information Processing and Distribution

This market package processes and distributes the environmental information collected from the Road Weather Data Collection market package. This market package uses the environmental data to detect environmental hazards such as icy road conditions, high winds, dense fog, etc. so system operators and decision support systems can make decision on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination market package, and aid operators in scheduling work activity.

Primary User Service(s) Implemented:

- 1.1 – Provide Pre-Trip Traveler information
- 1.2 – Support Enroute Driver information
- 1.6 – Traffic Control
- 1.7 – Incident Management
- 5.1 – Emergency Notification and Personal Security
- 8.1 – Maintenance and Construction Operation

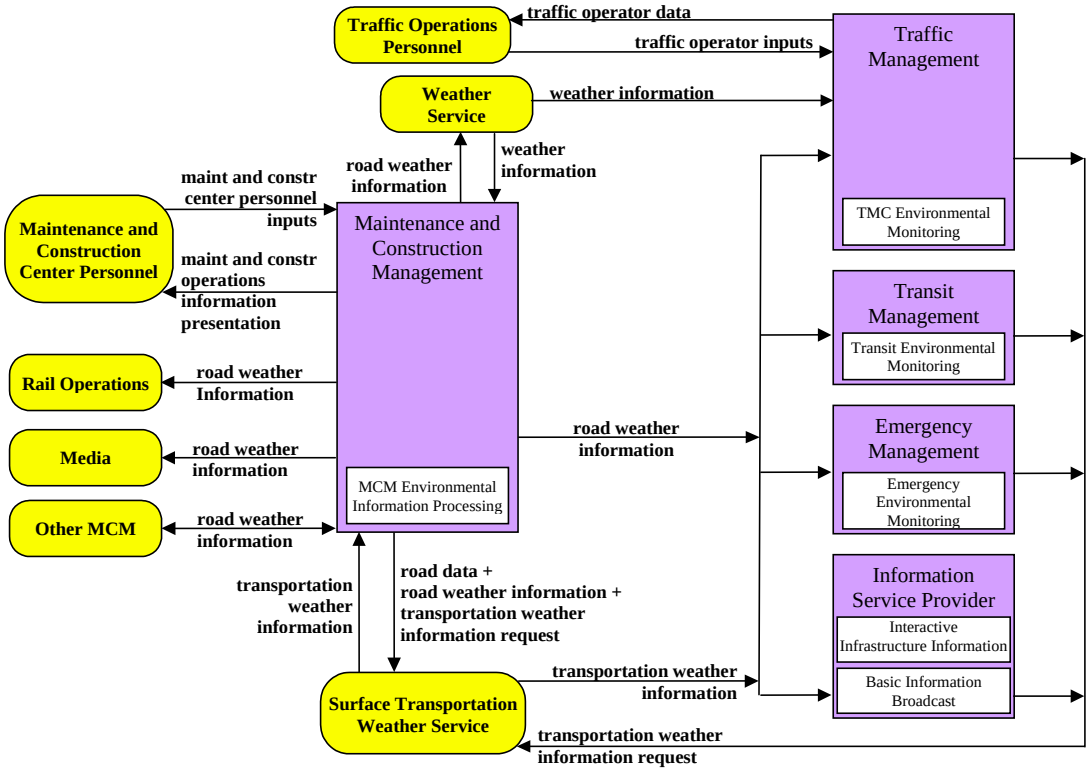

Figure A-41. MC04 Weather Information Processing and Distribution

MC07 – Roadway Maintenance and Construction

This market package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way. Maintenance services would include landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non-ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, CCTV, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling maintenance and construction activities.

Primary User Service(s) Implemented:

- 8.1 – Maintenance and Construction Operations

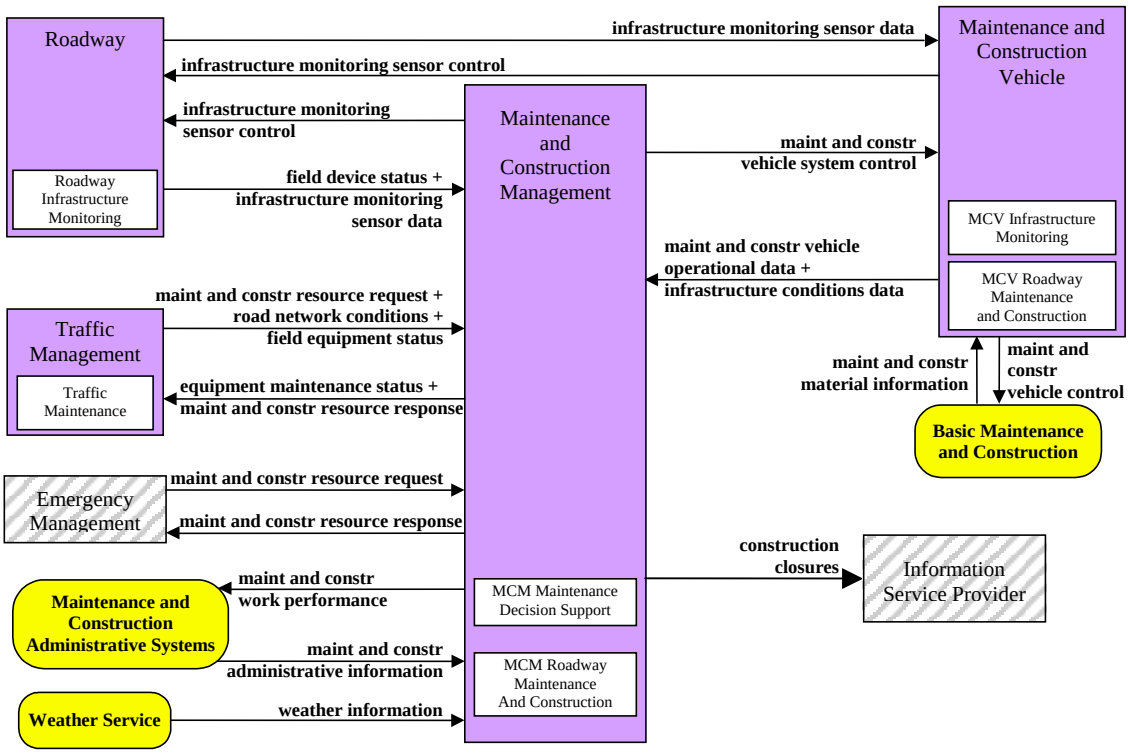

Figure A-42. MC07 Roadway Maintenance and Construction

MC08 – Work Zone Management

This market package directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds and delays are provided to the motorist prior to the work zones.

Primary User Service(s) Implemented:

- 8.1 – Maintenance and Construction Operations

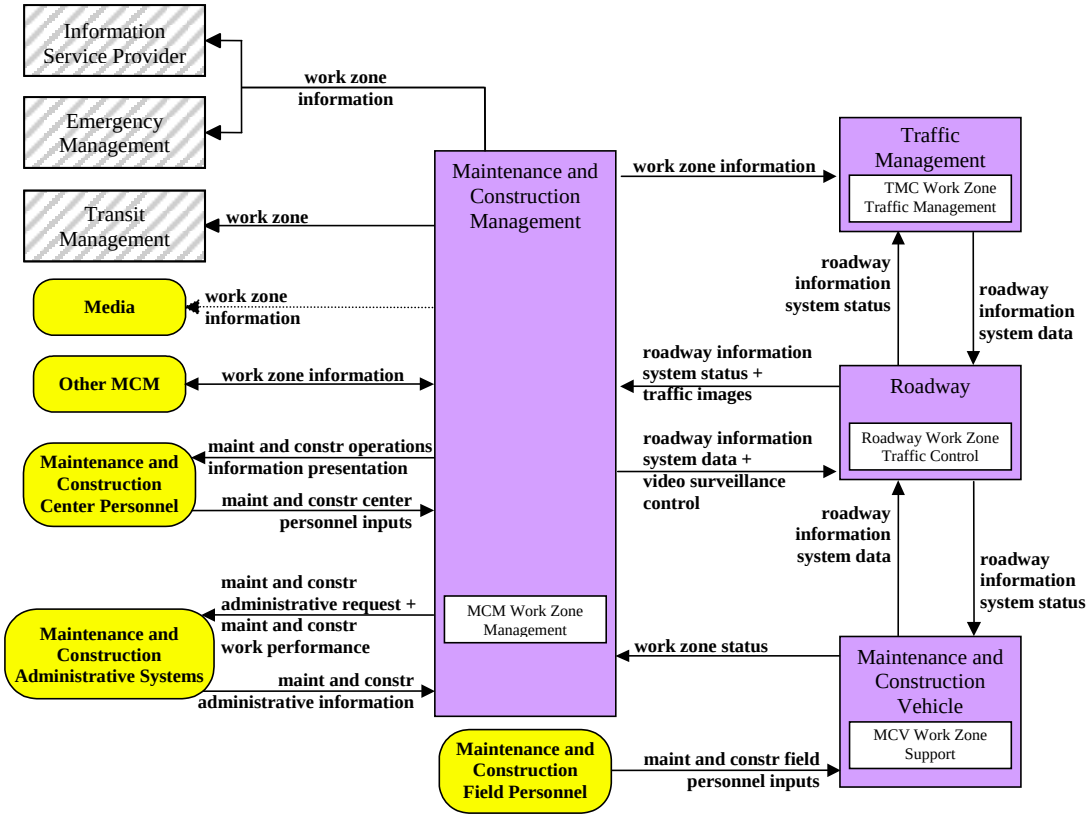

Figure A-43. MC08 Work Zone Management

MC09 – Work Zone Safety Monitoring

This market package includes systems that improve work crew safety and reduce collisions between the motoring public and maintenance and construction vehicles. This market package detects vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment or other potential safety hazards. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone. The market package supports both stationary and mobile work zones. The intrusion detection and alarm systems may be collocated or distributed, allowing systems that detect safety issues far upstream from a work zone (e.g., detection of over-dimension vehicles before they enter the work zone). This is a long-term market package.

Primary User Service(s) Implemented:

- 8.1 – Maintenance and Construction Operations

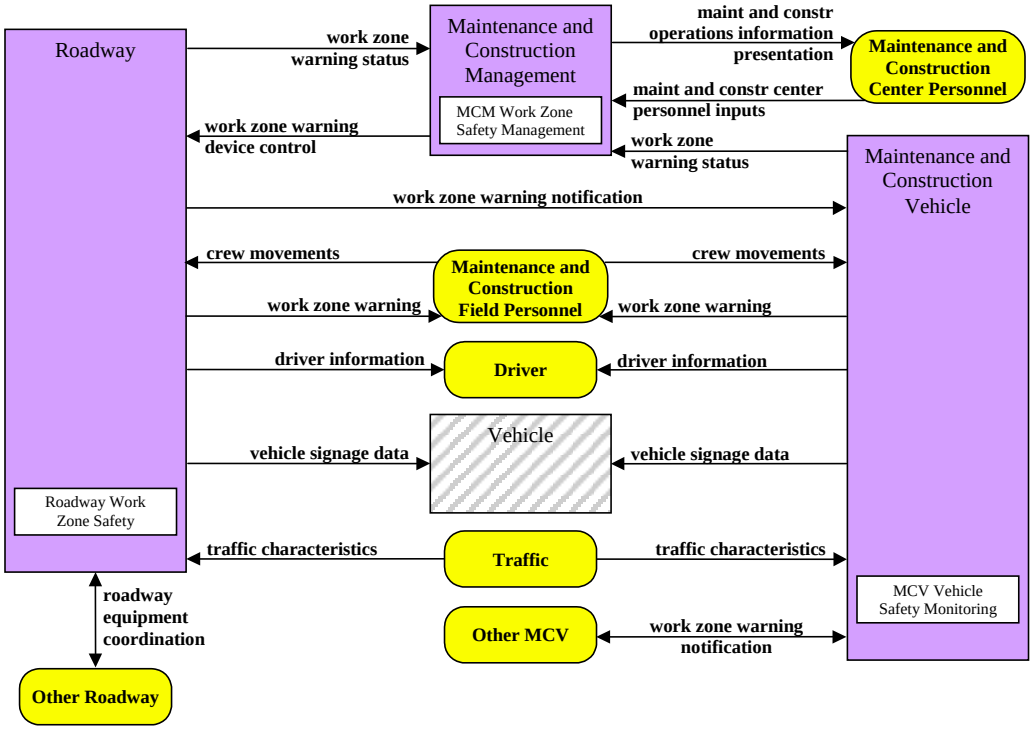

Figure A-44. MC09 Work Zone Safety Monitoring

MC10 – Maintenance and Construction Activity Coordination

This market package supports the dissemination of maintenance and construction activity to centers which can utilize it as part of their operations, or to the Information Service Providers who can provide the information to travelers.

Primary User Service(s) Implemented:

- 8.1 – Maintenance and Construction Operations

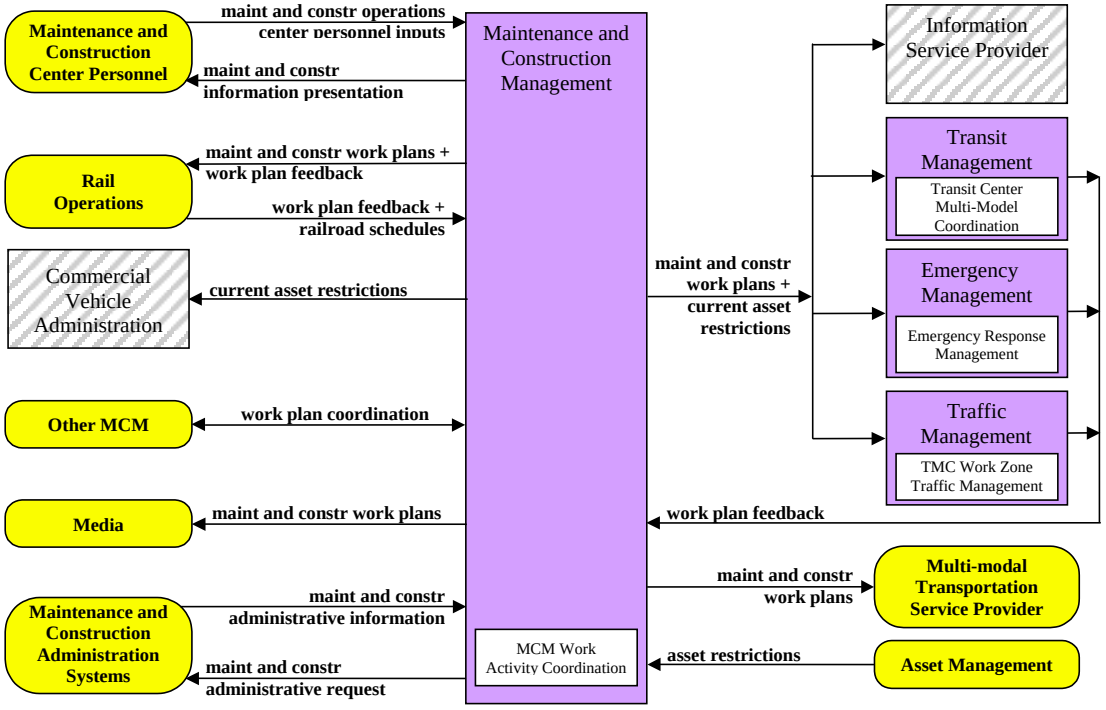

Figure A-45. MC10 Maintenance and Construction Activity Coordination

Aux-mp1 – Evacuation Transportation

When Emergency Management needs to evacuate the public from a hazardous area, ITS services are an important tool. Coordination with Transit Services and Traffic Management functions are essential to an effective and prompt evacuation.

Effective management of Transit Services and reversible HOV lanes can increase the throughput of the transportation infrastructure during the time of crisis. Transit Services deployed may include the Park & Ride areas for gathering people to be evacuated.

Information dissemination is a critical component of evacuation and is covered by "Aux-mp3 – Evacuation Information Dissemination." See also "Aux-mp2 – Evacuation Monitoring."

Regional cities and Counties in the region are expected to coordinate with TranStar to achieve efficient evacuation methods.

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 5.1 – Emergency Notification and Personal Security

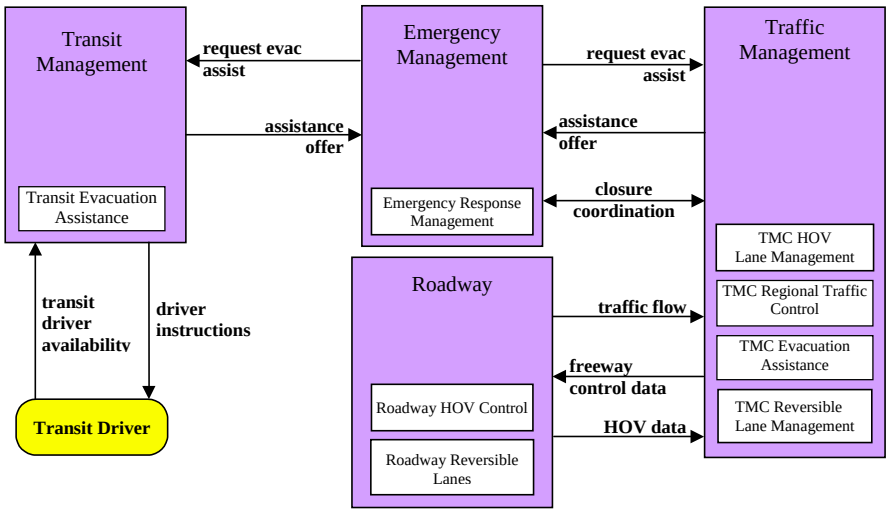

Figure A-46. Aux-mp1 Evacuation Transportation

Aux-mp2 – Evacuation Monitoring

When an evacuation is in progress, such as from a hurricane threatened area, the monitoring of traffic flow is critical for the coordination of law enforcement agencies. Measures of the evacuation progress determine whether the public evacuation notices are being sufficiently effective.

In cases of emergency evacuation, TxDOT's freeway surveillance can be used to provide evacuation status information for effective evacuation management. News services, represented by the "Media" terminator, may also provide important information.

Since evacuation may be due to bad weather, road conditions may be an important aspect of the evacuation.

Means for effective evacuation notices are the subject of another market package, "Aux-mp3 – Evacuation Information Dissemination." See also "Aux-mp1 – Evacuation Transportation."

Primary User Service(s) Implemented:

- 5.1 – Emergency Notification and Personal Security

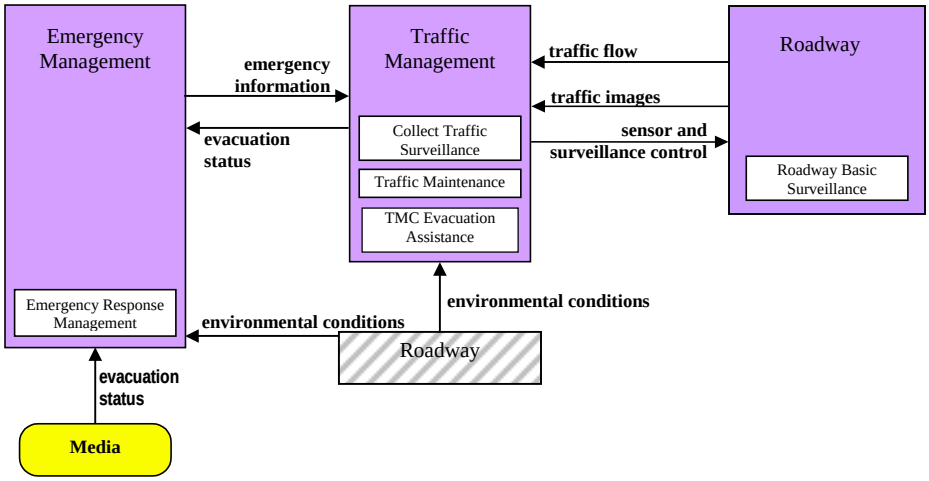

Figure A-47. Aux-mp2 Evacuation Monitoring

Aux-mp3 – Evacuation Information Dissemination

Effective evacuation relies on quickly alerting the public within the affected area. Emergency Management provides evacuation notices and other information to the public via the local news media. Information required for evacuation includes evacuation routes, availability of shelters, and availability of essential services.

TranStar's Dynamic Message Signs can be used to provide emergency information to the public. DMS, and in the future HAR, can provide route guidance and up to date information on shelter availability. TranStar's web site can also be used to provide evacuation information to the public.

See also "Aux-mp1 – Evacuation Transportation," and "Aux-mp2 – Evacuation Monitoring."

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 5.1 – Emergency Notification and Personal Security

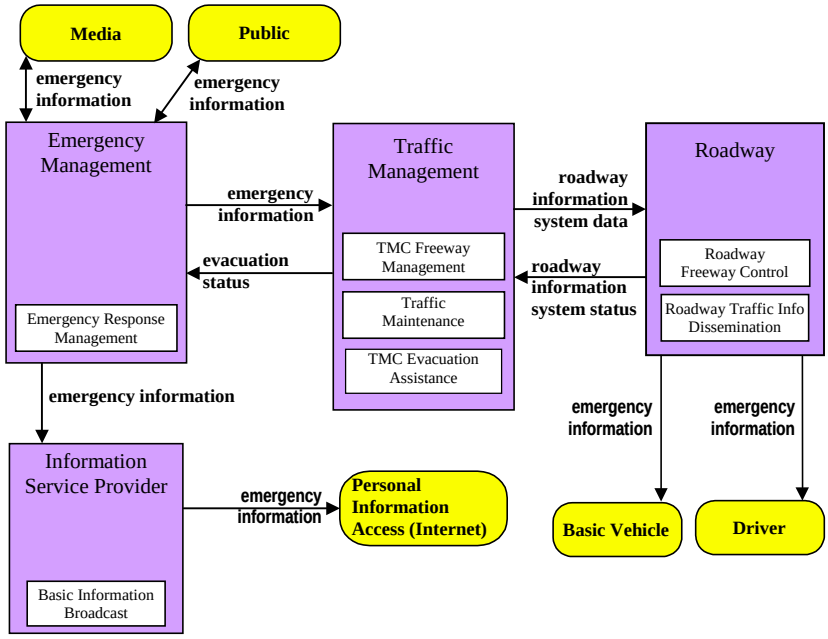

Figure A-48. Aux-mp3 Evacuation Information Dissemination

Aux-mp4 – Flood Level Reporting

This market package enhances "ATMS18 – Road Weather Information System," to also address reporting of flood levels in various ways, including providing information to the National Weather Service.

Flood reporting includes the use of roadside ITS equipment, such as traffic control signals and the locally controlled High Water Level Warning Signals. TxDOT's DMS signs and Highway Advisory Radio can alert drivers to high water conditions and offer alternate routes.

Due to flood prone roads required for ambulance access to the Texas Medical Center, some road closures are coordinated with them through the City of Houston Office of Emergency Management. Such road closures also involve the Construction and Maintenance teams, but these communications are covered in ATMS18.

See "ATMS18 – Road Weather Information System" for details of the roadway equipment involved in monitoring roadway environmental conditions.

Primary User Service(s) Implemented:

- 1.6 – Traffic Control
- 5.1 – Emergency Notification and Personal Security
- 5.2 – Emergency Vehicle Management

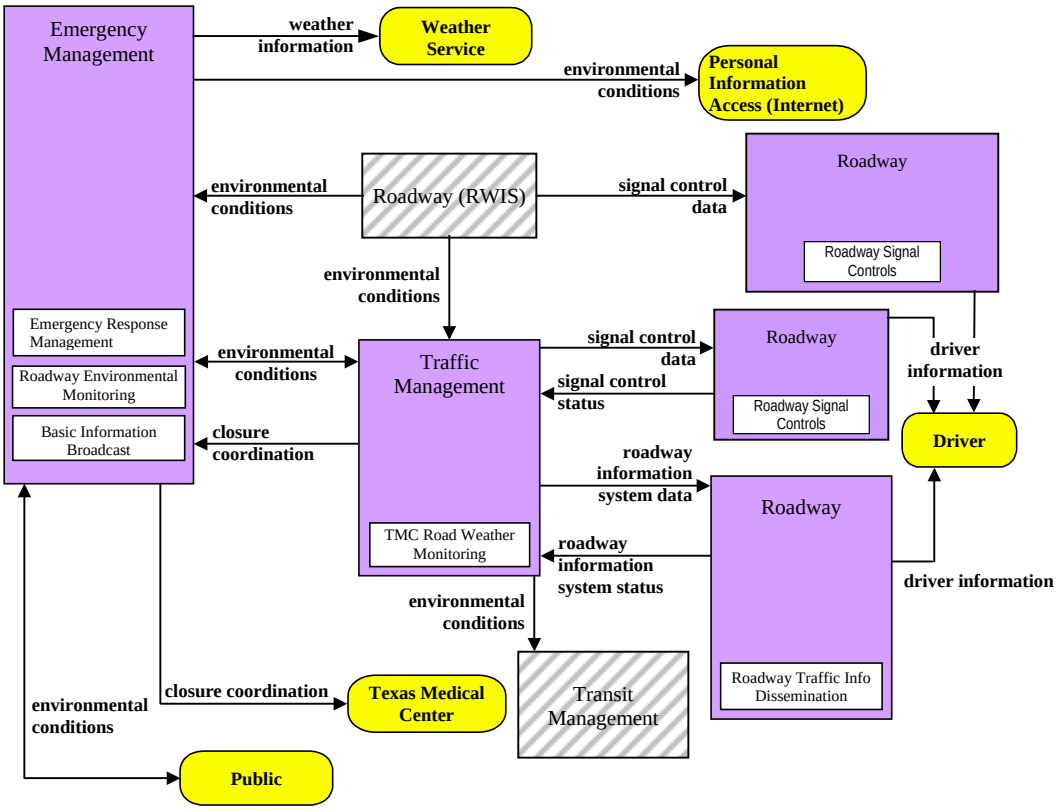

Figure A-49. Aux-mp4 Flood Level Reporting

Aux-mp5 – Use of Transit Vehicle as Shelter

In addition to the dangers involved in fire and HAZMAT incidents, emergency personnel on the scene are subject to extremely uncomfortable working conditions. The environment suits they wear often become hot and humid, contributing to fatigue.

One of METRO's buses can be brought to such a scene and provide an air-conditioned shelter for these personnel to temporarily remove the environment suits, cool down, and rest. The plans for TranStar's Mobile Command Bus will make it the vehicle of choice for this role.

Primary User Service(s) Implemented:

- 5.1 – Emergency Notification and Personal Security
- 5.2 – Emergency Vehicle Management

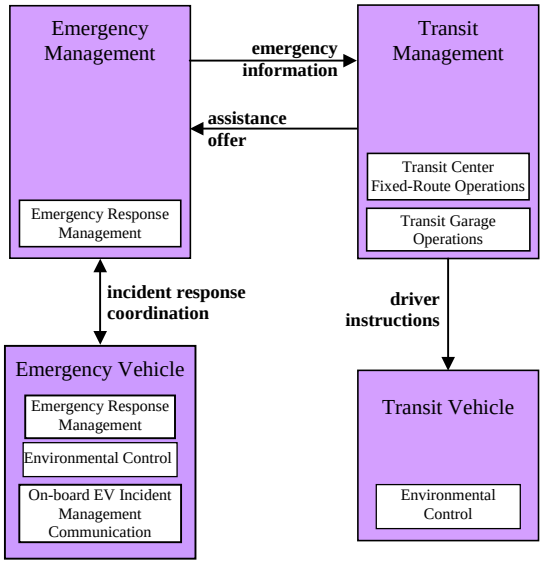

Figure A-50. Aux-mp5 Use of Transit Vehicle as Shelter

Aux-mp6 – Truck Rollover Warning System

Truck rollovers will tend to happen repeatedly at the same locations.

The plans for the Truck Rollover Warning System include providing a visible warning to the driver of large trucks as they approach certain curves at an unsafe speed. Roadside equipment detects the vehicle and activates the warning signal in response to the vehicle's size and speed characteristics.

Sufficient information may be provided to Houston TranStar to allow for notification to the appropriate law enforcement agency, and to determine if a truck rollover incident has occurred.

Other aspects of managing these incidents are covered by "ATMS8 – Incident Management System," and "CVO10 – HAZMAT Management."

Primary User Service(s) Implemented:

- 1.2 – Enroute Driver Information
- 5.1 – Emergency Notification and Personal Security

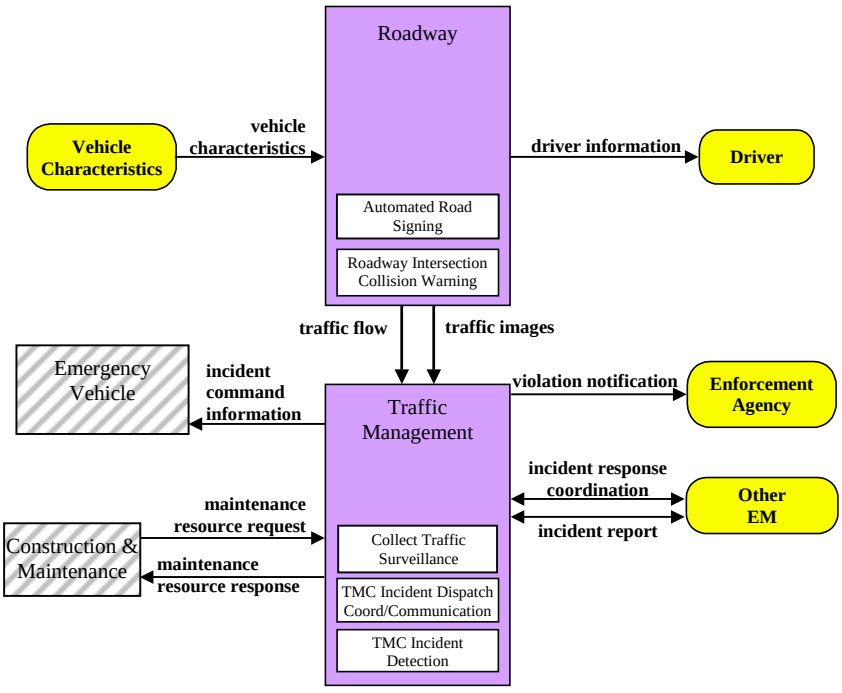

Figure A-51. Aux-mp6 Truck Rollover Warning System

APPENDIX B

Glossary of Terms

Architecture
A framework within which a system can be built. An architecture functionally defines what the pieces of the system are and the information that is exchanged between them. An architecture is not technology specific, which allows the architecture to remain effective over time. It defines "what must be done," not "how it will be done".

Architecture Flow
Information that is exchanged among Subsystems and between Subsystems and Terminators in the Physical Architecture view of the National ITS Architecture. Architecture Flows are the primary tool that is used to define the Regional ITS Architecture Interfaces. These Architecture Flows and their communication requirements define the Interfaces, which form the basis for much of the ongoing Standards work in the National ITS program. In this document, the terms "information flow" and "architecture flow" are used interchangeably.

Architecture Interconnect
Communications paths that carry information between Subsystems and Terminators in the Physical Architecture view of the National ITS Architecture. Several different types of Interconnects are defined in the National ITS Architecture to reflect the range of Interface requirements in ITS. Four different types of communications links are defined: Wireline, Wide Area Wireless, Dedicated Short Range Communications, and Vehicle to Vehicle communications. In addition to these types, several specialized Interconnects are also defined to reflect other Interface requirements, including human interface (e.g., what the system user sees and hears) and physical/environmental (e.g., what the ITS sensors sense).

Center Subsystems
Subsystems that provide management, administrative, and support functions for the transportation system. The Center Subsystems each communicate with other centers to enable coordination between modes and across jurisdictions. Some examples of center subsystems are Traffic Management, Transit Management, Commercial Vehicle Administration, Planning, Emissions Management, Toll Administration, Emergency Management, Information Service Provider, and Fleet and Freight Management.

Data Flow
Data Flows are modeled in the Logical Architecture view of the National ITS Architecture. Data Flows represent data flowing between Processes or between a Process and a terminator. A Data Flow is shown as an arrow on a Data Flow Diagram and is defined in a Data Dictionary Entry in the Logical Architecture. Data flows are aggregated together to form high-level Architecture Flows in the Physical Architecture view of the National ITS Architecture.

Dedicated Short Range Communications (DSRC)
A wireless communications channel used for close-proximity communications between vehicles and the immediate infrastructure. It supports location-specific communications for ITS services such as toll collection, transit vehicle management, driver information, and automated commercial vehicle operations. One of the four types of Architecture Interconnects defined in the National ITS Architecture.

Element
This is the basic building block of a Regional ITS Architecture. It is the name used by the Stakeholders to describe a system or piece of a system.

Equipment Package
Equipment Packages are the building blocks of the Physical Architecture Subsystems. Equipment Packages group like Processes of a particular Subsystem together into an "implementable" package. The grouping also takes into account the User Services and the need to accommodate various levels of functionality. Since Equipment Packages are both the most detailed elements of the Physical Architecture view of the National ITS Architecture and tied to specific Market Packages, they provide the common link between the interface-oriented Architecture definition and the deployment-oriented Market Packages.

Institutional Integration
Institutional Integration represents the process of combining existing and emerging institutional constraints and arrangements. Integration is at least two-fold in a region; technical integration involves the functional act of integration while institutional integration addresses the agency and/or regional environment for integration. Both are necessary components for interoperable systems.

Intelligent Transportation System (ITS)
Electronics, communications, and information processing that are integrated to improve the efficiency or safety of surface transportation.

ITS Architecture
Defines an Architecture of interrelated systems that work together to deliver transportation Services. An ITS Architecture defines how systems functionally operate and the interconnection of information exchanges that must take place between these systems to accomplish transportation Services.

ITS Project
Any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS User Services.

ITS Strategic Plan
A guide for long term implementation of ITS in the state, metropolitan area, or region. A Strategic Plan will normally include identifying regional transportation needs and then defining ITS Elements to be implemented over time, aimed at meeting those needs. A regional ITS architecture is typically a core component of an ITS Strategic Plan.

Interconnect
See Architecture Interconnect.

Interface
The connection between two systems. In the regional ITS architecture, an interface is described by the architecture interconnect – the line of communications between the two systems – and the information flows that define the types of information that will be shared over the interconnect.

Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA)
Legislative initiative by the United States Congress that restructured funding for transportation programs. ISTEA authorized increased levels of highway and transportation funding and an increased role for regional planning commissions/MPOs in funding decisions. The Act also requires comprehensive Regional and Statewide long-term

Transportation Plans and places an increased emphasis on public participation and transportation alternatives.

Inventory
See System Inventory.

Legacy System
Existing transportation systems, communications systems, or institutional processes.

Market Package
Market Packages identify the pieces of the Physical Architecture that are required to implement a particular transportation Service. They provide an accessible, service 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.

National ITS Architecture
A common, established framework for developing integrated transportation systems. The National ITS Architecture is comprised of the Logical Architecture and Physical Architecture, which satisfy a defined set of User Services. The National ITS Architecture is maintained by the United States Department of Transportation (USDOT).

Physical Architecture
The Physical Architecture is the part of the National ITS Architecture that provides agencies with a physical representation (though not a detailed design) of the important ITS Interfaces and major system components. The principal elements in the Physical Architecture are the Subsystems, Terminators and Architecture Flows that connect these Subsystems and Terminators into an overall framework. At the next level of detail, the Physical Architecture identifies Equipment Packages for each Subsystem and assigns Processes identified in the Logical Architecture to these Equipment Packages. Similarly, the Data Flows from the Logical Architecture are grouped together and assigned to Architecture Flows.

Region
The geographical area that identifies the boundaries of the Regional ITS Architecture and is defined by and based on the needs of the participating agencies and other Stakeholders. In metropolitan areas, a Region should be no less than the boundaries of the metropolitan planning area.

Regional ITS Architecture
A specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a particular Region. It functionally defines what pieces of the system are linked to others and what information is exchanged between them.

Roadside Subsystems
One of four general classes of Subsystems defined in the National ITS Architecture. This class includes the intelligent infrastructure distributed along the transportation network which perform surveillance, information provision, and control functions. This includes ITS field equipment on roadway facilities as well as ITS equipment at parking facilities, toll systems, and commercial vehicle check systems that are also at or near the roadside.

Sausage Diagram
A diagram which depicts all Subsystems in the National ITS Architecture and the basic communication channels between these Subsystems. The "Sausage Diagram" is a toplevel Architecture Interconnect diagram. Variations of the Sausage Diagram are sometimes used to depict Regional ITS Architectures at a high level.

Stakeholders
Anyone with a vested interest or “stake” in the regional ITS architecture. This includes public agencies, private organizations, special interests, and the traveling public.

Standards
Documented technical specifications sponsored by a Standards Development Organization (SDO) to be used consistently as rules, guidelines, or definitions of characteristics for the interchange of data. A broad array of ITS Standards is currently under development that will specifically define the Interfaces identified in the National ITS Architecture.

Subsystem
The principal structural element of the Physical Architecture view of the National ITS Architecture. Subsystems are individual pieces of the Intelligent Transportation System defined by the National ITS Architecture. Subsystems are grouped into four classes: Centers, Roadside, Vehicles, and Travelers. Example Subsystems are the Traffic Management Subsystem, the Vehicle Subsystem, and the Roadway Subsystem. These correspond to the physical world: respectively traffic operations centers, automobiles, and roadside signal controllers. Due to this close correspondence between the physical world and the Subsystems, the Subsystem interfaces are prime candidates for standardization.

System Inventory
The collection of all ITS-related Elements in a Regional ITS Architecture.

Terminator
Terminators define the boundary of an Architecture. The National ITS Architecture Terminators represent the people, systems, and general environment that interface to ITS. The Interfaces between Terminators and the Subsystems and Processes within the National ITS Architecture are defined, but no functional requirements are allocated to Terminators. The Logical and Physical Architecture views of the National ITS Architecture both have exactly the same set of Terminators.

Transportation Equity Act for the 21st Century (TEA-21)
Passed in 1997 by Congress to address the need to begin work toward regional integration of transportation systems. TEA-21 is the successor reauthorization of the ISTEA legislation.

Traveler Subsystems
Equipment used by travelers to access ITS services pre-trip and en-route. This includes services that are owned and operated by the traveler as well as services that are owned by transportation and information providers. One of four general Subsystem classes defined in the National ITS Architecture.

User Service
User Services document what ITS should do from the user's perspective. A broad range of users are considered, including the traveling public as well as many different types of system

operators. User Services form the basis for the National ITS Architecture development effort. The initial User Services were jointly defined by USDOT and ITS America with significant Stakeholder input and documented in the National Program Plan (NPP). Over time, new or updated User Services will continue to be developed and the National ITS Architecture will be updated to support these User Service changes.

User Service Requirement
A specific functional requirement statement of what must be done to support the ITS User Services. The User Service Requirements were developed specifically to serve as a requirements baseline to drive National ITS Architecture development. The User Service Requirements are not requirements to system/architecture implementers, but rather are directions to the National ITS Architecture development team.

Vehicle Subsystems
Covers ITS related elements on vehicle platforms. Vehicle Subsystems include general driver information and safety systems applicable to all vehicle types. Three fleet Vehicle Subsystems (Transit, Emergency, and Commercial Vehicles) add ITS capabilities unique to these special vehicle types. One of four general Subsystem classes defined in the National ITS Architecture.

Vehicle-to-Vehicle Communications
Dedicated wireless system handling high data rate, low probability of error, line of sight communications between vehicles. Advanced vehicle services may use this link in the future to support advanced collision avoidance implementations, road condition information sharing, and active coordination to advanced control systems. One of the four types of Architecture Interconnects defined in the National ITS Architecture.

Wide Area Wireless Communications
A communications link that provides communications via a wireless device between user and an infrastructure based system. Both broadcast (one-way) and interactive (two-way) communications services are grouped into wide-area wireless communications in the National ITS Architecture. These links support a range of services in the National ITS Architecture including real-time traveler information and various forms of fleet communications. One of the four types of Architecture Interconnects defined in the National ITS Architecture.

Wireline Communications
A communications link serving fixed locations. It may be implemented using a variety of public or private communications networks that may physically include wireless (e.g., microwave) as well as wireline infrastructure. Both dedicated and shared communications resources may be used. One of the four types of Architecture Interconnects defined in the National ITS Architecture.