Mexico National ITS Architecture

Task 10 Report-Final Report

SCT

In Association with Suma Sinergia

Wilbur Smith Associates

www.wilbursmith.com

This report was funded by the U.S. Trade and Development Agency (USTDA), an agency of the U.S. Government. The opinions, findings, conclusions, or recommendations expressed in this document are those of the author(s) and do not necessarily represent the official position or policies of USTDA. USTDA makes no representation about, nor does it accept responsibility for, the accuracy or completeness of the information contained in this report.

Mailing and Delivery Address: 1000 Wilson Boulevard, Suite 1600, Arlington, VA 22209-3901
Phone: 703–875–4357 • **Fax:** 703–875–4009 • **Web site:** www.ustda.gov • **email:** info@ustda.gov

The U.S. Trade and Development Agency

The U.S. Trade and Development Agency (USTDA) advances economic development and U.S. commercial interests in developing and middle income countries. The agency funds various forms of technical assistance, early investment analysis, training, orientation visits and business workshops that support the development of a modern infrastructure and a fair and open trading environment.

USTDA's strategic use of foreign assistance funds to support sound investment policy and decision-making in host countries creates an enabling environment for trade, investment and sustainable economic development. Operating at the nexus of foreign policy and commerce, USTDA is uniquely positioned to work with U.S. firms and host countries in achieving the agency's trade and development goals. In carrying out its mission, USTDA gives emphasis to economic sectors that may benefit from U.S. exports of goods and services.

Mailing and Delivery Address: 1000 Wilson Boulevard, Suite 1600, Arlington, VA 22209-3901
Phone: 703–875–4357 • **Fax:** 703–875–4009 • **Web site:** www.ustda.gov • **email:** info@ustda.gov

TABLE OF CONTENTS

	PAGE NUMBER
CHAPTER 1 - INTRODUCTION	**1-0**
1.1 PURPOSE	1-1
1.2 METHODOLOGY	1-2
1.3 ORGANIZATION OF THIS DOCUMENT	1-3
CHAPTER 2 – EXISTING CONDITIONS	**2-0**
2.1 DESCRIPTION	2-1
2.2 THE NATION	2-1
2.3 ORGANIZATIONAL OVERVIEW	2-3
2.4 TRANSPORTATION FACILITIES	2-9
2.5 OVERVIEW OF NATIONAL TRANSPORTATION ORGANIZATION	2-19
2.6 REGIONAL AND CORRIDOR DEFINITIONS	2-22
CHAPTER 3 –SYSTEM NEEDS, GOALS AND OBJECTIVES	**3-0**
3.1 SALIENT TRANSPORTATION CHARACTERISTICS	3-1
3.2 TRANSPORTATION NEEDS DEFINITION	3-1
3.3 DEFINITION OF ARCHITECTURE OBJECTIVES	3-6
3.4 COMMON THEMES AND DEVELOPMENT OF ARCHITECTURE VISION	3-10
CHAPTER 4 – INSTITUTIONAL, LEGAL AND REGULATORY ISSUES	**4-0**
4.1 OVERVIEW	4-1
4.2 OUTREACH EFFORT	4-1
4.3 LEGAL ISSUES	4-2
4.4 REGULATORY ISSUES	4-5
4.5 SOCIETAL ISSUES	4-6
4.6 INSTITUTIONAL ISSUES	4-7
4.7 NATIONAL ISSUES	4-8
4.8 ISSUES BY REGION	4-10
4.9 BORDER CROSSING	4-12
4.10 GENERAL RECOMMENDATIONS TO OVERCOME ISSUES	4-13
CHAPTER 5 - TECHNICAL ANALYSIS OF EXISTING & FUTURE SYSTEMS	**5-0**
5.1 OVERVIEW	5-1
5.2 HIGH LEVEL ITS FUNCTIONAL DEFINITION	5-2
5.3 HOW ITS SERVICE DOMAINS RELATE TO NATIONAL ITS NEEDS	5-3
5.4 REVIEW OF EXISTING ITS APPLICATIONS IN MEXICO	5-4

TABLE OF CONTENTS (CONTINUED)

	PAGE NUMBER
CHAPTER 6 - ECONOMIC AND FINANCIAL ANALYSIS	**6-0**
6.1 OVERVIEW	6-1
6.2 ECONOMIC COST/BENEFIT ANALYSIS	6-1
6.3 PRELIMINARY FINANCIAL PLAN	6-9
6.4 RISK ANALYSIS	6-18
6.5 SUMMARY	6-19
CHAPTER 7 – ENVIRONMENTAL BENEFITS	**7-0**
7.1 OVERVIEW	7-1
7.2 ENVIRONMENTAL STATE	7-1
7.3 LIKELY BENEFITS OF ITS	7-6
7.4 ENVIRONMENTAL MANAGEMENT MONITORING PROGRAM	7-8
7.5 OVERVIEW OF NATIONAL TRANSPORTATION ORGANIZATION	7-19
7.6 REGIONAL AND CORRIDOR DEFINITIONS	7-22
CHAPTER 8 –DEVELOPMENT OF A NATIONAL ITS ARCHITECTURE-SYSTEMS SERVICES AND CAPABILITIES	**8-0**
8.1 OVERVIEW	8-1
8.2 TASK METHODOLOGY	8-1
8.3 FUNDAMENTAL SERVICES	8-2
8.4 ITS USERS AND PROVIDERS	8-6
8.5 ITS SERVICES AND SERVICE GROUPS	8-14
8.6 SCREENING ITS TECHNOLOGIES	8-21
8.7 BASIC ARCHITECTURE FRAMEWORK	8-29
8.8 DETAILED ARCHITECTURE DEFINITION	8-36
CHAPTER 9 PROPOSED SYSTEMS & SERVICES	**9-0**
9.1 OVERVIEW	9-1
9.2 POTENTIAL ITS PROGRAMS AND PROJECTS	9-1
9.3 FUTURE SYSTEMS PROCUREMENT	9-69
CHAPTER 10 ACTION PLAN	**10-0**
10.1 OVERVIEW	10-1
10.2 CONCEPT OF OPERATIONS PLAN	10-1
10.3 PROJECT SEQUENCING AND INTEGRATION STRATEGY	10-3
10.4 IDENTIFY AGREEMENTS	10-11
10.5 REGIONAL ARCHITECTURES	10-12
10.6 ITS BUSINESS PLAN	10-16
10.7 ITS IMPLEMENTATION PLAN	10-19

APPENDICES
TABLE OF CONTENTS

	PAGE NUMBER
APPENDIX SUMMARY	**A-S**
APPENDIX A - SERVICES CHART AND DIAGRAM	**A-0**
Service Group Chart	A1-1
Service Group Diagram	A2-1
APPENDIX B - SUBSYSTEM DESCRIPTION	**B-0**
APPENDIX C– DEPLOYMENT COSTS	**C-0**
APPENDIX D - LIST OF VENDORS	**D-0**
APPENDIX E - REGIONAL ARCHITECTURES	**E-0**
APPENDIX F-ADDITIONAL RESOURCE/WHITE PAPERS	**F-0**
ITS Architecture Development Overview	F-1
Legal and Institutional Issues	F-13
Regional ITS Architecture Development	F-19
Funding Table Summary	F-23
Pesaje Facil Economic Review	F-26
Air Quality Quantities	F-29
ITS Technology Assessment	F-31
ITS Project Development Explanation	F-50
Immediate Action Plan	F-55

CHAPTER ONE
Introduction

1.1 PURPOSE

Wilbur Smith Associates (WSA) has been providing technical services to develop a National Intelligent Transportation Systems (ITS) Architecture for Mexico. Mexico's Secretaría de Comunicaciones y Transportes (SCT) has lead this effort through a grant from the U.S. Trade and Development Agency. The consultant team consists of WSA and Suma Sinergia. Together with SCT and related stakeholders, the full group will be further referred to in this document as the Architecture Team.

ITS is often defined as a group of systems which utilize advanced information and communications technologies to improve transportation services for travelers and freight. The Mexican National ITS Architecture will coordinate the management and operation of various transportation facilities throughout Mexico and support personal and goods movements. Examples of ITS applications may include the following:

- Improve response to incidents throughout the transportation network
- Provide notifications to motorists in order to reduce or avert accidents
- Present travelers with current information on travel conditions throughout the entire country
- Reduce delays in the shipment of freight and containers
- Improve traffic operations in urban areas and along corridors
- Permit collection of user fees to support the operation and funding of transportation facilities in an efficient manner

The key objectives of this National Architecture effort were as follows:

- Develop an ITS deployment plan that addresses transportation needs and identifies the institutional structure to deploy integrated ITS activities
- Identify known financial mechanisms to support ITS deployment in Mexico
- Identify ITS-related information interfaces and functions that will benefit from the use of standards
- Identify candidate technologies, and to the extent known, identify current and emerging markets for various ITS components

To this end, various agencies, authorities, and interested parties involved in the development, operation and use of transportation network in Mexico have participated in this broad-based transportation initiative.

1.2 METHODOLOGY

The architecture development effort consisted of the following tasks:

1. Review of Existing Conditions and Define Goals and Objectives
2. Review Institutional, Legal and Regulatory Issues
3. Technical Analysis
4. Economic and Financial Analysis
5. Environmental Benefits
6. Development of Systems' Requirements and Capabilities
7. Development of an ITS Architecture
8. Proposed Systems and Services
9. Development of an "Action Plan" for ITS Implementation
10. Final Report

Tasks 1 and 2 were critical first steps to addressing the ITS Architecture in Mexico. These tasks collectively examined current operations and planned activities, and identified the potential ways in which ITS can improve those operations. Together, these two tasks assisted in identifying the vision of the transportation industry in Mexico, as well as the constraints within that vision. In Task 1, the Architecture Team provided an inventory of existing systems and developed a series of goals and objectives for the National Architecture. The second task followed this with a review and discussion of the institutional issues facing the Mexico Transportation community.

Tasks 3, 4 and 5 provide various analyses necessary to develop a plan that the transportation community can immediately use. This included addressing specific questions, including technical issues and opportunities, financial alternatives to fund ITS efforts, and socioeconomic implications.

Tasks 6, 7, and 8 provide the framework for the National ITS program, through definition of specific system requirements and ITS services to be provided, the technical and institutional framework to provide these services (in other words, the National Architecture), and the program plan which would implement these ITS services.

In Task 9, an "ITS Action Plan" was formulated, which addressed initial "Early Start" projects and deployment requirements; included in this effort is the methodology by which the National ITS Architecture may be used to develop more detailed corridor or local architectures based on specific regional and local requirements and constraints, as well as more specific project architectures which can be used as a basis for actual system deployment activities. "Early Start" projects are defined as those that have a relatively low cost, and a relatively high expected benefit to the industry. These "early winners" would help demonstrate to decision makers the advantages ITS has to offer and will generate support and interest in this valuable area.

Task 10 consisted of the work effort necessary to finalize the recommendations and conclusions of the prior tasks and generate this Final Report.

1.3 ORGANIZATION OF THIS DOCUMENT

This Final Report documents the recommendations and conclusions of this National Architecture effort. It includes the following chapters:

1.0 Introduction (This Chapter)
2.0 Existing Conditions
3.0 Architecture Goals and Objectives
4.0 Institutional, Legal and Regulatory Issues
5.0 Technical Analysis of Existing and Future Systems
6.0 Economic and Financial Analysis
7.0 Environmental Benefits
8.0 Development of the National ITS Architecture – System Services and Capabilities
9.0 Proposed Systems and Services
10.0 Action Plan

CHAPTER TWO
Existing Conditions

2.1 DESCRIPTION

This chapter presents a baseline of the existing systems and situation in Mexico, based on review of the transportation system and discussions with agency staff as well as vendors. Additionally, the chapter defines specific regions within the country with common activities and geographic considerations, along with national transportation stakeholders. Regional stakeholders are addressed in more detail in the upcoming chapters.

Key inputs were provided from an initial list of stakeholders agreed by the Architecture team and invited to the study kickoff meeting in June 2004, along with an initial Architecture workshop conducted in July 2004. From these meetings, information was collected relative to current infrastructure and system needs.

2.2 THE NATION

Mexico is a geographically and environmentally diverse country, with rain forests in the south and open desert in the north. A geographic representation is reflected in Exhibit 2.1.

2.2.1 Geography and Environment

With 1,972,550 square kilometers of area, Mexico contains 4,353 km of borders with neighboring countries, including 3,141 km with its neighbor to the north, the United States of America. There is also 962 km of border with Guatemala and 250 km with Belize.

Mexico borders the Pacific Ocean, the Caribbean Sea, the Gulf of Mexico and the Gulf of California, for a total of 9,330 km of coast line, and has several significant and rugged mountain ranges. Volcanoes and earthquakes are prevalent in the center and south of Mexico (two of the worst earthquakes involved a major temblor in Mexico City in the mid-1980's and earlier ones in Guatemala. Hurricanes also impact the coastal areas as well as inland locations.

Natural resources include petroleum, silver, copper, gold, lead, zinc, natural gas, timber; petroleum and gas are two of the largest exports.

Two major areas of concern have been fresh water depletion and deforestation throughout the country, with groundwater scarce and polluted in northern Mexico, and limited in the central and southeast portions of the country. Pollution of rivers, deterioration of agricultural land, and lowering of ground level in the central valley as a result of groundwater depletion are also notable.

Exhibit 2.1
México

2.2.2 Population and Demographics

In 2000, Mexico has a population of 97.5 million in 31 states (including the Federal District, which encompasses the capital, Mexico City), of which the median age is just under 24 years. About 7 out of 10 Mexicans (approximately 65.7 million) live in urban environments (over 360 cities), one of the highest percentages in the world (Garza, 2003)[1]. Roughly one half of urban residents live in the nine metropolitan areas with populations of over 1,000,000, including México, Guadalajara, Monterrey, Puebla, Toluca, Tijuana, Torreón, Juárez and León. (CONAPO, 2001)[2]. Tijuana (bordering San Diego, California) and Juárez (bordering El Paso, Texas) are the two largest border cities, and are part of large bi-national metropolitan areas.

As with the United States and Canada, much of the land area can be classified as rural, with 13.2% of the land area being arable, 65,000 square kilometers of it irrigated, and the rest being in a largely natural state.

Within Mexico, the labor force is approximately 40 million (38% of the population), of which 56% are in service and information jobs, 24% in industry, and 20% in agriculture.

2.2.3 The Economy

Mexico has evolved into a largely free market economy, although 41% of the income is made by the wealthiest 10% of the population. Roughly 40% of the population is living under poverty conditions. Trade with the US and Canada has tripled since the implementation of the North American Free Trade Agreement in 1994, including construction of a number of factories in border areas which provide shipment of goods to the US. The US captures over 80% of Mexico's output, making the US the largest

1 Garza, Gustavo (2003). La urbanización de México en el siglo XX. El Colegio de México. México.
2 CONAPO. Página de Internet: <http://www.conapo.gob.mx>

trading partner. The economy is largely impacted by the performance of the US economy as a result. However, industry in Mexico has been growing at nearly a 5% annual rate. Over MN$1.75 trillion worth of goods was exported in 2002, including oil and gas, agricultural products, and manufactured goods.

2.3 Organizational Overview

Among the most critical components of the baseline transportation system are not infrastructure elements – but rather, the people and institutions responsible for the various aspects of the system. Ultimately, it is these people and institutions that implement the policies and make the operational changes needed to improve the system.

Section 2.4 provides a more detailed overview of the physical transportation network in Mexico. However, it is important to first understand the organization under which this network is operated, since this organizational structure appears to have a significant impact on the nature of transportation in the country.

2.3.1 Secretaría de Communicaciones y Transportes (SCT)

The agency most responsible for activities related to transportation is the Secretaría de Communicaciones y Transportes (SCT).

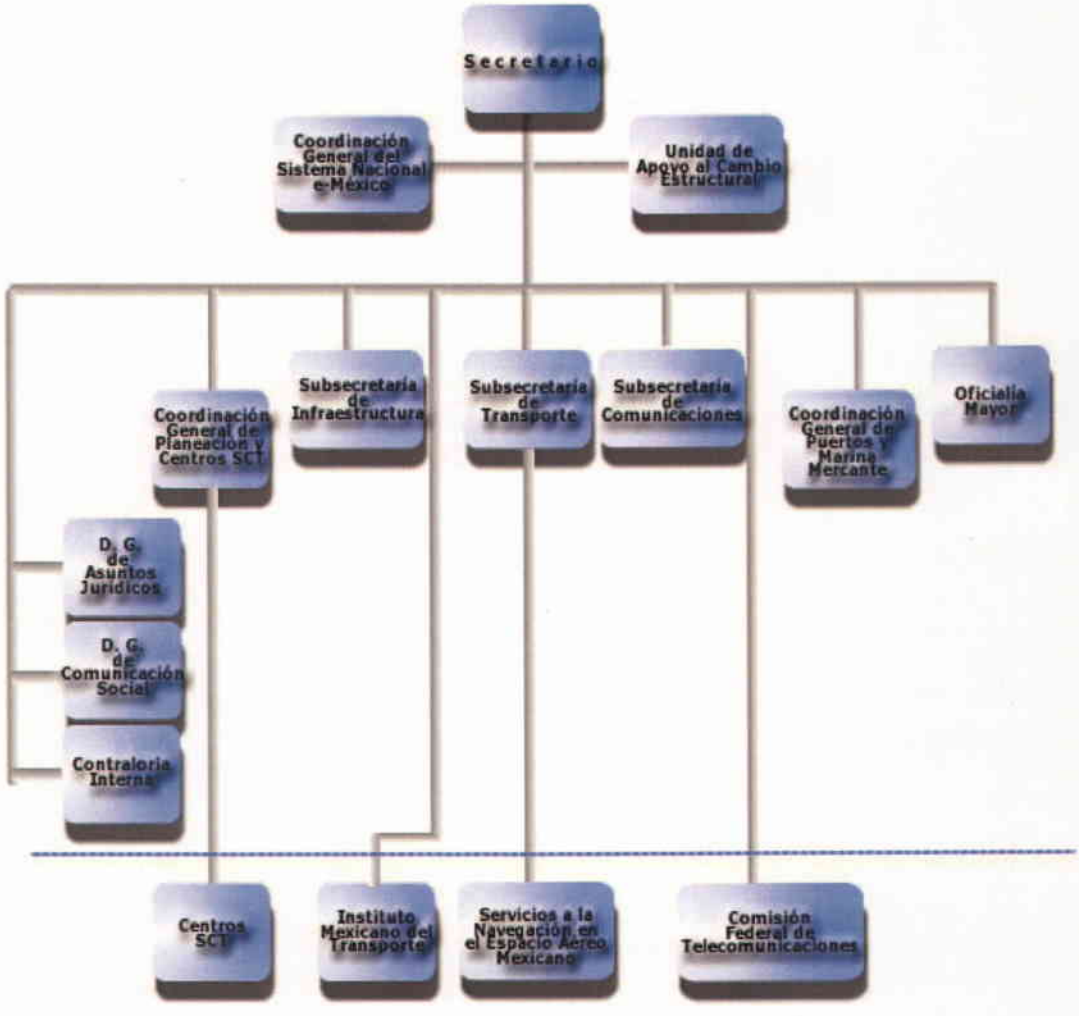
In contrast with the federal transportation agencies in the United States and Canada, SCT bears significant operational responsibilities, specifically for its network of primary highways, along with regulatory oversight for rail, ports, airports, telecommunications, and toll road facilities.

The current SCT organizational structure has been in place since 1995. Its functional organization chart is shown in Exhibit 2.2 below.

The SCT comprises:

- Three sub-secretariats (Infrastructure, Transportation, and Communications)
- One Main Administrative Office
- Two general coordinating offices (Planning and SCT Centers, and Ports and the Merchant Marine)
- 26 other administrative units, mostly general directorates
- 31 SCT Centers located in the State Capitals

Exhibit 2.2
SCT Organization



Source: SCT

The three sub-secretariats (Infrastructure, Transportation, and Communications) handle the activities discussed below.

2.3.1.1 Infrastructure

- *Toll Highway Unit (Unidad de Autopistas de Cuota (UAC).* Management of all toll operations, including supervision of national or regional concessions, toll operations and tolling feasibility studies including traffic and revenue forecasts. UAC is also responsible for tendering and awarding concession agreements for specific toll facilities.
- *Federal Highway Directorate (Dirección General de Carreteras Federales, DGCF).* Responsible for development of new highway programs as well as design and construction of federal highways, coordinates with other departments in the studies and evaluations associated with construction of new highway corridors, including those to be implemented as toll concessions.
- *Highway Maintenance Directorate (Dirección General de Conservación de Carreteras, DGCC).* Responsible for maintenance, rehabilitation and reconstruction of existing federal highways,

including preventive maintenance. Also coordinates state highway maintenance in conjunction with state SCT centers. Responsible for installation, operations and maintenance of traffic control devices, including signage and traffic signals, along with safety improvement, including for the rural roadway network.

- *Technical Services Directorate (Dirección General de Servicios Técnicos, DGST).* Responsible for conducting engineering studies, including pavement, soils, hydraulics), geotechnical and other specialties. Also develops standards associated with highway and bridge materials. Also responsible for conducting highway inventory and planning studies, including origin-destination studies, traffic counts; also involved in policy planning and development.
- *Regional Highway Infrastructure Unit (Unidad de Infraestructura Carretera para el Desarrollo Regional).* Responsible for rural highway corridor planning, development programs and implementation of construction, rehabilitation and maintenance programs for rural / intercity highways.

2.3.1.2 Transport

- *Federal Freight and Passenger Transport Directorate (Dirección General de Autotransporte Federal, DGAF).* Responsible for operations and policies related to passenger and freight transport services, including regulations and coordination with North American Free Trade Agreement (NAFTA) requirements. Maintains coordination with government departments related to customs and commercial / industrial policy.
- *Federal Tariff, Rail and Multimodal Directorate (Dirección General de Tarifas, Transporte Ferroviario y Multimodal, DGTTFM).* Responsible for oversight of fee collection for multi-modal (except maritime) freight and rail operation, and coordinates both with the Mexican National Railroad as well as with rail privatization efforts and private railroads.

2.3.1.3 Communications

- *Telecommunications Policy Directorate (Dirección General de Política de Telecomunicaciones).* Recommends and applies telecommunications programs and policies. Interprets and supports directives from the Federal Telecommunications Commission (Comisión Federal de Telecomunicaciones). Also assigns or establishes radio bandwidth assignments based on geographic needs and required public functions.
- *Radio and Television Directorate (Dirección General de Sistema de Radio y Televisión).* Recommends and applies policies relative to radio and television broadcasting, inlcluding receiving and reviewing broadcast applications.

2.3.1.4 Other SCT Coordination Responsibilities

SCT is responsible for coordinating the activities of the following state agencies:

- Mexican Agency for Federal Highways and Bridges (CAPUFE) Revenues and Connected Services
- Airport and Ancillary Services (ASA)
- Mexico City Airport Services (SACM)
- Tehuantepec Istmus Railroad (FIT)
- Mexican Communications (TELECOMM)
- Mexican Postal Services (SEPOMEX)
- National Merchant Marine Personnel Education and Training Trust (FIDENA)
- 24 Integral Port Administrative Offices (APIs), 16 which are federal and are located in the most important seaports on Mexican coasts.

SCT is also responsible for the administrative and functional coordination of three separate agencies with technical and operational autonomy:

- Federal Telecommunications Commission (COFETEL)
- Mexican Air Space Navigation Services (SENEAM)
- Mexican Transportation Institute (IMT)

While SCT is the primary agency responsible for the oversight of transportation, many of the above agencies have major roles within transportation. The two largest outside organizations that are involved in transportation are customs and the police. Additionally industry organizations and some local jurisdictions also have major roles at the national level.

2.3.2 Caminos Y Puentes Federales (CAPUFE)

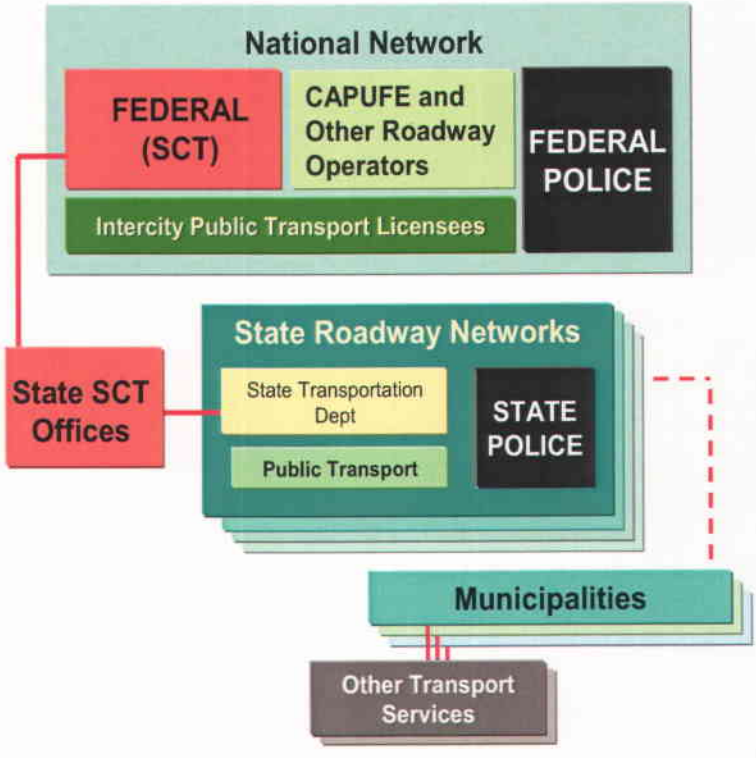
An important aspect of nationwide transportation activities is the role of Caminos Y Puentes Federales (CAPUFE), a Federal agency responsible for operations of toll roads and major limited-access highways connecting between cities and regions in Mexico. While there are several other private toll concessions in Mexico, CAPUFE is by far the largest toll road operator. More information is discussed in Section 2.4. CAPUFE until recently was also tasked with administering toll road facilities (including toll collection and processing). This role is currently being revised such that CAPUFE focuses on operation and toll collection / processing is handled under other SCT or private sector entities.

2.3.3 Other National and Regional Relationships

From a state or regional perspective, SCT contains offices in each of the 31 states which coordinate with state transportation and public works functions. Additionally. Mexico's National Police operates at a Federal level, with State Police operating within the 31 states. There are also numerous local jurisdictions in which law enforcement and emergency services occur. However, the principal management of road and public transport services are handled either through SCT (for primary highways), CAPUFE (major toll facilities), or through State transportation or public works agencies (for state highways and cities within the states or the Federal District.

A description of this relationship is shown in Exhibit 2.3, and represents a general description of the relationships that exist; it does not imply a standard that is uniform throughout the country.

Exhibit 2.3
General Overview of Institutional Relationships (Federal, State & Local Transportation Activities)



2.3.4 Overview of Participants in the National ITS Architecture Effort

2.3.4.1 Stakeholders

SCT staff were primarily responsible for definition of the list of stakeholders. This list represented a diverse set of interests, including several groups within SCT as well as external interests. Such diversity is essential in establishing the vision, goals, and objectives for the national ITS effort. Representatives of the stakeholders below were invited to the project kickoff meeting in June 2004, and represent all modes of transportation; and include public, private, and research organizations. In general, these included representatives of the SCT directorates and units listed in Section 2.3.1, along with several other jurisdictions, including:

- Civil Aviation Directorate
- Mexican Transport Institute *(Instituto Mexicano del Transporte, IMT)*
- Airport Services *(Aeropuertos y Servicios Auxiliares)*
- CAPUFE
- Customs *(Administración General de Aduanas, AGA)*
- Federal Police *(Policía Federal Preventiva (PFP))*

Other Organizations

- National Tourist Transport Council *(Nacional de Autotransporte de Pasaje y Turismo, CANAPAT)*
- National Cargo Transport Council *(Cámara Nacional de Autotransporte de Carga, CANACAR)*
- National Federation of Mexican Truckers *(Confederación Nacional de Transportistas Mexicanos)*

- National Association for Buses and Trucks *(Asociación Nacional de Autobuses, Camiones, y Tracto Camiones, ANPACT)*
- National Association for Private Transportation *(Asociación Nacional de Transporte Privado, ANTP)*
- Mexican Association of Transportation Engineeers *(Asociación Mexicana de Ingeniería de Transporte)*
- Mexican Highway Association *(Asociación Mexicana de Caminos)*
- National Chemical Industry Association *(Nacional de la Industria Química , ANIQ)*
- National Mexican Ground Transport Association *(Asociación Mexicana de Ingeniería de Vías Terrestres, A.C. , AMIVTAC)*

Educational Institutions

- United Professional Interdisciplinary Engineers, Social Sciences and Administrators *(Unidad Profesional Interdisciplinaria de Ingeniería, Ciencias Sociales y Administrativas , UPIICSA)*
- National Autonomous University of Mexico *(Universidad Nacional Autónoma de México, UNAM)*

As the Architecture development process is continuous and extends well past the end of this Study effort, it is expected the list of stakeholders would be expected to change over time. This initial list of stakeholders has been expanded since the beginning of the Study, commensurate with the additional knowledge and interest in this effort that has occurred as a result of regional meetings as well as other presentations. The stakeholder list will continue to vary over time as actual ITS deployments occur.

The ITS Architecture will best aid Mexico through its ability to be representative of all issues that confront the transportation community.

2.3.4.2 ITS Architecture Steering Committee

The Steering Committee for the National ITS Architecture effort is a smaller work group comprised of identified members of stakeholders to guide or steer the consultant team activities and provide official decisions when appropriate. While everyone has an opportunity to participate as a stakeholder, the Steering committee has additional responsibilities. Typically, they are more involved in the production of reports, giving input on earlier or more frequent drafts of reports. The Steering Committee includes, at the minimum, the main Architecture Team, including:

- Ing. Oscar Cruz Ruiz, Assistant Director-General for Planning and Development, SCT
- Ing. Venancio Pérez Sánchez, Subdirector for Technology and Safety Development, SCT
- Dr. Jorge Acha Daza, IMT
- Ing. Oscar Ringenbach Sanabria, Subdirector for Intermodal Project Analysis, UAC
- Ing. Alfonso de la Parra del Valle, UAC
- Lic. Manual Zubiría Maqueo, CAPUFE
- Ing. Miguel A. Barousse Moreno, CAPUFE
- C.P. Miguel Lando Coindresu, CAPUFE
- Comisario Fco. Javier Cárdenas Rueda, PFP
- Lic. Adalberto Guevara Avila, Director of Coordinated Systems, PFP
- Ing. Juan Manuel Orozco y Orozco, DGST
- Ing. Sergio Herrera del Angel, DGST
- Lic. Mauricio Mireles Poulat, AGA
- Arq. Lisbe Martínez, AGA
- Néstor A Valdez Oviedo, UAC

2.4 Transportation Facilities

Historically, ITS has focused on ground transportation, mainly on roads and local streets, with some implementation of advanced technologies on railroad systems which assist with respect to improving safety at highway-rail crossings, as well as providing information on departure and arrival of trains.

The Mexican transportation network is very diverse, although it largely focuses on roadway infrastructure as the backbone for passenger and goods movements. The interface of ground transportation with air and sea transportation is of great significance, certainly from the perspective of goods movements (intermodal transfers in particular), as well as providing essential information for travelers who may be beginning their journey on the ground transportation system, for the purpose of transferring to an airplane or vessel for completion of their journey. At the same time, many aviation-oriented technologies, including various electronics systems as well as satellite tracking, in-vehicle monitoring and radar, have found their way into ITS deployments.

There are approximately 1300 airports in Mexico with 40 international and 17 national airports. There are 37 water ports and facilities.

2.4.1 Road Infrastructure

The national road infrastructure, gradually developed over several decades, is classified as follows: federal network, state networks, rural roads, and enhanced paths (generally unpaved), according to their importance and characteristics.

The Mexico road network can be described as follows:

- Total length of network 330,000 km (estimated)
- Paved roads (free) 107,000 km (estimated)
- Paved roads (toll) 6,000 km (estimated)

Of the 107,000 km of paved routes that are free, 42,800 (40%) are Federal primary roads, while 64,700 km (60%) are split between the 31 state networks. The remainder of the network consists of 220,000 km of unpaved road, in which 160,000 km are rural and feeder roads, and 60,000 km are classified as "enhanced paths." Approximately 2/3 of the road network is unpaved (as compared to 40% for the United States).

2.4.1.1 Federal Network

The federal road network is served in its entirety by the federal government, operated and managed through SCT. It registers most of interurban cargo and passenger movements and channels long trips, trips related to foreign trade, and those produced by more dynamic sectors of the national economy.

The Federal network, inclusive of free and toll roads, is approximately 113,000 km. The Federal Primary network is illustrated in Exhibit 2.4.

The National Development Plan 2001-2006 has identified a need to continue to build upon this network. As of 2000 19,000 kilometers of interstate roadways, along 14 corridors connecting all of the major cities, represents approximately 60% of the total planned roadway system.

Most rural and feeder roads have been reassigned to state governments, thus the SCT is only directly responsible for 4,600 km. The total of rural roads under the responsibility of the states is 108,500 km, and the total under the responsibility of the municipalities and other agencies is 47,600 km.

The growth in the Federal roadway network (including free roads and toll roads) was limited through the 1990's. Toll roads were the main area of growth in the early 1990's, but there was little change in total length of facilities overall until 2002. (See Exhibit 2.5.)

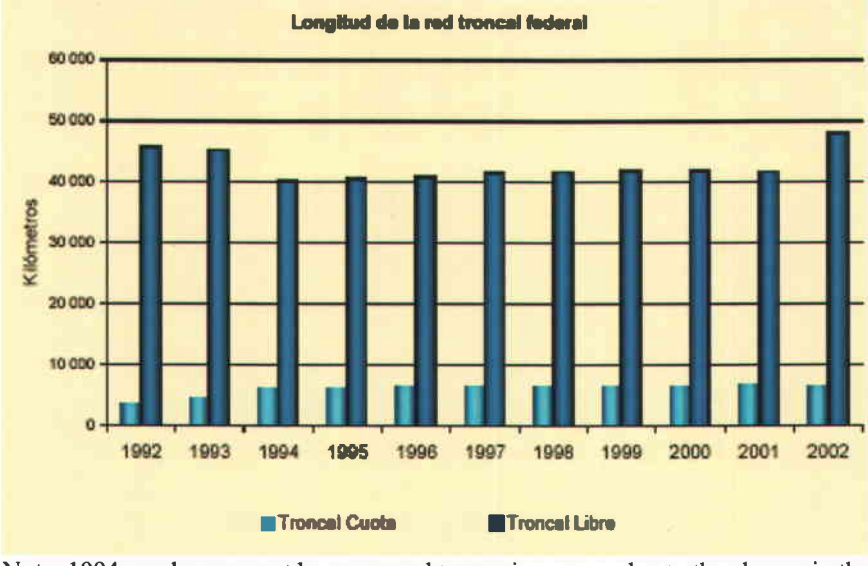
Exhibit 2.4
Federal Primary Highways

2.4.1.2 State Roadway Networks

State networks, making up 60% of all paved roads, play a very important role in regional transportation, in linking agricultural and cattle production zones and ensuring the integration of various regions in the country. On the other hand, rural roads and enhanced paths are simple roads and in general are unpaved; their worth is more social than economic, as they provide access to small communities which would otherwise be isolated.

States are also largely responsible for road and street maintenance in major cities within their jurisdiction.

Exhibit 2.5
Growth of Federal Primary Road Network



Note: 1994 numbers cannot be compared to previous years due to the change in the methodology used to gather information. In 1992 and 1993, numbers provided by SCT administrative units were registered. From 1994, data from the 31 SCT Centers is reported.
Source: 2002 Statistics Annual report, with data obtained from the Infrastructure Sub-secretariat.

2.4.1.3 Annual Network Investment

The annual highway investment needs in Mexico is 44,700 million pesos. The breakdown of the annual investment (in pesos) is as follows:

- Federal Highway Network maintenance — MN$7.5 billion
- States Highway Network maintenance — MN$10.5 billion
- Projects along the main corridors — MN$12.5 billion
- Projects outside of the main corridors — MN$5.0 billion
- Rural Highways — MN$4.5 billion
- Feeder Highways — MN$4.7 billion
- Bridges and Border Crossings — MN$1.2 billion

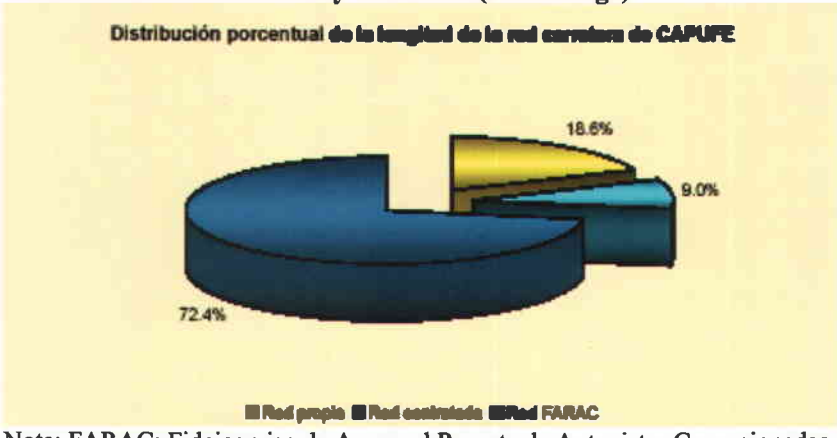
2.4.1.4 Toll Operations

The toll facilities are made up of 70 individual toll roads and 39 bridges of which approximately 75% are operated by the government (mainly CAPUFE) and the remainder through concessions to private sector entities.

As regards toll roads, the network operated by CAPUFE is the major component. Including both those roads operated by CAPUFE itself as well as ones owned by CAPUFE operated by third parties (including the largest operator, Fideicomiso de Apoyo para el Rescate de Autopistas Concesionadas, FARAC), the CAPUFE network is 4,700 kilometers long. (It is noted that, in 2005, changes are underway which would make CAPUFE primarily an operations agency, as opposed to an owning agency.)

There are also other toll facilities not owned or operated by CAPUFE. Non-CAPUFE toll roads in concession to private operators are 786 kilometers, and an additional 432 km are state toll concessions. Exhibit 2.6 summarizes the percentage of toll facilities controlled by CAPUFE, along with facilities controlled by CAPUFE but operated by third parties (i.e., FARAC), and other, private or state facilities.

Exhibit 2.6
Toll Roads Administered by CAPUFE (Percentage)



Note: FARAC: Fideicomiso de Apoyo al Rescate de Autopistas Concesionadas. Toll Roads Administered by CAPUFE as of September 1998.
Source: Mexican Agency for Federal Highways and Bridges - Revenues and Connected Services

The FARAC network is comprised by roads that were originally constructed as part of private concession agreements which were taken over by CAPUFE in 1997, plus additional facilities implemented since 1998. The new highways are concessioned to BANOBRAS, the national credit institution.

The concessioned network not overseen by CAPUFE is comprised of freeways built between 1989 and 1994, which were concessioned to private operators, state governments, and financial institutions.

As discussed in Chapter 4 (Technical Analysis of Existing and Future Systems), CAPUFE is served by an electronic toll collection system (IAVE) as well as cash and credit card payment systems. Other operators utilize different systems not compatible with CAPUFE.

Fourteen corridors contain toll facilities administered by CAPUFE. These facilities are shown in Exhibit 2.7.

Exhibit 2.7
Toll Roads Administered by CAPUFE

2.4.2 Seaports

Maritime transport and port facilities were responsible for more than 80% of the total export volume and 34% of the cargo handled by all the modes of transportation in Mexico during 2001. At the end of the year 2000, national ports registered the operation of 244.3 million tons of cargo, consolidated for participation in the foreign trade of important industries such as the oil, chemical, petrochemical, iron and steel works, cement, automobile, and fishing industries.

Of the maritime freight activities, 34% of it occurred at ports along the Gulf of Mexico, with almost half of this total occurring in Veracruz. Approximately 31% of freight movements occurred along the Pacific coast, with Lázaro Cárdenas and Manzanillo the largest ports. Primary seaport locations are shown in Exhibit 2.8.

Exhibit 2.8
Seaports in Mexico

Exhibit 2.9 summarizes cargo movements in thousands of tons from each major port facility in Mexico. Nearly 96 million metric tons of goods and products were moved annually through ports in Mexico in total as of 2002, not including petroleum products. This represented an approximate 4% increase over 2001, in part due to the economic problems occurring that year both before and particularly after the terrorist attacks of September 11, 2001 on the U.S.

In addition to the growth in freight tonnage, passenger travel via maritime vessels has increased as well. The number of passengers transported in cruise ships and ferries has recently increased: in 1994, 5.3 million passengers were served, while in 2000 this number totaled 7.4 million, an increase of 39.6 percent.

Exhibit 2.9
Freight Tonnage (Millions of Tons) by Major Port

	2001	2002	
Pacífico			%
Lázaro Cárdenas	11,787	13,101	14%
Manzanillo	8,367	10,028	10%
Guaymas	1,341	938	1%
Topolobampo	2,053	1,982	2%
La Paz	1,039	1,121	1%
Ensenada	1,615	1,968	2%
Mazatlán	690	837	1%
Salina Cruz	94	57	0%
Subtotal Pacífico	26,986	30,032	
% Total	29%	31%	
Golfo			
Veracruz	14,007	14,591	15%
Tampico	3,431	4,152	4%
Altamira	3,596	7,392	8%
Coatzacoalcos	2,664	2,909	3%
Progreso	2,056	2,057	2%
Tuxpan	1,317	1,582	2%
Subtotal Golfo	27,071	32,683	
% Total	29%	34%	
Otros Puertos	38,815	33,059	
% Total	42%	35%	
Total Nacional	92,870	95,773	

2.4.3 Airports

Over the last 50 years, Mexican airport coverage has expanded to cover almost the entire country. Almost every community of more than 50,000 is accessible by air, though not all facilities provided scheduled commercial airline service.

The national airport system is comprised by 1,215 air fields; 85 of which are airports (57 international and 28 national). Of all the airports, 35 are administered by groups of concessionaires, 27 are under the responsibility of Airports and Ancillary Services (ASA), and the remaining 23 are managed by various private or public entities.

The 35 most important airports are under the responsibility of four concession groups:

- Mexico City Airport Group (1)
- Central-Northern Group (13)
- Pacific Group (12)
- Southern Group (9)

Exhibit 2.10 provides a map of all the domestic and international airport facilities throughout the country.

Exhibit 2.10
Domestic and International Airports in Mexico

In 2002, 59 million passengers were handled by the National Airport System3, of which 21 million were travelers with international origins or destinations (35%) and the remainder were domestic travelers.

2.4.4 Railroads

Once a dominant means of transportation, since World War II railroads have declined in relative importance due to the growth of other modes of transport such as air, sea, and above all, road transport. Consequently, railroad transport has not kept pace with the economic growth and development of Mexico. This historic situation has led to other problems associated with poor maintenance and lack of investment in infrastructure.

Recently this trend has been reversed. The industry now operates under several concessions that are trying to realize potential benefits that railroads offer over other modes of transport; notably, improved connectivity between port facilities in Mexico and US railroad facilities. Exhibit 2.11 illustrates the national railway network within Mexico.

In Exhibit 2.12, the different rail carrier concessions and network components are described. Concessions (privatized operation and maintenance of the network), beneficiaries (non-privatized), and other lines yet to be awarded to concessionaires are summarized. In total, over 65% of the rail network has now been privatized, with another 15% yet to be awarded to concessions.

3 2002 Statistics Yearly Report, with Airport and Ancillary Services data.

Exhibit 2.11
National Rail Network

There are 6 concessionaire firms as per Exhibit 2.12, looking to restore the growth and importance of rail travel in Mexico. The intent of the concessionaires is to promote the competitive edge which rail typically has in moving high cargo volumes long distances and with relatively low operation costs and low pollution rates, as a means to enhance intermodal freight options within Mexico.

Exhibit 2.12
Rail Carriers and Concessions in Mexico

Main Characteristics of the Mexican Rail System			
Regime	Length (km)	% Total Network	% Main Network
Concessionaires	17,010	63.8	82.2
Northeastern Railroad (TFM)	4,283	16.1	20.7
Northern-Pacific Railroad (Ferromex)	7,164	26.9	34.6
Ojinaga-Topolobampo Railroad (Ferromex)	943	3.5	4.6
Nacozari Railroad (Ferromex)	320	1.2	1.5
Southeast Railroad (Ferrosur)	1,479	5.5	7.2
Mexico Valley Rail Terminal (Ferrovalle)	297	1.1	1.4
Coahuila-Durango Short Line	974	3.7	4.7
Chiapas-Mayab Railroad Company	1,550	5.8	7.5
Beneficiaries	278	1.0	1.3
Tijuana-Tecate Short Line	71	0.3	0.3
Tehuantepec Istmus Railroad (FIT)	207	0.8	1.0
Lines to be given in concession	3,399	12.8	16.5
Oaxaca and South	595	2.2	2.9
Remaining lines	2,804	10.5	13.6
Main Network	20,687	77.6	100.0
Secondary Network	4,413	16.6	

Main Characteristics of the Mexican Rail System			
Regime	Length (km)	% Total Network	% Main Network
Private Use Network	1,555	5.8	
Total	26,655	100.0	

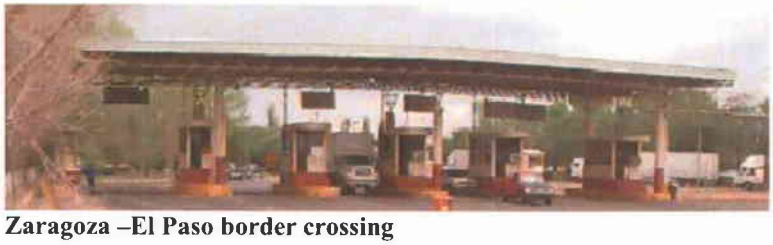
Source: 2002 Statistics Annual report, with data obtained from the SCT, Transportation Sub-secretariat.

Since 1995, growth in freight transport by rail has been strong, with over 45% growth between 1995 and 1998. That growth leveled off in 1999 and 2000. This is illustrated in Exhibit 2.13.

Exhibit 2.13
Growth in Freight Transport via Rail

Fuente: SCT, Ferrocarriles Nacionales de México y Ferrocarriles Concesionados.

2.4.5 Border Crossings



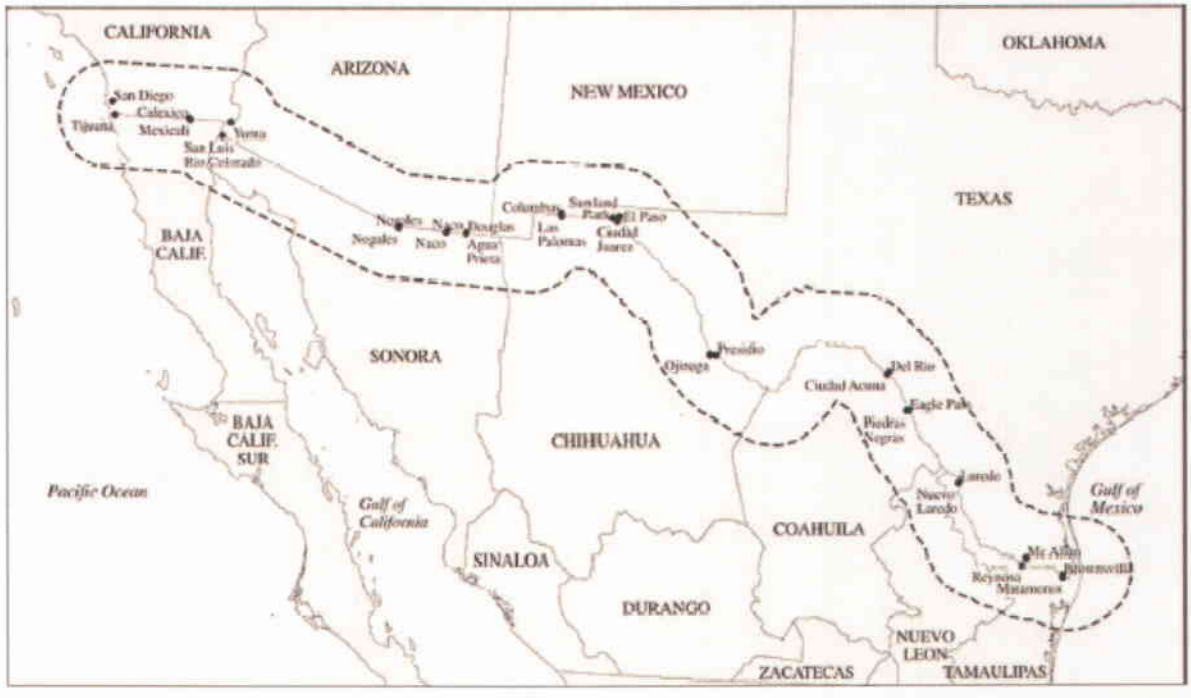
Zaragoza –El Paso border crossing

Ports of entry along the international borders include:

- **US Border:** Thirty highway crossings in both directions, five rail crossings (at Mexicali, Nogales, Juárez, Piedras Negras and Nuevo Laredo) and one toll ferry (at Gustavo Diaz Ordaz in Tamaulipas state)
- **Guatemala:** Two highway crossings, one rail crossing
- **Belize:** One highway crossing

The Mexico-US Border region is illustrated in Exhibit 2.14.

Exhibit 2.14
Mexico-US Border Region



Source: U.S. Environmental Protection Agency.

Numerous government agencies provide various services at the borders. The agencies and the various services provided are summarized below.

- Customs – Responsibility for assuring goods/services are legal and that applicable duties and taxes are paid upon entry or exit
- SAGARPA – Inspection of meat and plant products entering Mexico
- CAPUFE – Road / toll bridge maintenance
- SCT (roads) – Road maintenance on primary highways (non-toll)
- SCT (trucking) – Enforcement of motor carrier, driver and safety regulations.
- SEMARNAT – Regulation of hazardous materials and fumigation of forestry products
- SECODAM – Operation and administration of ports of entry
- SEGOB – Immigration and document inspection.

2.5 Overview of National Transportation Operations

The following presents a national review of transportation operations for both goods and people, including roads, rail, maritime, and public transport modes, over the transportation network described in Section 2.4.

2.5.1 Domestic Cargo Transport by Mode

In 2001, domestic cargo movement throughout the national transportation system was approximately 516 million tons. This is broken down as follows4:

- 79.3% is moved by road

4 2003 Transportation Statistics Manual . Mexican Transportation Institute. SCT. Mexico.

- 14.3% is moved by rail
- 6.3% is moved by sea
- Less than 0.1% is moved by air

There has been a significant increase in the use of rail for cargo shipments since the mid-1990's (from 11.2% in 1993 to a peak of 15.3% in 1999), which has mostly affected maritime transport (reduction from a high of 7.1% of all cargo movements in 1994 to 6.3% in 2001. However, all modes except air cargo have shown significant increases in tonnage moved since the early 1990's (approximately 19% growth overall from 1994 to 2000), in part due to NAFTA.

2.5.2 Domestic Passenger Transport By Mode

It is estimated that in 2001, intercity transportation generated the movement of 403.7 million passenger-kilometers. By mode, passenger distribution is as follows5:

- 96% use public roads
- 4% use air
- 0.1% use sea
- 0.02% use rail (not including urban rail transport such as Mexico City, Mexico and Guadalajara's metro or light rail systems)

The total movement in passenger-kilometers has fluctuated since 1994, from lows of 345.2 million in 1994 and 335.5 million in 1997 to over 403 million in 1996 and again in 2001.

2.5.3 Road-Based Passenger Travel Services (Non-Private)

In 2001, the federal transport fleet was comprised of over 45,000 buses, classified as Luxury Service, First-Class Service, and Second-Class Service. These services are provided by private firms, based on concessions awarded by the federal government.6 All but 5% of these concessions are held by corporations, the remainder by private individuals..

It is noted that the information in this section does not address state or other permits of concessions for public transportation services on state or other roads. These permits and services are separate from the Federal network discussed here.

The public transport fleet on the Federal roadway network consists of the following7:

- Nearly 2500 Luxury Class buses (De Lujo and Ejecutivo), over 5% of the fleet
- 10,000 First-Class buses, 22% of the fleet
- 26,000 Second-Class buses, 62% of the fleet
- Other services (airport shuttles, other) make up the remaining 11%

Additionally, the fleet used for Mixed and Exclusive Tourist services had more than 16,000 units, not included in the above summary.

2.5.4 Non-Road Passenger Travel Modes

Non-road passenger travel modes include rail, sea, and air. The 2001 rail passenger transportation fleet was comprised by 40 passenger coaches; the passenger sea transportation fleet was made up by 27 ferries and the air transportation fleet had more than 6,000 aircraft, of which 73.4% were private aircraft, 17.9% commercial aircraft, and the remainder were official aircraft.

---

5 Ibid.
6 SCT-DGAF. 2003 Basic Federal Road Transportation Statistics
7 Ibid.

2.5.5 Motor Vehicle Fleet

In 2001, there were more than 17.8 million vehicles registered in Mexico. These are broken down as follows:

- 69% automobiles and other private/personal vehicles
- 30% cargo trucks
- 1% passenger buses

However, of the 5.4 million cargo trucks registered in 2001, more than 4% were used for federal public transport services. Please note that the number of cargo trucks does not include pick-up trucks and work vehicles for private use; this which totaled more than 5 million units.

Just less than half (45%) of the nation's vehicle fleet is registered in only four states plus the Federal District. The percentages of registered vehicles relative to national totals are as follows:

- Federal District, 18% (including Mexico City)
- Nuevo León, 14% (including Monterrey)
- Jalisco, 7% (including Guadalajara)
- Tamaulipas, 6% (includes several smaller cities, including Ciudad Victoria and Matamoros, and is located along the Gulf south of the US Border)

2.5.6 Age of the Federal Permit Transportation Vehicle Fleet

As a representation of cargo truck conditions in general, the age of Federal permit vehicles (233,000 total) was reviewed. The distribution by age reveals that:

- 41% were less than 10 years old (typical vehicle life cycle)
- 30% between 11 and 20 years old
- 29% are older than 20 years.

The above means that approximately 60% of the fleet registered in 2001 was older than 10 years old. The greater percentage of the depreciated motor units corresponds to 3-axle trucks (class C-3), with 75% of the vehicles being over 10 years old. On the other hand, 52% of 2-axle tractor trucks (class T-2) are less than 10 years old.

2.5.7 Ferry Passenger Transportation Services

In 2001, the number of passengers transported by ferry was 4.1 million passengers. The Caribbean routes showed a dramatic growth in the '90s, with 92.6% of the total. The Pacific routes developed slowly and only participated with the remaining 7.4%.

In 2001, the Caribbean routes traveled 135.5 million passenger-kilometers, equal to 51.6% of the total; while the Pacific routes (from the mainland to the Baja peninsula) traveled 126.9 million passenger-kilometers, equal to 48.4% of the total.

2.5.8 Mass Transportation Systems

Mass transportation systems in metropolitan areas throughout Mexico, while largely consisting of a variety of small, medium and large buses, also includes, in the largest cities (Mexico City, Guadalajara and Monterrey) several heavy rail and light rail systems. Mexico City also recently deployed the nation's first Bus Rapid Transit (BRT) system in summer 2005 along the Insurgentes Avenue corridor.

Mexico City's MetroBus BRT

With the exception of MetroBus, most other bus services in cities across Mexico involve a variety of buses (diesel or gasoline powered) along dedicated routes which are operated via concession or by a public agency (state or local).

The more advanced and extensive mass transportation services as found in Mexico City, Guadalajara, and Monterrey are summarized in Exhibit 2.15, below.

Exhibit 2.15
Overview of Mass Transportation Systems in Three Large Regions

	Heavy Rail Metro System			Light Rail			Bus Rapid Transit		
City	Number of Lines	Length (km)	Fare	Number of Lines	Length (km)	Fare	Number of Lines	Length (km)	Fare
Mexico City	9	202	MN$2.00	1	18**	MN$1.50	1	19	MN$3.50*
Guadalajara				2	24	MN$3.50*			
Monterrey				2	42.5***	MN$4.50			

* - Denotes use of contactless smart cards with stored value, permitting cashless fare payment.
** - Connects with 489 km electric trolley buses (Trólebus) system
*** - Uses light rail vehicles, but system is completely grade-separated. Proposed system is 80 km.

Mexico City's Metro system is considered, per kilometer, the most inexpensive rail transport system in the world. Fares are paid through purchase of fare tickets (flat fare of MN$2.00 per trip).

Mexico City's MetroBus (the BRT line referenced above) operates in the median of Avenida Insurgentes, with 36 stops located along the 19-km route, serviced by 90 low-pollution, high-capacity (160 passenger) buses traveling at 15 minute intervals along dedicated median bus lanes.

Both Mexico City's Metrobus and Guadalajara's Tren Urbano utilize contactless smart cards which contain prepaid amounts (e.g., MN$20 in Guadalajara) which are then debited with each use.

2.6 Regional and Corridor Definitions

With 31 states in Mexico, and the diverse character of the nation, a "national" architecture cannot be developed in a generic fashion. But at the same time, it needs to be developed in a consistent fashion, and the basic framework elements need to be applicable across the diverse regional geographic and economic environments.

The Architecture Team recognizes that there are both common *regional needs* (addressing local conditions and common characteristics between one or more states in a particular section of Mexico) and common *corridor needs* oriented to a travel corridor. In general, most travel corridors in Mexico radiate from Mexico City, with much more limited direct connectivity between cities outside Mexico City. The corridor needs by definition may involve multiple Regions, and typically involve freight and passenger mobility issues at border crossings and at ports or multi-modal facilities.

Exhibit 2.16 (table) and Exhibit 2.17 (map) define seven specific regions which are oriented along transportation corridors. Much of the travel in Mexico is along specific corridors, most of them radial to Mexico City. This is especially true in the north where, for example, there is no major road connecting the neighboring states of Chihuahua and Coahuila.

Issues associated with these specific regions and corridors will be addressed in the upcoming chapters and particular ITS deployment initiatives appropriate for these regions and corridors will be developed.

Exhibit 2.16
Regions and Related Corridors

Region	States	Related Corridors
1	Baja California Baja California Sur Sonora Sinaloa	Central region to Nogales and Mexicali
2	Colima Jalisco Nayarit Michoacán	Guadalajara to Pacific ports, Central Region to Nogales and Mexicali
3	Coahuila Nuevo León Tamaulipas San Luis Potosí	Central region to Chihuahua
4	Durango Chihuahua Zacatecas Aguascalientes	Central region to Monterey
5	Campeche Tabasco Quintana Roo Yucatán Veracruz	Central region to Yucatan penninsula
6	Chiapas Oaxaca Guerrero	Central region to Chiapas, Guadalajara to Pacific ports
7	Distrito Federal Hidalgo México Guanajuato Morelos Puebla Tlaxcala Querétaro	All corridors originate or pass through this region.

Exhibit 2.17
Regions and Corridors

CHAPTER THREE
System Needs, Goals & Objectives

Based on the information presented in Chapter Two, along with further assessment and discussion of transportation issues with SCT staff and other national and regional stakeholders, the Architecture Team began the assessment of transportation needs. This effort, occurring in a series of regional workshops between September and November 2004, was critical in developing a thorough understanding of what role ITS could play in improving transportation in Mexico and more specifically what the National ITS Architecture effort would need to accomplish.

The Regional Workshops were conducted for each of the seven regions defined in Chapter 2.

3.1 SALIENT TRANSPORTATION CHARACTERISTICS

There are many aspects to transportation activities in Mexico. The salient characteristics are found below:

- As in many other developed and developing countries, congestion continues to grow at an unprecedented pace in Mexico City and many other urban zones
- Probably of greater significance is the role of international trade and commerce in Mexico's economy and in turn the role of the transportation system in handling this trade. In 2002, MN$4.5 trillion of cargo was moved within Mexico, of which 74% was international cargo. Most of this cargo is carried over Mexico's roadway network.
- Employment is increasingly international in nature also. In 2003, 600,000 commuters (US and Mexico) commuted across the border from homes on one side of the border to employers on the other side of the border. IN Chapter 5, existing ITS initiatives are underway at the border to reduce delays for cross-border commuters.
- The toll road network continues to grow, despite the difficulties associated with concessions and road privatization in the 1990's, where many roads became impossible for the private sector to operate as a result of lower than expected revenues.
- Since September 11, 2001, there has been a much greater emphasis in the U.S. for obtaining information about the source and nature of cargo that is shipped internationally, including from Mexico. The automation of such information is highly useful not just for preclearance and expedited inspections at ports and at border crossings, but also for freight operations and fee collection for domestic freight travel within Mexico.

3.2 TRANSPORTATION NEEDS DEFINITION

In light of the general characteristics presented above, several problems relative to the transportation network became clear. These are presented below and summarized in the form of "Needs Statements" related to particular operational and technical areas. These needs statements in turn form a definition of goals associated with the National ITS Architecture. These goals were developed based on agency and other stakeholder comments and considerations developed in the regional workshops.

The goals are summarized in Exhibit 3.1 below and are further detailed in the remainder of this section.

Exhibit 3.1
Needs Statements Related to Mexico National ITS Architecture

NEEDS STATEMENTS (GOALS)
Need 1 – Reduce accidents, fatalities, and injuries on the roadway network.
Need 2 – Increase security at the border crossings.
Need 3 – Increase security of people and goods throughout the entire transportation system.
Need 4 – Improve consistency of freight information standards and data between Mexico and other nations.
Need 5 – Improve documentation and correction of commercial vehicle operational and safety problems.
Need 6 – Improve management of road pricing and revenues
Need 7 – Manage changes in traffic flow conditions
Need 8 – Reduce the impact of incidents on the transportation network.
Need 9 – Provide improved management of regional public transport resources.
Need 10 – Enhance travel accessibility for citizens living outside major urban regions.
Need 11 – Reduce transportation impacts on air quality
Need 12 – Improve information on travel in Mexico

3.2.1 Safety and Security

A universal theme that has been echoed by various officials throughout the initial needs assessment process has been a concern over safety and security of travel, both for people and goods. In particular, the major issues are:

- Safety – Specifically, the large number of accidents and deaths on the highway system
- Security – Specifically, the loss of personal or commercial property due to petty theft as well as more serious criminal activities

3.2.1.1 Safety Needs

Concerning safety, the needs are simple – to reduce the number of fatalities and accidents on the roadway system. The focus is on the roadway network, since the airline industry has a very good safety record as does the maritime and railroad industries. While safety applies to all modes, the largest numbers are those related to roadway accidents.

Need 1 – *Reduce accidents, fatalities, and injuries on the roadway network.*

3.2.1.2 Security Needs

Security has been important for the flow of people and goods throughout the country. The economy depends on the movement of goods and services to all individuals. This is witnessed significantly the Mexico-US border region as both nations are undertaking an important effort to enhance security and safety though a series of actions. Bilateral cooperation is the key to the success of these efforts.

Need 2 – *Increase security at the border crossings.*

But security goes beyond the borders. The flow of goods must be understood from end to end. There are many opportunities for theft and destruction of goods at all points along its journey. This effort does go significantly beyond transportation, though it is intimately involved with transportation. The entire

homeland security issue from both an internal and external perspective must be considered. Significant cooperation with the enforcement and judicial system are critical to their success.

Need 3 – *Increase security of people and goods throughout the entire transportation system.*

3.2.2 International Trade

Most of the trade with the United States is by truck through one of the many border crossings. This is supplemented by rail and coastal shipping. The major problems associated with this issue (outside of those already mentioned) are related to time delays. At the U.S. border, trucks wait for hours for inspections. The inspections are for safety and security as well as simple documentation checking and exchange. All sides agree that those firms that have good records should not be unnecessarily delayed. All sides agree that faster processing is in everyone's best interest, but not at the expense of safety and security. As will be discussed in Chapter 5, there are a number of ITS initiatives at the borders already underway (including SENTRI for passenger vehicles and FAST for commercial vehicles, throughout the Mexico-US Border region). However, there are also other U.S. initiatives, notably national preclearance for trucks and freight, involving two programs, PrePass and Norpass. Those are not yet integrated into the border crossing technologies.

Similarly, at seaports, there is considerable time spent with inspections and processing paperwork from customs. Certain operations are efficient – the authorities are aware of the type and size of cargo coming in before they arrive, and local carriers are aware of what general work they will be doing before they arrive. Also, the operations for loading and unloading the ships are very efficient. There is also the coordination between Mexico and the U.S. on secure cargo manifests which are electronically forwarded from Mexican Customs to U.S. Customs.

However, there are problems with a lack of uniformity of interpretation of the customs rules. (This also applies at the border with the U.S.)

Finally, although SENTRI and FAST participants receive expedited service at the border, there are still operational delays at the border crossings for other users. With the variety of agencies required to clear vehicles and goods coming into Mexico (e.g., Customs, SEGARPA, SEMARNAT, SECODAM, SEGOB, SCT, etc.) there are also various efficiencies that could be implemented to reduce delay.

In general, the two major issues are related to uniformity of information standards and services across international boundaries, which could lead to a resultant improvement in efficiency of freight movements across international borders.

Need 4 – *Improve consistency of freight information standards and data between Mexico and other nations.*

3.2.3 Commercial Vehicle Operations

While much of the international trade involves commercial vehicles, there are other aspects of commercial vehicle operations that also warrant examination. Safety, security, and enforcement are all common themes when discussing commercial vehicle operations with SCT and other stakeholders. While efficient fleet management (i.e., dispatching, operation and maintenance of vehicle fleet) is also important, the vast majority of the commercial vehicles are maintained by owner-operators (one-truck companies). Fleet management is of much greater value to the larger carriers.

The first major issue is that many trucks are improperly loaded or overweight. The damage a vehicle does to a roadway is exponentially related to weight. Improper and overweight vehicles cause excess damage to the roadways. With limited budgets for repair, the end result is additional damage to the roadways that negatively impact all users for many years to come. It is assumed that the majority of the problems are concentrated in a minority of the drivers. Many of the carriers work hard to abide by all laws and

regulations. Training and certification are important ways that the government already deals with this issue.

Enforcement is another aspect of this issue. One of the major issues discussed with the Architecture Team has been timely recording and documentation of problems, as well as the ability to share the data with other inspectors. Since inspectors in one part of Mexico do not typically have the ability to communicate a particular problem to inspectors in other parts of the country (due to no standardized national inspection or vehicle registration database), very often one truck can be stopped by multiple inspectors for the same infraction on the same trip. Security checkpoints are numerous and induce large delays on the carriers on a single shipment. It is important that all approaches be used to address this problem – training, enforcement, and incentives. In particular, with increased enforcement, technology should be used to allow the carriers with a negative history to be targeted more often than those with a positive history. Operators therefore have a greater incentive to comply with the laws.

Need 5 – *Improve documentation and correction of commercial vehicle operational and safety problems.*

3.2.4 Toll Collection

Toll roads represent are a major element of the intercity roadway corridors throughout Mexico. Increasingly throughout the world, the use of toll-based financing is the primary way for new roads to be developed, operated and maintained. Likewise, as it becomes more difficult to implement new roads in Mexico due to budgetary limitations at the Federal and State levels, the financing of new roads and repayment to investors (public and private) through toll collection is becoming more common. Mexico has relied on both a national toll road agency (i.e., CAPUFE) and private concessions to develop, operate and maintain toll roads. CAPUFE took over a significant number of failed concessions in the 1990's when toll road revenues did not meet projections.

The greatest issue with any toll road is the collection of revenue. It is the core element behind the philosophy of toll roads. Considerable discrepancies often occur with manual toll collection. Additionally, it is difficult for the toll authority to monitor transactions and to understand and serve its patrons if there are no records related to the traveler, e.g. understanding origin and destination information, addressing traffic fluctuations and real-time operational conditions on the network.

Additionally, the IAVE system, when it is upgraded, needs to have the ability to work with all toll facilities in Mexico; this is of particular importance to commercial vehicles or other long distance travelers who use the entire Mexican roadway network. In particular, the standardization of payment systems for toll facilities (both existing and proposed) is a key element of ITS. It also can lead to cost savings relative to relying upon mainly cash toll collection activities, both in terms of staffing as well as in terms of efficiencies with respect to processing large numbers of payments. The use of standardized electronic toll collection methods throughout Mexico also provides opportunities to better finance improvements and expansion of existing facilities, as well as the deployment of improved management and operations activities using ITS tools.

The ability to electronically manage cargo and truck credentials as well as fee payment in a uniform, integrated fashion can result in both for reduced delay to freight movements as well as improved efficiency in collecting revenues. In many nations, the concept of distance-based payment for freight as well as passenger vehicle movements is being considered, and in some cases (such as Germany and New Zealand) is being deployed for freight movements.

Need 6 – *Improve management of road pricing and revenues*

3.2.5 Traffic Management

Traffic and incident management activities differ between different types of facilities. While recurring congestion tends to occur mainly in urban environments, management of traffic due to incidents or weather conditions can be an issue anywhere in the country.

On urban routes, maintaining smooth traffic flow through traffic signal coordination is desired; increasingly, the use of real-time traffic flow information is essential to address unexpected or inconsistent traffic patterns. Additionally, advance warnings of congestion (for example, warning of delays or accidents ahead using tools such as dynamic message signs) can be useful in reducing rear-end collisions, thus improving travel safety.

The major issue in urban environments is not necessarily maximizing travel speed (which may not be desirable if a region's policy is to encourage public transport use and pedestrian travel), but in providing more consistent, predictable traffic flow, which improves safety

Congestion is often a relative term – it means different levels of service in different urban areas. While this makes the problem universal, the solutions are not. Nevertheless, the key issue is in knowing when traffic flow conditions change, and applying the appropriate strategy to either mitigate these changes or to warn the roadway operator and the driver of such conditions.

Need 7 – *Manage changes in traffic flow conditions*

3.2.6 Incident Management

Related closely to traffic management is incident management. Incident management can be defined in many ways, but typically it is addressing any situation where roadway capacity has been reduced by some outside event. Most typically this is traffic accidents, though it can be rockslides, weather related, etc. But it can also involve a planned event, specifically including road work. Incident management is often more complex than traffic management because it usually requires the cooperation of several different agencies. For example, for a traffic accident, fire departments, ambulance services, towing companies, law enforcement, and highway maintenance are all involved in one way or another.

For limited-access facilities such as freeways or toll roads, road work and accidents may cause lane closures that could create significant congestion impacts regardless of whether the road is in an urban or a rural environment. In the worst cases, road closures may result in requiring traffic to remain stopped or for travelers to turn around. In more remote regions of the country, the lack of information related to a closure as well as detour or alternate routes can result in significant delays.

Need 8 – *Reduce the impact of incidents on the transportation network.*

3.2.7 Public Transport Management

There are two basic types of public transport systems in Mexico. The first is the large urban system of fixed rail and large bus fleet system. Large-scale systems around the world are very similar in their operations. While each has individual and unique issues, they all involve trying to match services in terms of fleet size and routes to demand. All have the same issues related to the maintenance and operations of large scale fleets and infrastructure. These systems are capable of increased efficiencies through all manners of improved fleet management.

Matching of fleet operations to demand is critical to transit operations. If too much capacity is used, the fleet suffers increased wear and tear and increased personnel costs. If too little capacity is provided, the public is forced to endure greater delays and they lose confidence in the efficiency of the system. Knowledge of changes in demand and anticipation of them allows an operation to get the most efficient use of the fleet. This reduces their costs and generally increases ridership with the provision of good services.

Need 9 – *Provide improved management of regional public transport resources.*

The second type of public transport consists of licensed operations that typically address either intercity movements or rural/suburban commuting to urban centers. These are licensed vehicles that are assigned specific routes. The central problem for these operators is that authorities have limited ability to track performance of these vital carriers and limited ability to provide connection protection and integration. A second problem is that adjoining services often do not have coordinated schedules. Ultimately, the usefulness of concession-based transit services is similar to those of regional systems – supporting travel demand. As trips may require more than one carrier or service in order to serve the needs of communities, coordination between different carriers becomes more useful and essential. This is also critical in light of the relatively low private auto ownership levels in rural areas – many residents are dependent upon concession-based, and sometimes illegally operated, transport services, in order to access jobs, educational or shopping opportunities.

Need 10 – *Enhance travel accessibility for citizens living outside major urban regions.*

3.2.8 Air Quality

Many urban areas suffer from air quality issues. In Mexico City, laws were created many years ago to restrict driving by day of the week. The lack of air quality has negative impacts on public health and economic vitality of a city or region, as well as causing permanent environmental damage in many areas. Much of the poor air quality is caused by vehicles. By reducing the vehicles operating in an area (while still serving the needs of the people) air quality can be improved along with the other public benefits this brings.

In essence, management of travel demand based on environmental needs (as well as congestion, discussed earlier) will remain a critical issue into the foreseeable future.

Need 11 – *Reduce transportation impacts on air quality*

3.2.9 Information on Travel in Mexico

Many of the needs statements in the above sections directly or indirectly address freight issues; reducing urban congestion and improving access for rural residents; providing an improved means of collecting and managing revenues that could be used to pay for building operating and maintaining transportation facilities.

Improving information on travel conditions and on available transportation options is a need which is related to the other needs – once improvements are made to the transportation network and there are additional options as well as tools designed to make the transportation network operate better, improving customer access to this information will be essential. Currently, there are very limited resources beyond information on current route networks and fees, whether it is for public transport services or for toll roads. All this information is contained in separate places, and there is little or no information related to current travel conditions.

Need 12 – *Improve information on travel in Mexico*

3.3 Definition of Architecture Objectives

The previous section addressed specific problem areas and identified 12 distinct needs statements (Goals) which will serve as the basis for defining a vision and overall direction for the Mexico National ITS Architecture. However, the measures for achieving these goals are defined through a second level of detail – through a definition of objectives.

Objectives break the solution to a problem (or problems) into positive measurable steps, including specific action items which are ultimately used as the basis for evaluation. In other words, the success of

the National Architecture may be measured in many quantitative and qualitative ways, but ultimately, its ability to meet the individual objectives defined here will be its measure of success.

Note that the objectives presented in this section are not technology specific. They refer to the specific results that are desired from the architecture, but do not prescribe the approach, technology or the methodology by which this should be done.

Each of the 12 goals presented in Section 3.2 can be broken down into specific measures which can readily identify whether a solution is addressing them. These measures will serve as the basis for the development of objectives.

3.3.1 Need 1 – Reduce Accidents, Fatalities, And Injuries on the Roadway Network

This particular need can be addressed by the following objectives, keeping in mind that accidents may be a misnomer – the intent is to prevent them as much as possible. Hence, the objectives refer to "preventable incidents":

Objective 1.1 *Reduce the number and severity of preventable incidents*
Objective 1.2 *Reduce the number and severity of fatalities due to incidents*
Objective 1.3 *Reduce the number and severity of injuries due to incidents*

3.3.2 Need 2 – Increase Security at Border Crossings

Security issues at border crossings basically involve permitting individuals who do not have the proper credentials or who are of questionable background from entering the country, or departing the country for a neighboring country. Improved access or preclearance of national records for individuals can reduce processing delays as well at crossings. Likewise, the departure of undocumented residents of Mexico, as well as the entry or exit of non-Mexican nationals who are considered to pose a security risk in the U.S. is a concern. (For example, may individuals who would have difficulty traveling or emigrating to the U.S. directly from their own country via air, due to security risk issues might have an easier time entering from a third country such as Mexico through surface ports of entry. The following would thus be objectives related to increasing security at border crossings:

Objective 2.1 *Eliminate border passages who constitute security risks*
Objective 2.2 *Increase the percentage of eligible national residents who are pre-cleared through border crossings.*

3.3.3 Need 3 – Increase security of people and goods throughout the entire transportation system

Personal and goods movements throughout Mexico are thought by many stakeholders to be at risk for crime or fraud. Improved preclearance as well as tracking information could assist in more quickly recovering stolen property; information about vehicles or individuals that is readily available to police anywhere within the country could assist in tracking down missing goods or shipments, as well as individuals responsible for the crime. Objectives are thus as follows:

Objective 3.1 *Provide ability for law officials to access truck and freight identification and profile information throughout country*
Objective 3.2 *Protect freight and personal identification information from being accessed by non-authorized individuals*

3.3.4 Need 4 – Improve consistency of freight information standards and data between Mexico and other nations.

Security of freight departing or arriving Mexico from air or maritime port facilities is increasingly being impacted by rules in the U.S. Current cooperation with U.S. security initiatives has involved development

of identification and security standards which in turn could be applied domestically in Mexico, in a reciprocal manner. Additionally, NAFTA is providing opportunities for freight shipments and truck operations to occur more frequently across the U.S.-Mexico border, and could benefit both countries. Objectives are:

Objective 4.1 *Provide ability to access identification of trucks and freight eminating from neighboring countries as well as Mexico*

Objective 4.2 *Improve accessibility to truck and freight information by traffic and law enforcement personnel.*

3.3.5 Need 5 – Improve documentation and correction of commercial vehicle operational and safety problems.

As discussed previously, one of the major issues related to commercial vehicle operations is the ability to document commercial vehicle operational and safety problems which are detected by SCT or Federal or state police inspectors. The problem is that information collected by one inspector is not immediately available to all other inspectors and agencies; hence, there might be repeated citations for the same problem on a single trip. Conversely, the ability for a registered repair agency or fleet operator to notify the government that specific repairs have been made is limited.

Better documentation of commercial vehicle operations will facilitate both correcting these problems as well as reducing the amount of redundant inspection activities that may be occurring due to inability to coordinate and share information. Objectives include:

Objective 5.1 *Eliminate redundant inspections for commercial vehicles on same trip*

Objective 5.2 *Make data on specific commercial vehicle operational and safety problems accessible by all licensing and law enforcement agencies*

3.3.6 Need 6 – Improve management of road pricing and revenues

Road pricing and revenue management, whether through direct tolling or through other mechanisms, is essential in assuring (a) that the vehicles that create the most wear and tear on the roadway network pay their fair share of expenses relative to the operation and maintenance of the system; and (b) that a revenue stream can be developed and maintained both as a leverage for roadway financing and as a means to directly improve and enhance the transportation system. Objectives include:

Objective 6.1 *Eliminate revenue losses and "leakage" from current tolling and other revenue mechanisms*

Objective 6.2 *Increase revenues to more proportionately reflect those vehicles and conditions which create more stress on the roadway network*

3.3.7 Need 7 – Manage changes in traffic flow conditions

Traffic control and management activities have occurred for a number of years along Mexico's transportation network, although these activities are largely concentrated either in urban areas or in road work or construction zones, where the strategies are localized. The essence of traffic management is to manage changes in traffic flow conditions. These changes may occur due to recurring congestion (for example, daily commuter traffic or seasonally-heavy traffic) or due to non-recurring congestion (for examples, delays caused by accidents, construction, inclement weather conditions, and other activities that result in a temporary capacity reduction). The keys to managing changes in traffic flow conditions are to (a) know when these changes occur or are going to occur; (b) provide immediate responses to these conditions – these may involve some pre-planned adjustment in traffic signal timings, adjustment in appropriate travel speeds, or advance warnings of conditions so as to eliminate the effects of "surprises". The objectives below represent the desired effects:

Objective 7.1 *Monitor changes in traffic flow on a continuous basis*

Objective 7.2 *Reduce unpredictability and inconsistency of traffic flow*
Objective 7.3 *Reduce incidents occurring as a result of changes in traffic flow conditions.*

3.3.8 Need 8 – Reduce the impact of incidents on the transportation network.

This is complementary in many ways to Need 7. In this case, incidents may either be caused by drivers (speeding, alcohol, reckless driving), by vehicle malfunctions, or by road conditions (inclement weather, roadway pavement or bridge failure). However, many incidents are in effect scheduled closures, which mainly occur due to road work activities. Depending on locale, these incidents may or may not have an impact on traffic flows, although the growth in traffic volumes over the years indicates that most incidents do affect traffic operations in some way. Incident impacts are typically addressed by (a) clearing the incident more quickly from the road so as to lessen the effect of the capacity reduction; (b) providing advance warning on the incident in order to enable travelers to change their travel speed, use alternate travel routes or make alternative travel plans in a timely fashion.

The objectives below represent the desired effects:

Objective 8.1 *Reduce duration of unscheduled incidents*
Objective 8.2 *Reduce upstream delays as a result of incidents*
Objective 8.3 *Reduce secondary incidents which occur upstream of incident locations.*
Objective 8.4 *Reduce fatalities or injuries which occur as a result of incidents. (Combines Objective 1.2 and 1.3)*

3.3.9 Need 9 – Provide improved management of regional public transport resources.

Public transport management activities should contribute to more convenient, safer services for the public. Aspects of convenience includes maintaining scheduled operations as well as improved connections between different routes and modes, plus addressing short term and long term travel demand needs. Aspects of public safety include monitoring stations and vehicles to assure the safety passengers and drivers and detect any criminal activity. Management of public transport facilities should thus include monitoring of current vehicle location and passenger loadings, and adherence to travel schedules, as well as the means to maintain schedules, include improved coordination with on-street and other traffic flows, knowledge of passenger demand at particular times, and availability of additional vehicles and personnel to support demand fluctuations.

Objectives in support of the above include the following:

Objective 9.1 *Improve public transport schedule adherence*
Objective 9.2 *Reduce waits at public transport stations and stops during periods of high travel demand*
Objective 9.3 *Reduce criminal activities on vehicles and at public transport facilities*

3.3.10 Need 10 – Enhance travel accessibility for citizens living outside major urban regions.

In many rural areas in Mexico, there is a very high dependence on public transport, as many of the poorer regions have a very low car-ownership level. Given that public transport service concessions are oriented to particular highway routes and not necessarily to the communities which generate the travel demand, there has been an increasing presence of non-licensed public transport services which connect smaller communities directly with larger communities without requiring multiple changes in buses or long waits at intermediate bus stop locations. One way of reducing the illegal transportation services is by enhancing public transport services to better address rural community travel demand. Service improvements to the legal, licensed services or expansion of concession opportunities to address community travel demand, possibly through the use of smaller van-type shared-ride vehicles, is desirable. Such services are best

implemented through some level of integration between various different transportation service types and operators. Many such independent operators may exist within a rural community or the regional centers that act as employment or commercial areas for the region. Integration of public transport activities in rural areas might include coordination of schedules and sharing of vehicle location and status information, especially in small cities or regional centers where different services meet or interface. Some of the issues here are similar to those related to urban public transport services, but address different institutional and demand-related concerns. Objectives relevant to the National ITS Architecture might include:

Objective 10.1 Reduce travel times for public or shared transport between rural or smaller communities
Objective 10.2 Reduce the number of unlicensed public transport / shared-ride services
Objective 10.3 Reduce the time required to connect between different transport services.

3.3.11 Need 11 – Reduce transportation impacts on air quality

Congestion and delay create the most significant impacts on air quality. The reduction of delay as well as optimization of traffic flows can enhance air quality. At the same time, poor air quality, regardless of how it is caused, often needs to be addressed in a remedial fashion (due to weather and other climactic conditions) as well as in a preventative fashion. To this end, access to particular cities, districts or communities may be limited during polluted periods, andr traffic flows optimized as much as possible to assure that the remaining travelers can achieve reduced delay and reduced pollution. The main objective here is:

Objective 11.1 Reduce pollution caused by point-based sources (e.g., autos, buses)

3.3.12 Need 12 – Improve information on travel in Mexico

Decisions on where and how to travel in Mexico are usually based on pre-packaged information, either through guidebooks or Internet-based information. Real-time information related to weather, construction, or accidents may not be easily available and can cause significant delays. In many areas, it requires travelers to turn around and go back to an alternate route or return to their origin. The reduction of wasted trips and delay due to having accurate, timely information can provide a great deal of benefit to both tourists as well as regional and interstate travelers within Mexico. There is one main objective as a result of this:

Objective 12.1 Reduce wasted trips and delay due to closures, accidents, road work, weather or other travel impediments.

3.4 Common Themes and Development of Architecture Vision

The objectives presented above include a series of common themes and similar activities. These are as follows:

- Reduction of accidents, incidents and other unexpected conditions which cause injuries and fatalities
- Sharing of critical customs and immigration information between Mexico and other countries
- Sharing of critical personal and vehicle information between licensing and law enforcement agencies within the country
- Improved security of persons and property using the transportation systems
- Reduction in travel times and delays across all modes and facilities
- Provision of financial and other resources needed to improve the transportation system

The National ITS Architecture must thus contain the following characteristics:

a) Ability to share critical information between public agencies
b) Ability to share critical information with other countries
c) Mechanisms to better manage incidents and resulting injuries and fatalities
d) Mechanisms to reduce travel times and delays for all modes of travel
e) Mechanisms to enhance security of persons and property
f) Mechanisms to generate revenues and efficiencies that will permit improvement of the transportation system

From the above, the Architecture Team began with an initial draft Vision developed by SCT and then incorporated the above themes. The Vision Statement is as follows:

Recognizing the continuing importance of all modes of transport to the quality of life of every Mexican, and that information and operations activities can be more effective than infrastructure, information technologies will be applied as an integrated program to the national transport tasks, to deliver a significant net contribution to Mexico's economic, transport, environmental and social needs and objectives over the next decade. ***This contribution will permit improvements in travel safety, performance, and security of persons and property; and will enable enhanced exchange of critical performance and transportation information within Mexico and between Mexico and other countries. It will also assist in generating the resources and efficiencies needed to further improve transportation services throughout the country.***

CHAPTER FOUR
Institutional, Legal & Regulatory Issues

4.1 OVERVIEW

ITS deployment involves the integration of various monitoring, communications and traffic control technologies, the integration of transportation information from various sources, and cooperative efforts from many agencies or authorities that may not have otherwise worked together in a coordinated or integrated fashion.

Most ITS deployments completed to date around the world are "stand-alone" – they are not integrated with any other system. The typical reasons are simple – there is often just one source of funding, there is usually just one "owner" or "operator", and deployments are usually restricted to a single jurisdiction. Additionally, even in the most benevolent management of a project, integration with other systems is typically a secondary concern.

Hence, experience in deployment of ITS throughout the world has shown that often "non-technical" issues are typically more difficult to overcome than technology issues.

Thus, the main purpose of ITS architectures and standards is to provide aid and guidance in the integration of various systems which may involve multiple government agencies, multiple types of facilities, and even multiple modes of transportation. When done at a National level, such an architecture amounts to a framework or "road map" both for developing regional or project ITS architectures as well as a guide to defining what particular information or communications standards need to be developed or where established international standards should be considered.

The previous chapters have addressed the key operating agencies involved in transportation in Mexico and their various activities. From workshops held on a regional level with various stakeholders, a number of transportation issues were defined which will serve as a basis for defining the role of ITS in operating Mexico's transportation network. From that information, this chapter summarizes potential institutional, legal and regulatory barriers to ITS deployment. Also provided are recommendations to overcome such implementation barriers.

4.2 OUTREACH EFFORT

Under the Mexico National ITS Architecture ITS effort, several regional workshops were conducted with a large number of the major stakeholders in transportation. Between August and November 2004, the Architecture Team visited 5 different regions, with participation from approximately 200 attendees representing over 100 different government agencies and offices. Individual interviews were conducted with at least 12 different government agencies and offices. At the same time, there are 31 states (plus the Federal District) in Mexico, and 28 metropolitan areas above 500,000 in population. Due to the time, logistical and budget limitations of this study, it was impossible to have "universal" involvement in this process. However, the agencies that have been represented did represent the largest stakeholders, and great effort was placed on inviting those individuals from different departments and areas of specialty, such that collectively they represent a wide variety of interests within the transportation industry in Mexico. As a result of this, a wide variety of issues were identified, as was apparent in the assessment of needs, goals and objectives presented in the last chapter.

In combination with the experience of various Architecture Team members in high-level government departmental and policy planning activities, considerable input was provided into this effort. This expertise has been incorporated into the Architecture Team's overall knowledge base relative to the transportation industry and ITS development experience throughout the world. Thus, the end result incorporates both global experience and current, relevant operational concerns within Mexico. Together

with the workshops and interviews, this has permitted the development of an extensive list of institutional, legal and other non-technical issues relevant to national deployment of ITS.

4.3 Legal Issues

4.3.1 Mexican Laws – General Overview

A law can be defined as a general or compulsory legal rule or set of rules imposed by a legitimate authority to regulate the conduct of men or to establish the bodies required to fulfill such purposes. A law is the work of the legislative branch and its source is the desire of the majority.

In Mexico, the Legislative Branch is the one that can enact the laws, both Federal Congress and State Congress. Regulations, which are a set of obligatory general rules promulgated by the executive branch, are dictated to ensure that laws are obeyed. Generally speaking, a Traffic and Transportation Regulation addresses issues related with pedestrians, drivers, vehicles, and the environment where circulation takes place.

The main difference between a Law and a Regulation is that the first establishes the general bases; establishes the precedents. A Regulation foresees compliance with the Law, it perfects, supplements, and details aspects of the same. Due to its origin, a Law is established by the Legislative Branch; the regulations by the Executive Branch. (Molinero, 1997)

4.3.2 Transportation Legal Regulations

Legal systems affect transportation in a variety of ways. In some countries, litigation is a big concern. In others, legal challenges to projects have helped to create very formal processes to ensure projects address all concerns. In others, protection of the environment takes precedence. In all cases, there are legal limits to how transportation services are implemented and managed. Many laws have been created over the years that were initially intended to address a single issue such as purchasing, jurisdictional boundaries, safety, etc. Most were created with the intent of improving the way transportation is managed.

The main legal regulations governing the transportation sector in Mexico are as follows:

<u>Federal Environment</u>

- Political Constitution of Mexico
- International Treaties (agreements)
- Federal Public Administration Organic Law
- Planning Act
- General Communications Act
- Federal Road, Bridges, and Transportation Act and their regulations
- Rail Service Regulation Act and its regulations
- Civil Aviation Act and its regulations
- Airport Act and its regulations
- Ports Act and its regulations
- Navigation Act and its regulations
- Federal Public Servant Responsibilities Act
- Federal Administrative Procedure Act
- Foreign Investment Act
- Federal Economic Competition Act
- Public Works and Services Act related to them and its regulations
- General Environmental Protection and Ecological Balance Act
- General National Assets Act
- International Multimodal Transportation Regulation

State Environment

- Political Constitution of the Free and Sovereign States
- Urban Development Act (or its equivalent)
- Public Administration Organic Law for each state (or its equivalent)
- Public Transportation and Traffic Statutes and Regulations for each state

Municipal Environment

Regulations at this level are based on the increasing decentralization that is taking place in all the branches of public administration in Mexico, arising from the 1982 amendments to Article 115 of the Constitution, which return autonomy to each municipality. Within this article it is established that individual States in Mexico will adopt democratic, representative governments, and that Municipalities serve as the basis of territorial division and state political and administrative organization.

In this sense, the Municipalities are to be responsible for public and traffic safety; and all others public services established by local legislatures in accordance to territorial and socio-economic conditions of the Municipalities, as well as their administrative and financial capabilities.

4.3.3 Procurement and Operations / Maintenance Implications

The Federal Public Administration Organic Law (LOAPF) identifies the responsibilities of Federal and State Branches of Government. SCT's responsibilities are set forth in Article 36 of LOAPF, in which it is stated that for the study, planning, and implementation of administrative matters, the Federal Executive Branch will have the support of State Secretariats, among which is included the SCT. SCT is responsible for the following items, amongst other responsibilities:

- Developing and managing communication and transportation development programs according to national needs
- Awarding permits and concessions for the development of motor transportation services on federal highways and overseeing the technical aspects of their performance and operation, as well as the enforcement of the corresponding legal dispositions.
- Building and maintaining federal roads and bridges including international ones, as well as federal motor transportation stations and centers.

Restrictions are often placed on the procurement process (bids) for a variety of reasons. In general, the main purposes are to ensure fairness in selecting vendors and to ensure standards are abided by. The restrictions vary based on situation. For any federally funded project, all federally mandated standards and procurement regulations are enforced. For other public entities, if any part of the project funding are federal, again all federal standards and regulations are enforced. Local agencies not relying on federal funding have additional options, although most of the regulations are in place to protect the agency from loss and are to be followed as best as possible.

For private entities, there are fewer restrictions. However, the general practice is still to have competitive bids and to follow industry standards. There are sometimes longer-term objectives that may constrain the selection of partners or purchasing options according to local or project requirements, but this is considered rare.

In general, there have not been significant issues raised with respect to current procurement processes; in general, they focus on competitive bid processes as opposed to sole-source negotiated procurements.

4.3.4 International Rules

Most international laws are concerning commerce. These are met through the day-to-day activities of the Mexican Customs Department. The biggest impact of international law is upon freight shippers and carriers.

The Mexican and US governments continue to meet and exchange ideas on a variety of issues related to international commerce and border operations. Additionally, Mexico continues to work with trading partners throughout the world. There are a number of demonstration and test projects involving ITS and other technology applications (refer to Chapter 5) that work at increasing coordination between the nations, in particular at the borders. Again, the majority of the effort on these projects comes from the shippers and carriers that must process all the necessary international forms. Continued participation in bi-lateral improvements is necessary to reduce trade barriers.

4.3.5 Limits of Enforcement

The legal system also includes the enforcement side. Laws are of little use if they are not enforced or there is no means of following through with punishments. In transportation, enforcement can be categorized into two areas. The first is at the *procedural level* at an in terms of the agency establishing procedures that meet the requirements of the law and ensuring both the agency and the affected companies follow those procedures. The second is in terms of the *actual enforcement*, assuring that Police or inspectors enforce specific laws on individual drivers/operators.

At the first level, there are formal procedures and processes for procurement of services and operation of concessions. A concern is the lack of staff to adequately monitor the performance and effectiveness of these procedures and processes.

At the second level, again lack of staff is considered in issue. Adequate trained personnel are needed to inspect commercial vehicles and enforce basic traffic laws. However, law enforcement responsibilities also involve safety and security, and thus it becomes difficult to provide adequate attention to freight inspection and enforcement activities. Certain operational procedures could be improved, such as less frequent inspections for those carriers that have proven themselves to be reliable. Police also have responsibility for basic security, which has become increasingly demanding. Special operations intended to provide security for cargo transport in particular have already begun.

To assist in improving the effectiveness and efficiency of enforcement, ITS applications could be considered. Examples include the use of technology to monitor traffic to better target enforcement, providing coordination with electronic manifests and seals, and sharing of agencies' databases for enforcement purposes.

4.3.6 Public Agency Liability

This is not considered to be as big a concern in Mexico as in other developed nations. The public are more concerned about agencies meeting basic user services than optimal efficiency or privacy. In various locations throughout the world, ITS projects have had restrictions placed on them to meet liability and privacy concerns. For example, physical constraints on pan-tilt-zoom units or screens have been deployed for certain CCTV cameras to assure that only roadway operations are visible from the cameras, not private residences or businesses. Also, the accuracy of roadway information and advisories are of concern, particularly if an accident occurs, even indirectly, because of an advisory or traffic control display that provides a specific directive.

While there appears to be little current concern in Mexico about public sector liability, this is one area that can change quickly. In previous instances of gross infringement upon the rights of the citizenry, this issue can be quickly become a major concern.

4.3.7 Privacy

Privacy is not yet considered a major issue in Mexico. The reason is there are few national or even regional electronic databases that contain personal or vehicle information (Buró de Crédito, which tracks payment history of credit holders is an exception). As more electronic systems are developed (especially those involving electronic payment), this issue may become more important to the average Mexican. There are some concerns about privacy in that some feel that personal information available in databases will be used to target individuals for crime.

4.4 Regulatory Issues

Regulatory activities include training, licensing, permitting and inspection. Related issues are discussed below.

4.4.1 Motor Carrier Driver Training

A significant issue involving motor carriers involves the number of crashes on Federal roads, the main cause of which is human error.

To improve driver operations and safety, SCT established a National Training Center Program for Federal and Private Motor Transportation Drivers. In 2002, 106 Training Centers officially acknowledged by the SCT were opened, providing training in a variety of different areas.

Federal motor transportation training plays a significant role in increasing road safety on federal roads, improving the efficiency and capability of the services and making the driver's job safer, more comfortable and convenient. Consequently, SCT established a Driver Training Program to provide specialized instructors and facilities.

Minimum Driver Training Programs for drivers of Cargo, Materials, and Hazardous Materials were developed, along with similar programs for passenger carriers and tourism.

4.4.2 Driver Licensing

Driver licensing occurs at federal and state levels, with federal licensing focused on professional drivers (working with motor carriers). State-issued driver's licenses, far more prevalent, are provided for private passenger car operations.

Pursuant to existing regulations, anyone interested in getting, endorsing, or in its case, renewing a federal driver's license must enroll in and complete an education and training program in any of the Private or Federal Motor Transportation Driving Training Centers authorized by the SCT; this requirement is in lieu of the theory-practical tests that used to be given to get the federal license.

Regarding federal operation licenses for federal motor transportation vehicles in 2003, the following transactions took place: 17,385 new issues; 15,155 additional categories; 41,503 endorsements; 50,961 duplicates, and 15,754 reissues.

State-issued drivers licenses, on the other hand, are not uniformly handled. There are few standards and little or no sharing of license database information between states. Hence, there is no formal mechanism to track individuals who may travel from state to state and regularly break vehicle or driving laws. Of interest is that many states in Mexico do not even recognize their own issued driver's licenses as official identification cards.

4.4.3 Federal Motor Transportation Permits

In 2003, a total of 33,344 permits were issued nationwide for federal and private motor transportation services, these cover a total of 54,405 vehicles. Of all the permits, 87% accounts for cargo services, which include general cargo, specialized cargo, and private cargo services, and the remaining 13% accounts for passenger and tourist services.

4.4.4 Federal Motor Transportation Supervision and Inspection

In 2003, 1,720 inspections and supervisions were carried out in passenger terminals, company lots, contamination emissions and verification centers for purposes of verifying that federal motor transportation permit holders complied with existing regulations and the requirements of safety and efficiency demanded by the public; this was done in coordination with the SCT and the Department of Federal Motor Transportation.

Likewise, 109,580 Federal motor transportation Vehicles were inspected nationwide.

4.5 Societal Issues

A number of issues are more socioeconomic in nature than institutional. The issues presented in the section arose from discussions within the workshops and in the various agency interviews by the Architecture Team. They are instructive in that they may influence the ability or willingness to adopt new services that might be developed through deployment of ITS. They may also influence the approach that may need to be taken into introducing, implementing and operating such services.

4.5.1 Cash Society

Mexico is much more a "cash society" than many other nations. Credit is not frequently used. This has hampered the introduction of automated fee collection systems. In particular, electronic toll collection is most often implemented as an automated charge against a credit card or bank account. Fewer than 100,000 drivers are known to have electronic toll collection devices (transponders) in Mexico, despite the significance of toll roads as high-speed access routes between major cities.

Despite this, as with other nations, the use of prepaid phone cards and even smart cards for public transport use, are gaining favor and popularity. Therefore, it is possible that proper marketing with respect to the convenience of cashless payment services (whether for road tolling or public transport) could make a difference. However, the benefits of cashless payment for toll roads are also tied to providing higher-speed or even "open road" (no plaza) transactions. Without appropriate enforcement mechanisms (e.g., national drivers license databases which could be connected with localized video enforcement), it is difficult to market the technology more effectively or sell its benefits to the public.

4.5.2 Illegal Federal Road Access

Along many toll roads, there are local access roads that have been built by the local community. These access roads are unregulated and untolled, resulting in a loss of revenue for the toll concession. These roads are usually tolerated and in reality provide an important service because they often provide the only access to a town. CAPUFE has approached this issue by developing a census of these kind of users and provides them with an adjusted toll according to the specific situation. However, a bigger issue is emergency access to local communities, and the ability to quickly access such communities leads to more important issues – in particular, how can such access routes be made safer, and designed and maintained in a more legal fashion.

4.5.3 Small Commercial Vehicle Operators

The vast majority of the trucks operating within Mexico are owner-operators. These carriers operate on very small margins, and often need to accept loads that may not meet acceptable operational practices. The result is that they lack the resources to implement technology in the first place – even if they are assured of recouping their expenses later.

There is a need to further regulate these operators, for the safety and well being of all travelers. This segment of the motor carrier industry has a higher percentage of older vehicles that are generally not maintained to the same standards as the larger fleet. Mandating particular inspections or preclearance/registration activities (generally involving ITS technologies) is one viable option, but if owner costs are not fully reimbursed or funded by government, there might be at least a short term problem with some carriers going out of business. This in turn could place a greater demand on those carriers that continue to operate in order to ensure goods are moved throughout the country.

4.6 Institutional Issues

Public sector institutions throughout the world carry their own issues unique to their organization. Such issues, however may be significant in terms of how projects are deployed, implemented or operated. In the case of ITS, institutional issues may not affect the overall functionality of the various systems, but it may affect how the system is deployed and who operates and maintains various system components.

4.6.1 Contracting of Transportation Services

In Mexico, the provision of transportation services is the responsibility of the Government. This would include provision of roads and other infrastructure, along with associated public passenger transport services on these roads for those not traveling by private vehicle. However, the operation of transportation systems are generally considered as private sector activities which are carried out under a civil contract. These contracts establish an agreement between a person identified as the carrier, who commits to driving or transporting individuals or goods from one point to another, upon the payment of a certain rate, by another individual identified as a passenger, client, or user.

In Mexico, Article 28 of the Constitution established that the provision of public services is the responsibility of the Government; in the case of transportation, these can be provided directly by said administration or indirectly through a concession or permit.

A concession is the legal act whose purpose is to authorize its holder to provide a public service or the exploitation of government assets – in other words, the concessionaire is granted the authority to operate and maintain a government property, such as toll road, airport, or stadium, for a fixed period of time, after which term the government gains access to these assets again, either to renew a concession or to operate the assets directly. In contrast, permits, authorizations, or licenses relate to either the provision of a private service that is of public interest or to authorize private sector individuals to carry out activities that are purely of a private nature, but which require express Government authorization, due to public safety, peace, or health issues (Molinero, 1997). In this case, the permit holder will use their own resources or services (e.g., vehicles meeting the permit requirements) to carry out the requirements of the permit.

The legal situation of the concessionaire and the permit holder is clear. In the first case the Government is the one who authorizes the provision of a public service through a concession, with a set expiration date, which could or could not be extended. In case the service is provided with a permit, the permit holder will only exercise the right to provide such service, which could be more efficient and cheaper, and in case it is provided as required by law it will always be subject to extension by the Government. (Molinero, 1997)

The Government's pre-1995 experiences relative to toll road concessions caused SCT to develop new concession requirements, which would be based on development of toll revenue and market studies, development of 30-year concession agreements, and an assurance that concessionaires have the ability to finance and operate the system without the assistance of government subsidies.

4.6.2 Revenue Generation

There are a few distinct types of revenue generation that currently exist in Mexico. Public funding from taxes is the primary source. Direct user fees are a second – either in the form of tolls or payment for public transit. Another source is fees such as licenses. For those activities completely within the private

sector (e.g., fleet management), revenue for projects is part of the general operating expenses as determined by the company. For many of the companies, they are owner-operators and revenue for operations is much more limited.

Recent changes involving the operation and maintenance of toll facilities will result in revenues from toll roads being used increasingly for government services, as opposed to purely the operation, maintenance and expansion of toll facilities.

4.6.3 Police

The police are responsible for security and safety. They respond to all traffic accidents on the roadway system. The jurisdictions are by roadway owner, that is, federal police have responsibility on the federal roadway system, etc. Police are also responsible for enforcement of overweight cargo vehicles, inspections of cargo, and security.

There are several police jurisdictions (federal, state, local and modal). The police are generally responsible for enforcement of laws. This includes safety and contraband inspections. There are few formal inspection facilities throughout the country. The majority of the inspections are mobile – the police will set up at a certain location and pull traffic over as necessary. Most inspections are very manual, with hand checking of manifests and physical/visual inspection of cargo.

Coordination between police forces is fairly informal – generally with communications centers coordinating with each other. What this also means is that there is little electronic continuity or interface between police forces with required to vehicle inspection, enforcement data, etc.

4.6.4 Emergency Assistance Functions

060 is an immediate emergency assistance system, which allows the channeling of emergency assistance requests to various institutions which provide emergency assistance such as civil protection, fire department, transit, government public safety, and police as pertinent. In this service, more than 152,000 calls have been channeled and the average response time is 14 minutes and 55 seconds.

The police are also tasked with responding to incidents. Incidents are typically called into either 060 or the nearest barracks. The local police will call other agencies if they believe the other police force is responsible for responding. Emergency medical services are provided by hospitals or the Red Cross. Coverage in the rural areas is sparse, so response times are poor.

4.7 National Issues

There are some issues of national importance that need to be documented. These issues have typically been addressed to a certain extent within the previously defined categories. The following section will highlight only those aspects that relate on a national level.

4.7.1 Lack of National Identity Databases

Drivers licenses are generally not recognized as official forms of identification – sometimes even in the state they were issued. The only two recognized forms of identification are passports and voter identification cards. While this may not seem to be an issue related to transportation, its implications are far-reaching. Lack of national databases makes it difficult for agencies (including law enforcement) to track individuals and assemble all information (both good and bad) about them. Without this database, it is not clear whether a driver has completed all training, has a clean record, or is wanted by law enforcement in another location. Because many of the electronic payment systems are kept on a cash basis, there has is no need to know personal information, because the bearer is assumed to have been the one to purchase the services. However, if electronic tolling or other payment services are to be further considered as part of ITS activities, there must be a means of matching a vehicle and a driver to ensure

proper billing. So while electronic toll collection can move forward, the addition of open road tolling will be a much more challenging task due to the current tolling operational issues.

4.7.2 Still Building the Federal Roadway Network

Only 40% of the total Mexico federal highway infrastructure has been built. There is still considerable infrastructure to be completed throughout Mexico. This is balanced against the needs of upgrading corridors in urban areas and improving the condition of the existing pavement. As discussed in Chapter 2, much of the network is still not paved.

4.7.3 Lack of Railroads

There are fixed rail transit lines in the larger cities, along with a national network of railroads. However, the total distance is limited and much of it was constructed many years ago. Railroads are often viewed as direct competitors to the trucking industry. While this is true to an extent, there are certain items that are best moved by railroads (e.g., bulk grain), but that even with considerable movement by trains, trucks are often used at least at one end of the trip.

With the relatively new concession structure for railroads, it is important to examine where improvements can be made. The national issue is that additional railroads should be viewed as completion of the freight movement capabilities of Mexico. Any new railroad should consider all aspects of intermodalism. Additionally, much of the existing track is in need of repair or upgrading. This should accompany any expansion.

4.7.4 Funding – Limited Resources

Funding is a concern in all countries around the world. Governments are tasked with a wide variety of services they need to provide to their constituents, and considerable debate centers on how the public resources should be spent to meet those needs.

In Mexico, the government has a plan to increase spending on transportation and the infrastructure. ITS will likely play a role in this debate, but the decision on where to dedicate resources will have to made on a year-by-year basis.

4.7.5 Security

Mexico prides itself on remaining a politically neutral nation. There is very little involvement in the internal affairs of other nations. Consequently, homeland security is much less of a threat to Mexico than many other nations. However, personal security is still an issue with the Mexican citizens. Personal and property safety and protection are of key concern, and commercial theft while freight is en route is an issue that has to be better addressed through improving various national licensing and registration systems which permit interoperability and sharing of ideas between states and Federal government.

4.7.6 Tourism

Tourism has accounted for 8% or more of Mexico's Gross Domestic Product (GDP) over the past decade, supporting at least 1.7 million jobs and over $MN7.2 trillion (US$700 billion) in revenues to the national economy. Of this, 12.7% of tourism revenues come from international tourists, while the remainder are domestic tourists.

Thus, traveler information for domestic travelers as well as international travelers could be of great value, including information on travel directions, as well as real-time road construction, incident or weather conditions.

4.7.7 Substandard Road Geometrics

As mentioned previously, many of the heavily traveled routes have road geometries that are designed for smaller urban vehicles. Around ports and on federal routes, this becomes a significant problem.

In addition, many federal roads have not been built to a consistent standard. In the US and Europe, standard clear zones are used in both width and slope. Where such zones are not feasible, remedial measures are used, such as barrier walls. Additionally, traffic control in work zones is highly regulated with standards for signage and pavement markings. A significant portion of Mexico's roadway network is in older urban areas and mountainous terrain. Neither is well suited for high speed travel and fully implemented cross sections.

While ITS solutions do not substitute for well-designed roadway infrastructure, they can assist in monitoring operations and providing advisory information in advance relative to incidents, road work and weather conditions, so that the impacts of unexpected, non-recurring conditions can be mitigated (for example, reducing secondary incidents upstream of the first incident), or that alternate routes or travel modes can be considered prior to beginning a trip.

4.7.8 Standardized Electronic Toll Collection

All toll roads in Mexico are operated either by CAPUFE, or by private concessions. These concessions have one thing in common – they are all federal concessions granted by SCT. While CAPUFE has standardized its electronic toll collection on its IAVE system, the other concessions have not standardized. Also, CAPUFE is in the process of updating and possibly changing its ETC vendor in order to support international ETC communications and interface standards (either North American or European standards have been under consideration).

For the long distance traveler (which is the majority of the commercial vehicles), standardization of the toll technology and payment systems is critical. The driver does not want to have to have several tags and needs to have only one account to pay.

4.8 Issues by Region

The Mexico National ITS Architecture will quite naturally be focused on transportation issues of national significance. However, the majority of the issues identified by the Architecture Team were uncovered through the discussions in the Regional Workshops. These meetings demonstrated a notable consistency throughout the country in terms of transportation needs. While some issues are of different relative importance in different parts of the country, and there are differences with respect to level of current ITS implementation and availability of resources in each region, the main transportation issues affecting the country are apparent in all regions.

There are 31 states in Mexico along with the Federal District. As shown in Chapter 2, these states were grouped by the Architecture Team into seven specific regions which are oriented along transportation corridors. Much of the travel in Mexico is along specific corridors, most of them radial to Mexico City. This is especially true in the north where, for example, there is no major road connecting the neighboring states of Chihuahua and Coahuila.

Characteristics of each region as presented at the end of Chapter 2 are presented below:

4.8.1 Region 1 - Central region to Nogales and Mexicali

This region contains major ports and border crossings with the US as well as some of the major tourist cities. The main regional issues are appropriately improved efficiencies at ports and borders, goods movement, safety and security, and improved public transportation. This region is also unique in that it contains passenger ferry transport.

Goods movement to and from the central part of Mexico is an important part of the economy. Additionally, tourism both at the border from California and Arizona and in the resort areas of La Paz and Cabos San Lucas are also critical. In order to accomplish both tasks, public transportation and safety and security were considered by the stakeholders to be of high importance.

4.8.2 Region 2 - Guadalajara to Pacific ports

This region contains major seaports as well as additional tourist locations. The region also includes the second largest city in Mexico – Guadalajara. The main regional issues are appropriately improved efficiencies at ports, goods movement, safety and security, and improved public transportation.

Guadalajara has several technology applications including a traffic control system and a large public transportation network which utilized electronic payment technologies. The region also contains some of the largest ports for goods to and from the Pacific. Movement of these goods to both Guadalajara and the central region are critical to the economy.

4.8.3 Region 3 - Central Region to Monterrey

This region contains border crossings with Texas as well as two large cities - Monterrey and San Luis Potosi. The main regional issues are improved efficiencies at border crossings, goods movement, safety and security, and improved public transportation. While this region does border the Gulf of Mexico, tourism has been more focused more on the border towns.

Monterrey has an extensive traffic management system which is presented in further detail in Chapter 5 – in fact, one of the more modern systems in the world. Additionally, there are large public transportation networks within both Monterrey and San Luis Potosi. This region contains many of the most productive industrial areas of Mexico and movement of these goods produced here is critical to the national economy. As in other regions, movement of goods is intertwined with border crossings and safety and security. The large population centers also create large public transportation needs in this region.

4.8.4 Region 4 - Central Region to Chihuahua

This region contains several border crossings with Texas, along with two large cities – Juárez (the largest city on the US border, located directly opposite El Paso, Texas) and Chihuahua. While industry in Juarez thanks to NAFTA has grown substantially in recent years, this is also one of the most rural regions. The main regional issues are improved efficiencies at border crossings, goods movement, safety and security, and improved public transportation.

Movement of goods between Texas and central Mexico is a critical concern in this region. Safety and security were more of a concern here with the large stretches of open road in rural areas.

4.8.5 Region 5 - Central Region to Yucatan Peninsula

This region contains the busiest seaport in Mexico (at Veracruz), as well as considerable tourism along the Yucatan Peninsula, particularly Cancun in the state of Quintana Roo. The main regional issues are improved efficiencies at ports, goods movement, safety and security, and improved public transportation.

Veracruz is a critical economic engine to this region, and the associated movement of goods between the Port and Central Mexico are among the most important aspects of this economic engine. The port is undergoing many improvements and has just initiated a major safety and security program to help protect the movement of those goods to their final destination. Additionally, this region has numerous tourist destinations along the Gulf of Mexico.

4.8.6 Region 6 - Central Region to Chiapas

This region contains border crossings with Guatemala and some ports along the Pacific coast. The main regional issues are improved efficiencies at ports, goods movement, safety and security, and improved public transportation.

More than any other region, this region highlighted the need for basic improvements in the transportation network. Geometric improvements were actually the most important need. Also, this region tended to highlight the issues with public transportation more than the other regions. In particular, rural travel from

smaller towns to centers such as Oaxaca were of interest, given a significant number of the available jobs are in these cities. Particular concern about unlicensed passenger carriers operating directly between rural communities and larger urban centers was expressed.

Many problems were noted in goods movement between the ports and the interior, to a great extent because of the limited road network connecting the coast with the interior cities.

4.8.7 Region 7 - Central Region

This region contains Mexico City and the surrounding urbanized states. The main regional issues are goods movement, safety and security, and improved public transportation. While border crossing and port improvements are not listed here, this region is the source and destination of much of the international trade.

Mexico City contains a large adaptive traffic signal control system (discussed further in Chapter 5), which works in conjunction with extensive video monitoring. As with Monterrey's system, it is one of the more advanced traffic control systems in North America.

Public transportation is critical to travel throughout this region. While the systems that have evolved handle significant numbers of passengers (and in the case of the Metro system, operate at or beyond capacity much of the day), coordination and control is not as strong as it could be – there are more efficiencies to be gained. Also, with no direct connection to a port, this region depends on the rest of Mexico for receiving the large amounts of goods consumed here. The movement of freight is viewed as critical to the livelihood of everyone.

4.8.8 Regional Summary

As is apparent from above, while there may individual priorities amongst the regions, in general there are very similar transportation needs throughout the country.

The safe and efficient movement of goods across Mexico is viewed by most regions as necessary for the success of their economy (especially those regions with extensive industry or seaports). Key to this is efficient port and border operations.

Equally important for everyone's quality of life was safety and security. Again, this covers both a desire to see a reduction in the number and severity of accidents, as well as prevention of theft and violent crimes along the major motorways.

Finally, improvements in public transportation were noted. The system that has evolved in Mexico is a collection of public and private systems with considerable unlicensed services that have formed to meet the needs of those in the more rural areas. While the design of the systems may have been good, the implementation could use some additional controls.

4.9 Border Crossing

There are almost 200 million vehicle crossings and almost 100 million pedestrian crossings at the US border every year. With the international agreement on NAFTA, this trade has increased dramatically in recent years and is expected to continue to grow. The movement of both goods and people across international borders is vital to the continuing shared economic benefits.

4.9.1 US-Mexico Border

Whenever people or goods move across an international border, there are numerous checks and records to be made. In terms of transportation, this equates to delays. While less scrutiny might improve traffic flow (vehicles per hour), both nations are increasingly concerned about security. There need to be checks to eliminate the movement of illegal goods and individuals wanted by law enforcement or investigative agencies. As will be discussed in Chapter 5, there have been a number of demonstration projects and

initiatives which have been deployed at the US-Mexico border in order to both improve efficiency of border operations as well as improve the screening capability of individuals that are not pre-screened travelers.

Such initiatives have helped to formalize relationships with the agencies involved. Both trust and understanding has been built between agencies on both sides of the US-Mexico border.

However, not everything has been standardized yet, including the various technologies. Additionally, all of these projects require bi-national participation to be effective. There is considerable reason for both nations to continue to cooperate, given the large amount of border traffic.

Additionally, many of the border crossing projects involve non-transportation agencies, even though the impact of the projects is focused on transportation. Border patrol, customs, and homeland security are all heavily involved in these projects. None of them have responsibility for any transportation infrastructure, but all work closely with the local transportation agencies.

4.9.2 Central American Border with Guatemala and Belize

Mexico also has border crossings with Guatemala and Belize. The traffic volumes are considerably less than those at the US border and are much less commercial in nature. There are significant numbers of passenger crossings for work on farms in Mexico.

Similar problems exist in terms of customs processing relative to the US border. However, historically there have been more security issues along this border since it is in a much more rural environment and in an area that has a history of civil unrest. There is considerable undocumented cross border travel, much of it for day trips away from the major crossings. The Mexican rules and regulations are the same, though the standards that are required with the neighboring states are different than with the US.

In general, ITS and other technologies have not been considered a priority along this border. The delays are less significant in terms of volumes and value of goods (more agricultural, less manufacturing). Additionally, it is likely of greater interest to spend available resources on reducing illegal crossings along the entire border than focusing on tighter security and control at just a few crossings.

4.10 General Recommendations to Overcome Issues

To summarize the findings of this chapter, while non-technical issues are critical and knowledge of them is essential in understanding how ITS should be deployed in Mexico, there do not appear to be any institutional barriers to implementing ITS beyond limitations in terms of funding. The issues and concerns expressed throughout this Chapter are not significantly different than in other developed nations, although there are demographic differences which may encourage greater emphasis on certain types of programs (e.g., public transport, border crossing activities).

The following present general recommendations that will provide an underlying backbone and prerequisite to any ITS activities deployed based on the National ITS Architecture framework defined in this project.

4.10.1 Institutional and jurisdictional coordination

First and foremost is institutional and jurisdiction cooperation. Defining and selecting technology is often the easiest part of an ITS deployment. Getting organizations to agree on how to share costs, responsibilities, and control is usually much more difficult. The architecture process shows how to create an environment to accomplish this. The first step is to identify those agencies that should be involved. The second step is to identify what information or control needs to be shared between agencies. The most difficult activity is to identify reasons for the agencies to participate. Helping the common good has limited appeal, especially if an agency is asked to bear more responsibilities and costs for a particular ITS deployment that they do not perceive has adequate, measurable direct benefits to them.

One of the keys is selecting locations and agencies that are most promising for the initial deployments. If a group of agencies that already work well together is selected, the process will work better and the likelihood of success is greater. For those areas where the participating agencies do not have an existing relationship, the National ITS Architecture is a good process for them to start building those relationships. By beginning the process of identifying local needs and educating the agencies of the benefits of cooperation, many locations will find themselves in a good deployment position one or two years from now.

Many organizations have control of various programmatic activities distributed to the regional offices. If this is the case, projects should be chosen in areas where the local office is much more interested in participation. Success in one region is a good way to demonstrate to less enthusiastic offices the benefits they can receive if they participate in similar projects in their region.

4.10.2 Continue Working with US Agencies on Border Issues

The flow of commodities through the US border was consistently listed as one of the top two or three priorities. This is vital to the economy of Mexico. Any improvements in border operations has a direct benefit in reduced costs to Mexican companies.

International cooperation is always more difficult, because many more agencies need to be involved. An item that is of great importance in coordinating with the US government involves national and regional ITS architecture efforts in the US. The US Federal Highway Administration has adopted several policies and requirements for approval of funding tied to the development of ITS Architectures. With developed architectures completed for Mexico, funding and approval on the US portions of projects is much more likely. Demonstration of this planning and coordination is important for the equal advancement of ITS projects along this border as well as providing the direct benefits from the ITS architectures in terms of better project design and implementation.

4.10.3 Adoption of Standards

Specific communications and interface standards needs will be defined and discussed in Chapter 9 in conjunction with definition of the National ITS Architecture. In general, Mexico has an opportunity to take advantage of international standards development activities in adopting standards in Mexico either nationally, or regionally. It is not necessary, nor should it be necessary, to "lock in" specific vendors to provide particular services or products to support particular transportation and ITS needs. All such vendors should be able to meet the common standards

It is general practice that maintenance of equipment is done by the local agency. While industry standardization with respect to hardware and software interfaces may promote more competitive procurements (since there would be more interoperability between systems), in general each local agency may have a comfort level with particular manufacturers or vendors that provide satisfactory or superior service. As each metropolitan region is relatively isolated from other regions, however, it is not as critical to provide interoperability of traffic control hardware.

At the same time, national primary routes or systems which involve collection of information throughout the country are well-suited to various types of communication and data exchange standards. Use of one standard for collecting traffic flow data and making it available on national web sites or to private sector traveler information services would be highly useful. Likewise, exchange of vehicle registration and preclearance data between Police, SCT and Customs may be highly useful in tracking and monitoring goods movements or tracking stolen freight or vehicles.

As another example, a single technology standard should be chosen for all electronic toll collection. Multiple vendors may supply the various concessions, so long as the user has to buy only one tag and it works in all system.

Somewhat complementary to the toll collection example is electronic parking control. This is generally a very local issue – the local jurisdiction should be able to decide which technology to buy since they will be the ones operating and maintaining the technology. However, if a national interoperable standard is adopted related to toll collection concerning dedicated short range communications, then the electronic parking should also utilize the national standard to provide greater interoperability for the end user.

In summary, standards will be addressed in greater detail in Chapter 9. However, new implementations of ITS projects should utilize industry accepted standards as applicable to help improve later regional integration.

4.10.4 New Legislation and Policies

Two main areas of legislation and policy may need to be addressed in order to deploy improved transportation operations activities using ITS.

One area may be incident clearance. Some states in the US have quick clearance laws that protect the agencies from liability if their forces have to move a car to the side of a road. These laws are implemented so as to reduce travel delay if it is possible to clear the incident from the road without leaving debris or surface damage (e.g., spilled liquids) on the road. Having such a law protects against vehicle owners that complain that the agency damaged their car during a relocation of the vehicle and seek compensation.

A second area related to changes in the relationships between specific agencies, including the sharing of real-time and other information between one another, along with procedures which involve multiple agencies to be involved. In particular, if a group of toll road concessions are all signing contracts with the same federal agency, they should be required to cooperate with each other in all manners of operations, whether it involves compatible toll systems or collection of incident or road work information, or traffic flow data. This often requires action on behalf of the government. The intent of all of these actions should be to improve the operations of the transportation network and speed the integration of technologies.

Both of these issues highlight the need to bring administrators and legal staff into the ITS project development process earlier rather than later. They will often have solutions to problems that are beyond the typical engineering solutions. As a participant, they should have a better idea of what ITS is trying to accomplish and be more willing to work with the other departments in implementing the best solutions.

CHAPTER FIVE
Technical Analysis of Existing & Future Systems

5.1 OVERVIEW

This Chapter provides a summary of the ITS applications currently deployed in Mexico, and then reviews the technical aspects of these existing systems along with systems which may be appropriate in the future, based on knowledge of current and emerging ITS applications from around the world. The resulting analysis serves as the first step in establishing operational requirements for the Mexico National ITS Architecture.

The National and Regional ITS Workshops contributed both technical and anecdotal information relative to current ITS deployment experiences. The majority of the information gathered on current systems came from the Regional Workshops described earlier in this Final Report. The participants provided input both during the meeting and through questionnaires distributed at the meetings.

To gather more technical detail, the Architecture Team also met with several transportation technology vendors throughout Mexico as part of the Intertraffic Latin America exhibition, held October 2004 in Mexico City. They also supplied information on where they have deployed systems and what functionality is provided.

The functionality of existing and potential future ITS deployments in Mexico need to be defined in a structured fashion. This is done not only to understand how "legacy" systems may be relevant to future ITS work in Mexico, but also to define what functional deficiencies in current transportation services could be addressed through ITS.

The structured approach to defining ITS functionality considered several options, including direct use of US and Canadian National ITS Architectures. However, substantial work has also been done in Europe, Japan, Taiwan, and Korea which the Architecture Team felt should be considered in defining the functionality of the Mexico National ITS Architecture. Hence, the Team chose a relatively recent methodology developed by the International Standards Organization (ISO), Technical Committee 204 (Transport Information and Control Systems). TC 204's most recent update of the ITS Fundamental Services[1] contains substantial information gathered from the ITS architectures of North America, Asia and Europe with respect to ITS services that can be, and have been, deployed.

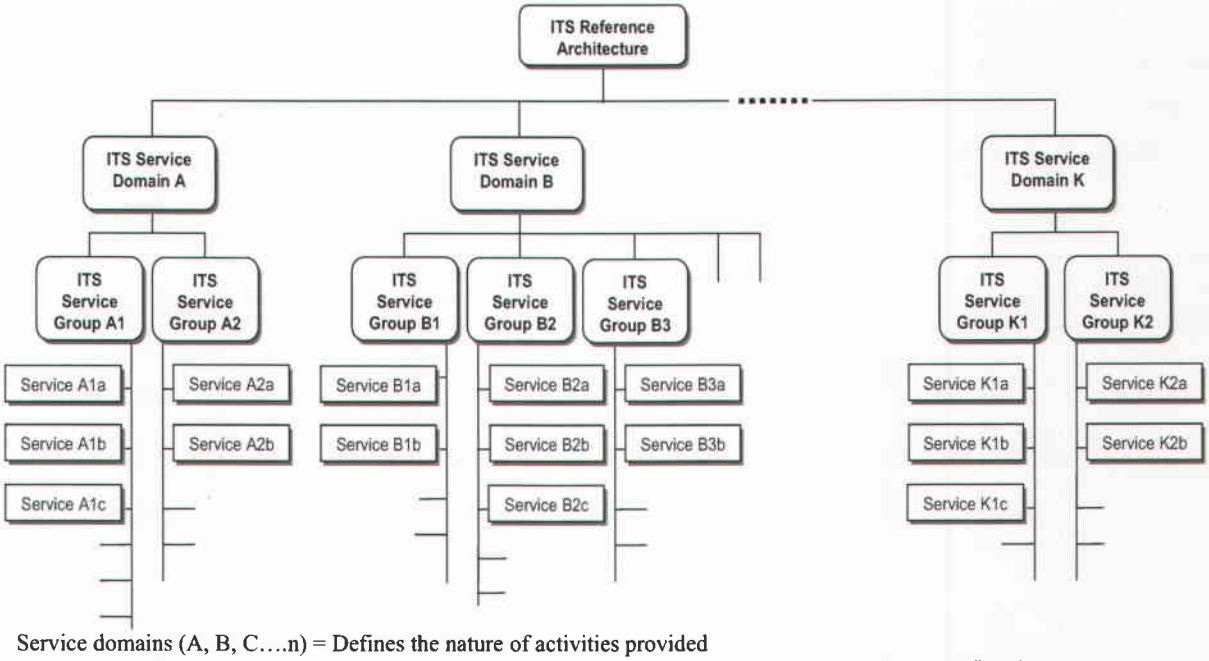
The logical service groupings which are presented in this Chapter serve as the basis for identification of planned services and finally, the National ITS Architecture. Further, the extent to which current ITS deployments in Mexico address these functions is identified.

5.2 HIGH-LEVEL ITS FUNCTIONAL DEFINITION

The ISO TR 14813-1 document defines ITS service domains, groups and services as a three-level framework for developing ITS-related concepts of operation, which in turn lead to the definition of the appropriate requirements and standards necessary to deploy specific ITS applications. Exhibit 5.1 shows the three-level framework, which is further described below.

1 ISO Technical Report 14813-1, 2005 committee draft

Exhibit 5.1
Hierarchy of ITS Service Definitions



Service domains (A, B, C….n) = Defines the nature of activities provided
Service groups (n1, n2….nx) = More specific activities carried out in service domain, but does not define the actors
Services = Further defines activity in terms of the actors involved (e.g., users, travel modes), Also serves as basis for most elemental 'use cases' (user view of architecture)

An ITS service domain refers to a specific application area which comprises one or more service groups. This area contains specific "families" of ITS activities which are not specific as to users or providers. They are mapped specifically to overall transportation needs and goals. The following lists and describes 11 ITS service domains as currently defined by ISO:

- Traveler information – Provision of both static and dynamic information about the transport network to users, including modal options and transfers.
- Traffic management and operations – The management of the movement of vehicles, travelers and pedestrians throughout the road transport network
- Vehicle – Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations.
- Freight transport – The management of commercial vehicle operations; freight and fleet management; activities that expedite the authorization process for cargo at national and jurisdictional boundaries and expedite cross-modal transfers for authorized cargo.
- Public passenger transport – Operation of public transport services and the provision of operational information to the operator and user, including multimodal aspects.
- Emergency – Services delivered in response to incidents that are categorized as emergencies.
- Transport-related electronic payment – Transactions and reservations for transport related services.
- Road transport related personal safety – Protection of transport users including pedestrians and vulnerable users.

- Weather and environmental conditions monitoring – Activities that monitor and notify weather and environmental conditions.
- Disaster response management and coordination – Road transport based activities in response to natural disasters, civil disturbances, or terror attacks
- National security – Activities that directly protect or mitigate physical or operational harm to persons and facilities due to natural disasters, civil disturbances, or terror attacks

An ITS service group describes more specific applications within each of the above service domains (e.g., for the domain "Traveler Information", there may be service groups entitled "Pre-Trip Traveler Information, "En-Route Traveler Information", "Trip Planning Support", etc.). The service groups do not target specific users or imply specific service providers. They are mapped to specific transportation objectives which address measurable or recognizable improvements. **ITS Service Groups are defined in further detail in Chapter 8 of this Final Report as the first level of functional requirements for the Mexico National ITS Architecture.**

An ITS service group consists of products or activities which are targeted to specific ITS users and service providers. These are not formally defined by ISO, but are instead defined for the individual ITS architecture application (i.e., Mexico) based on the universe of potential system functional activities. **ITS services will be defined in detail in Chapter 8 and 9 of this Final Report, as the second level of functional requirements.**

5.3 How ITS Service Domains Relate to National ITS Needs

The ITS Service Domains can be related to the specific national ITS needs statements (goals) described in Chapter 3 quite readily. The primary relevance of ITS Service Domains to the needs statements is illustrated in Exhibit 5.2 below.

Exhibit 5.2
Relationship of ITS Service Domains to Needs Statements

	ITS SERVICE DOMAINS										
NEEDS STATEMENTS for MEXICO	Traveler information	Traffic management and operations	Vehicle	Freight transport	Public passenger transport	Emergency	Transport-related electronic payment	Road transport related personal safety	Weather and environmental conditions monitoring	Disaster response management and coordination	National security
Need 1 – Reduce accidents, fatalities, and injuries on the roadway network.		■				■		■	■	■	
Need 2 – Increase security at the border crossings.										■	■
Need 3 – Increase security of people and goods throughout the entire transportation system.					■					■	■
Need 4 – Improve consistency of freight information standards and data between Mexico and other nations.				■							■
Need 5 – Improve documentation and correction of commercial vehicle operational and safety problems.			■	■							
Need 6 – Improve management of road pricing and revenues		■					■				
Need 7 – Manage changes in traffic flow conditions		■									
Need 8 – Reduce the impact of incidents on the transportation network.		■	■			■					
Need 9 – Provide improved management of regional public transport resources.					■						
Need 10 – Enhance travel accessibility for citizens living outside major urban regions.	■				■			■			
Need 11 – Reduce transportation impacts on air quality		■							■		
Need 12 – Improve information on travel in Mexico	■	■				■			■	■	

Later in this Chapter, the relevance of particular Needs to specific Regions is addressed, along with the relevant ITS Service Domains which would receive further consideration.

5.4 Review of Existing ITS Applications in Mexico

In this section, WSA identifies the various ITS systems in place around Mexico. This document will take a closer look at these systems. These systems are shown by ITS Service Domain and then by Region.

5.4.1 Current ITS Deployments by Service Domain

While there has not been widespread deployment of ITS throughout Mexico, there have been a number of deployments associated with the following ITS Service Domains:

- Traffic Management and Operations (Section 5.4.1.1)
- Transport-Related Electronic Payment (Section 5.4.1.2 and 5.4.1.3)
- Public Passenger Transport (Section 5.4.1.3)
- National Security (Section 5.4.1.4)
- Freight Transport (Section 5.4.1.4)

In general, the projects that have been deployed to date are "stand-alone" in nature. In other words, they utilize and are based on specific vendor-supplied hardware and software products. They are not part of large, integrated, linked systems which incorporate various technologies and products in order to solve regional traffic management and traveler information needs over an entire jurisdiction.

For the purposes of this document, the focus is upon ITS initiatives that have been deployed by government agencies, whether Federal or State, as well as public transport agencies. It is noted that many private sector initiatives, related to tracking of vehicles within a fleet, have been underway in Mexico and will be of interest as commercial freight operations and border crossing issues are addressed later in this National ITS Architecture development effort.

5.4.1.1 Traffic Management and Operations

The majority of the systems deployed to date in Mexico involve traffic signal operations, along with some significant deployments of traffic monitoring activities using Closed-Circuit television (CCTV) cameras, along with some limited deployments of electronic Dynamic Message Signs (DMS). Traffic detection systems using tools such as loop detectors (in pavement) as well as radar detectors (non-pavement-intrusive) have been provided mainly for actuated traffic signal operations as well as some level of signal timing input.

Mexico City's use of the Sydney Comprehensive Adaptive Traffic System (SCATS) , developed in Australia, represents Mexico's first involvement in the use of "traffic adaptive" control, which involves the development of traffic signal timings that are based on current and emerging traffic flow conditions on a cycle-by-cycle basis.

Telecommunications for traffic signal operations involves a blend of copper wire (twisted-pair), fiber optics, and wireless (spread spectrum) communications. Very often, communications to traffic control devices is through leased phone line services, while much of the communications to CCTV is over fiber optics.

Traffic management deployments are summarized by, but are not limited to, the following programs which are described below. These do not represent a complete review of all systems, but represents a cross-section of what has been deployed in Mexico to date:

- **Mexico City:** As discussed above, Mexico City has deployed SCATS software for its urban traffic control system (Systema Computerizado de

Semáforos. The system, operated by the Secretería General de Protección y Vialidad del Departamento del Distrito Federal, is deployed at roughly 1300 intersections in conjunction with custom-built, proprietary traffic signal controllers. 280 CCTV cameras are provided along with 3-line DMS situated along major routes, plus a fiber optic network.

- **Monterrey:** An extensive regional traffic management system, SINTRAM, has been deployed in Monterrey, consisting of 600 intersections, controlled through a French-developed traffic control system, GERTRUDE, using off-the-shelf, proprietary signal controllers. The system, controlled from a restored power plant, includes 20 CCTV cameras and 20 DMS. Dynamic speed control signs were also implemented on one of the key primary highways through the region, but are not adjusted in real-time due to leased communication links not being available to these particular devices. Fiber optic communications is provided for CCTV and other communications.
- **Chihuahua:** The City of Chihuahua also includes a traffic management system which includes central control of around 90 intersections, a modern traffic management center, and 28 CCTV cameras located along the roadway network. However, this system differs from the above, as well as most other systems implemented in Mexico, in that it uses mainly U.S. traffic control equipment, notably California Model 170 controllers and related control hardware and cabinetry, with a McCain QuicNet traffic control system and compatible "firmware" (specialized software programmed into the programmable read-only memory (PROM) card of the controller). A similar system is also deployed in Agua Caliente.

Other traffic control systems which have been deployed in Mexico include systems in Ciudad Juarez, Guadalajara, Acapulco, Mexicali, Tijuana, Veracruz, Queretaro, Jalapa, Saltillo, Boca del Rio, and other cities.

Some general observations, based on the characteristics of the above systems, along with specific discussions with traffic control vendors who provide systems in Mexico, follow below:

- There are currently no national standards related to telecommunications between central systems and traffic control devices at the roadside, and there has been no deployment or adoption to date of the U.S. National Transportation Communications/ITS Protocol (NTCIP) for center-to-field (C2F) applications
- There are currently no national standards related to development and connectivity of traffic control equipment. Currently, each domestic traffic controller manufacturer develops their own proprietary hardware and operations software within the controller, along with interfaces. In some cases, US products which follow the State of California's Model 170 and Model 2070 standards have been implemented in Mexico, along with traffic controllers compatible with National Electrical Manufacturers Association (NEMA) standards.
- There have also not been any deployments, as far as it is known, of center-to-center communications standards (e.g., between traffic engineering and police, or between cities), using the U.S. NTCIP profiles for center-to-center (C2C) communications.
- While actuated traffic control is relatively common, few cities (notably Mexico City and Monterrey) do some type of real-time variation in the traffic signal timing plans. Monterrey's system selects from a series of traffic control plans based on current traffic, as well as environmental conditions. Mexico City's SCATS system bases its traffic operation on traffic patterns that develop on a cycle-by-cycle basis.
- While there are some DMS located on intercity primary routes operated by CAPUFE, as well as in some metropolitan areas such as Mexico City and Monterrey, development of integrated messaging strategies is still in its infancy, and in general there are not enough DMS's installed to permit development of operational plans and alternate routing strategies that can be presented for

drivers on a continuous, real-time basis, even during accidents or road work activities which close multiple lanes.

The main domestic traffic control vendors in Mexico include Semex (the largest), Inmer (who did the system controllers, CCTV and control center hardware in Mexico City), and Eyssa (who has served as a distributor and integrator for various U.S. traffic control equipment, notably Model 170, 2070 and NEMA equipment). Semex and Inmer develop their own proprietary traffic control equipment, with Semex being the largest producer of traffic signal controllers in Mexico.

5.4.1.2 Transport-Related Electronic Payment

Two types of electronic payment have been deployed in Mexico. These include Electronic toll collection (ETC) and electronic fare payment services for public transport. The latter public transport payment services been implemented in Guadalajara (Tren Urbano) and in Mexico City (MetroBus), and are further discussed in the projects addressed under Public Passenger Transport (Section 5.4.1.3).

Electronic toll collection (ETC) is one of the most visible ITS deployments to date in Mexico. ETC consists of three main elements:

- The on-board unit, usually an electronic radio frequency (RF) data transponder (often called a "tag") mounted on the windshield
- The roadside processing unit, including a radio antenna which receives the short-range radio frequency (RF) data from the vehicle transponders and transmits the information to a reader unit at the side of the road
- The central equipment, which receives roadside data and transmits it to the "back office" for financial processing.

CAPUFE has developed an electronic toll collection system standard (Identificación Automática Vehicular, or IAVE) for the 14 corridor facilities (shown earlier in Exhibit 4.5), 4700 km in total, but it has not been universally adopted for all toll road facilities in Mexico outside CAPUFE's supervision, of which there are approximately 1220 km.

Only 80,000 IAVE transponders are in use across Mexico. In contrast, the Chicago region of Northern Illinois (population 6 million) boasts over 1,000,000 IPASS transponders in use, and the eastern United States, which has standardized on the E-ZPass transponder, has over 8 million customers using the same technology. With several other states in the U.S. moving toward compatibility with E-ZPass (including the Midwest states of Indiana and Illinois), there will likely be nearly 9 million E-ZPass customers by 2005.

IAVE is currently in the process of reviewing its next generation of toll collection technologies. Current IAVE system components are developed in Europe. As Europe has moved to a continental Dedicated Short-Range Communication (DSRC) standard of 5.8 GHz, CAPUFE recently issued a tender for new DSRC equipment. An initial selection was made of a European company that provides 5.8 GHz equipment. However, DSRC standards in the U.S for electronic toll collection and for electronic preclearance of commercial vehicles differ from Europe. Current standards are for the use of 900 MHz equipment, of which the standards differ from region to region in the US, although there are three main standards:

- California Title 21 (read-only communications, not 2-way), which defines the interface, protocol and functional requirements for tags to be used in California for ETC. Technically, this permits

any vendor to manufacture a tag for use in California provided it meets this standard. It is noted the US state of Colorado is also implementing this standard.

- EZPass Interagency Group (IAG), which utilize proprietary tags manufactured by Mark IV along with compatible communication protocols. Two states previously not in the IAG, Illinois and Virginia have used the same tags and protocols as well, but recently these states have joined the organization as well, thus providing the ability for US drivers to travel throughout the northeastern US using one form of ETC. In the future, it will be likely possible to travel from Illinois to New York, Massachusetts or Virginia using EZPass.
- Individual state standards, including those in Florida (SunPass), Texas, Oklahoma, Georgia, South Carolina, Kansas, and Louisiana.

The U.S. has recently approved implementation of a DSRC standard at 5.9 GHz, which will serve as the basis for the next generation of technologies to be deployed for ETC as well as all other potential DSRC applications. The standard includes not just the radio frequency, but also the development of a standard communications protocol that accommodates ETC, electronic truck preclearance, communication between vehicles and roadside devices (for in-vehicle information, safety and warning systems), and vehicle-to-vehicle communications.

CAPUFE is thus entertaining various vendor options which will address a larger array of options, taking into consideration North American compatibility as opposed to European standards as had been used previously.

One of the major trends in electronic toll collection throughout the world, open road tolling (ORT), involves the ability to collect electronic payments from vehicles while they pass under a pay point at highway speeds. CAPUFE currently uses remote supervision through digital imaging systems for several toll plazas (which are controlled by gates) , in order to provide enforcement of toll payment. However, a major issue in carrying out automated enforcement is the ability to access a database of vehicle registrations, in order to match the license plate of a vehicle whose driver has not paid, with the appropriate driver registration and address information. Such information is used to send an invoice (which becomes a fine if the toll is not paid within a prescribed amount of time). For open road tolling, information needs to be collected at higher speeds and in all likelihood, for a larger number of vehicles.

However, the various states in Mexico currently maintain their own vehicle registration databases, and none of these are networked into a nationwide database. Thus, CAPUFE would need to have external interfaces with all the individual states, each of which have registration records databases which differ from one another and are not integrated. This would be a costly effort to implement. Additionally, the lack of nationwide linkage of vehicle registrations has other implications, notably related to enforcement and record-keeping with respect to both passenger and commercial vehicle operations.

Thus, such improvements that would lead to an integrated vehicle registration database would need to be a separate effort. Once done, it would be more practical for CAPUFE to deploy open road tolling strategies, particularly as video and digital enforcement could be done in an automated fashion and would be more reliable.

To summarize the above, the main aspects of ETC to date in Mexico are as follows:

- CAPUFE has an existing system, IAVE, for Electronic Toll Collection, which is in the process of replacement with a state-of-the-art system. The system would be intended to be compatible with other international standards (e.g., current or emerging DSRC standards in the U.S. or Europe)
- While 4700 km of toll facilities work with IAVE, about 1220 km do not, as they are not part of the CAPUFE network
- There are relatively few users of IAVE (80,000 nationwide)

- Electronic enforcement and development of open road tolling is currently impeded by enforcement limitations, notably the lack of a standardized network of state vehicle registration data.

5.4.1.3 Public Passenger Transport

The more advanced or up-to-date the public transport system is in a given location in Mexico, the more likely it has some level of advanced technology deployment. While ITS deployment for public transport is far from universal in Mexico, there are several types of activities underway. These are represented by, but are not limited to, the following applications:

- **Vehicle Location and Tracking Systems.** Rail systems traditionally have required continuous monitoring of location and operations for the purposes of safety, whether through using track circuit data or vehicle position tracking (e.g., GPS). However, bus operations increasingly have been using some combination of Automated Vehicle Location (AVL) systems based on GPS and computer-aided dispatch (CAD) systems, used for scheduling and dispatching vehicles as needed to meet either travel demand or maintain schedule adherence. Representative systems of this nature have been deployed in Tamaulipas and Jalapa.
- **Passenger Information Systems.** Passenger information systems can range from "Next train in X minutes" signage on platforms to more interactive information available through electronic kiosks. At San Pedro on the Metrorrey network, traveler information kiosks have been deployed to provide public transport information.
- **Electronic Fare Payment Systems.** As discussed in Chapter 2, the Guadalajara Tren Urbano and Mexico City MetroBus systems have deployed a contactless Smart Card, which permits monetary value to be added at electronic machines, and in turn a specific amount for a trip is debited from the card every time the card is waved over a sensor at the entrance to the station platform.
- **Vehicle and Personal Security Systems.** Increasingly, public transport systems are providing video surveillance both at station platforms and on vehicles, in an attempt to better monitor and deter potential criminal activities from occurring on the public transport system.

General observations related to public transport and related ITS deployment in Mexico, particularly in urban areas but also nationally, include the following:

- In general, limited or no real-time or current information or advisories are provided related to current rail or bus operations.
- Based on the Team's observations and anecdotal information from various stakeholders, there seem to be a variety of different systems and services in various regions, many of which operate completely independently from one another. Connectivity between different public transport agencies' services appears to be very limited; connectivity between systems operated by the same agency, on the other hand, tends to be better.
- There does not appear to be any sharing of travel information between public transport providers and road network operators, in part because there is limited or no real-time information gathered on major parts of the roadway network.

5.4.1.4 National Security (Border Crossing Initiatives) and Freight Transport

Given that roughly 80% of Mexico's trade occurs with the United States, it is perhaps no surprise that much of the ITS work done relative to freight travel and border crossing activities has occurred in tandem with the U.S. There have been several key initiatives to date, along with two main active systems currently in place. Initially, much of the activity was oriented to reducing delay and expediting trade in a consistent fashion with NAFTA. Increasingly, many of the technology deployments have focused on

safety and security, particularly related to U.S. Homeland Security initiatives that have been deployed in the wake of the terrorist attacks of September 11, 2001.

Bi-National Initiatives

- *Automated data collection studies* – Crossings at Tijuana-Otay Mesa, Calfiornia; Nuevo Laredo (World Trade Bridge), Zaragosa-El Paso, Texas. U.S. funded initiative addressed various electronic sensor and imaging technologies for travel time, delay and classification data at or approaching border crossings. (2000-2001)
- *Electronic Prototype International Crossing (EPIC)* at the Nogales Border Crossing is no longer in operation but was the subject of an in-depth evaluation, focusing mainly on State of Arizona-registered trucks rather than the NATAP program (see below) which was later deployed under the IBEX, EPIC and TRIBEX initiatives.
- *North American Trade Automation Prototype (NATAP)* is a U.S. Treasury Department, providing automation and standardization of various credentialing activities and functions between the US and Mexico ports of entry at each border crossings, for US and Mexican freight carriers. This in turn permits cross-border interoperability of specific clearance functions. It also provides information to truckers related to delays and congestion at the border crossings. When a truck carrying a NATAP shipment arrives at the border, radio frequency scanners mounted at each port of entry read trip load information from a transponder in the truck. Information about the shipment, including a photograph of the driver, is then immediately available at an inspector's computer. NATAP gives the inspector all the information necessary, including targeted hits and random examinations, to make an informed decision about the release or referral of the shipment without having to wand in anything or do any other type of clerical work. The inspector releases or refers the truck using touch screen technology, and the driver gets a visual and audible response on his transponder.
- It was implemented at Otay Mesa, California Crossing (IBEX), and Laredo-Nuevo Laredo and Juarez-El Paso Crossings (TRIBEX). The evaluation showed there was the possibility of saving roughly 20% of passage time through border crossing areas. Of the above systems, only TRIBEX remains in operation as a deployment/demonstration.

Current Systems in Place

Programs have been deployed at specific border crossings to expedite movement of bi-national commuters at the urbanized border crossings, who use the border crossings on a regular basis, usually for employment across the border.

The **Secure Electronic Network for Traveler's Rapid Inspection (SENTRI)** program is oriented to local commuters who regularly use the Tijuana crossings (Puerta México, Otay Mesa) and the crossing at Ciudad Juárez (Stanton Street crossing into El Paso). The SENTRI system identifies low-security-risk travelers and allows them to utilize dedicated lanes. Program participants are issued machine-readable cards and transponders for their vehicles. As of January 2004, almost 70,000 were enrolled.2

The **Free and Secure Trade (FAST)** program focuses on freight vehicles and carriers who have been enrolled in another program, Customs-Trade Partnership against Terrorism (C-TPAT), a voluntary program requiring participating businesses certify that their supply chain is secure, through undergoing a self-vulnerability assessment under the direction of U.S. Customs. Sixty importers are currently approved as C-TPAT members, with other applications being reviewed. FAST equips vehicles operated by C-TPAT member firms with radio frequency transponders, for the purpose of validating the security of

2 CSIS MEXICO PROJECT: "U.S. Mexico Border Security and the Evolving Security Relationship", U.S.-Mexico Binational Council, April 2004, pp.8-9.

shipments before the carrier reaches the port of entry, in order to reduce delays at the border crossing. FAST was first implemented at the Ciudad Juárez/El Paso Córdova (Bridge of the Americas) crossing in late 2003, and five additional locations are being equipped with FAST lanes in 2004, including Nuevo Laredo-Laredo, Otay Mesa, Mexicali-Calexico, Nogales, Reynosa-Hidalgo, and Matamoros-Brownsville.3

As of March 2004, Mexico and the U.S. also have initiated Electronic Data Exchange for northbound trade at all border crossings between the two countries. Four core data elements are cross referenced through a bar code assigned to exports or entry documents, including tariffs, quantity, origin, and volume. The initiative is intended to reduce fraudulent and illegal product shipments.

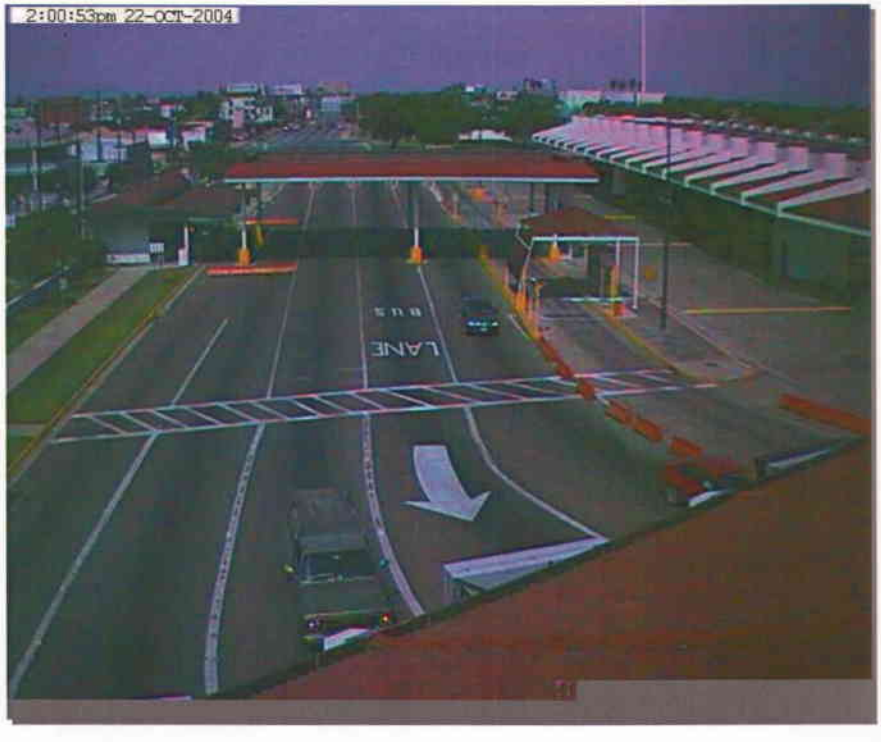
Mexico also exchanges ship manifest information electronically with the U.S. through the Container Security Initiative (CSI), which requires pre-screening and risk analysis of cargo containers upon departure from Mexican ports and transmitting the information as part of the electronic manifest sent to U.S. port facilities.

The above programs generate electronic operations information from the various tags and sensors provided to the users, which in turn support the availability of real-time delay information at border crossings for Mexico-bound shippers.

Exhibit 5.3 illustrates a typical modern plaza layout with express and non-express lanes, and Exhibit 5.4 provides a sample web page showing real-time border crossing information, including "alternative wait times" for vehicles equipped with FAST or SENTRI credentials and transponders.

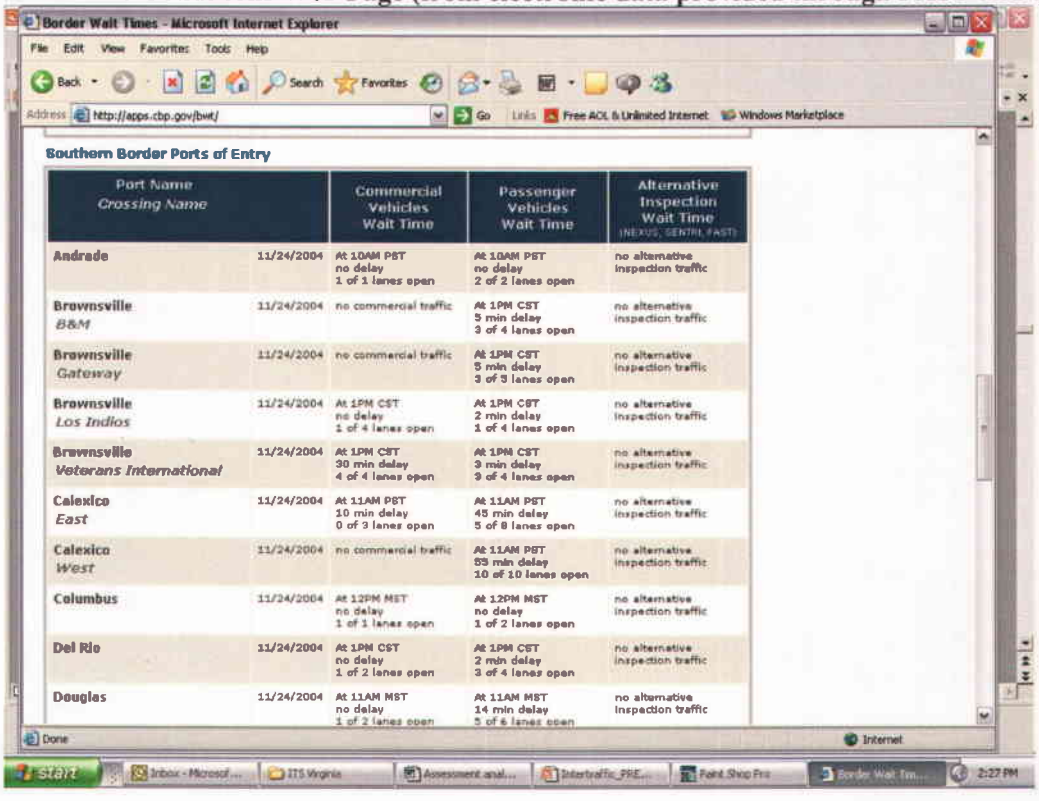
It is noted that the above technologies are not yet integrated with nationwide preclearance systems, notably the PrePass program which has been deployed for commercial vehicle operations in all the U.S. border states.

Exhibit 5.3
Border Crossing Layout Showing Separate Bus and SENTRI Lane Operations



3 Ibid., p. 13.

Exhibit 5.4
Real-Time Conditions Web Page (from electronic data provided through FAST and SENTRI)



Port Name / Crossing Name		Commercial Vehicles Wait Time	Passenger Vehicles Wait Time	Alternative Inspection Wait Time (NEXUS, SENTRI, FAST)
Andrade	11/24/2004	At 10AM PST no delay 1 of 1 lanes open	At 10AM PST no delay 2 of 2 lanes open	no alternative inspection traffic
Brownsville B&M	11/24/2004	no commercial traffic	At 1PM CST 5 min delay 3 of 4 lanes open	no alternative inspection traffic
Brownsville Gateway	11/24/2004	no commercial traffic	At 1PM CST 5 min delay 3 of 3 lanes open	no alternative inspection traffic
Brownsville Los Indios	11/24/2004	At 1PM CST no delay 1 of 4 lanes open	At 1PM CST 2 min delay 1 of 4 lanes open	no alternative inspection traffic
Brownsville Veterans International	11/24/2004	At 1PM CST 30 min delay 4 of 4 lanes open	At 1PM CST 3 min delay 3 of 4 lanes open	no alternative inspection traffic
Calexico East	11/24/2004	At 11AM PST 10 min delay 0 of 3 lanes open	At 11AM PST 45 min delay 5 of 8 lanes open	no alternative inspection traffic
Calexico West	11/24/2004	no commercial traffic	At 11AM PST 55 min delay 10 of 10 lanes open	no alternative inspection traffic
Columbus	11/24/2004	At 12PM MST no delay 1 of 1 lanes open	At 12PM MST no delay 1 of 2 lanes open	no alternative inspection traffic
Del Rio	11/24/2004	At 1PM CST no delay 1 of 2 lanes open	At 1PM CST 2 min delay 3 of 4 lanes open	no alternative inspection traffic
Douglas	11/24/2004	At 11AM MST no delay 1 of 2 lanes open	At 11AM MST 14 min delay 5 of 6 lanes open	no alternative inspection traffic

5.4.2 ITS Deployment by Region - Current Systems and Future Needs

Chapter 2 identified seven regions throughout Mexico based on travel corridors:

1. Central Region to Nogales and Mexicali
2. Guadalajara to Pacific ports
3. Central region to Monterrey
4. Central region to Chihuahua
5. Central region to Yucatan peninsula
6. Central region to Chiapas
7. Central region

The systems identified above are associated with their specific regions in this section. The planned systems were identified from surveys distributed and completed by stakeholders who participated in the various Regional Workshops. The information is summarized in a series of tables beginning on the next page.

The tables address needs which were presented in Chapter 4 (and are mainly non-technical in nature but with some operational relevance), in terms of the already-defined Needs Statements. The relevant Service Domains are described, followed by a listing of both existing projects as well as needed ITS improvements based on the input from the stakeholders.

Service Domains are referenced by number as shown below:

1. Traveler information
2. Traffic management and operations
3. Vehicle

4. Freight transport
5. Public passenger transport
6. Emergency
7. Transport-related electronic payment
8. Road transport related personal safety
9. Weather and environmental conditions monitoring
10. Disaster response management and coordination
11. National security

Region 1 - Central Region to Nogales and Mexicali			
Need	**Applicable Domains**	**Existing**	**Needed – Region 1**
Reduce Accidents, Fatalities and Injuries on the Roadway Network	2, 3, 6, 8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali 3. Emergency Management is handled by jurisdictional agencies	1. Enhanced Traffic Management and Operations 2. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 3. Central Communications /Dispatch coordination for Emergency Management
Increase Security at Border Crossings	4, 11	1. Secured Electronic Environment for Traveler's Rapid Inspection (SENTRI). 2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased coordination between security agencies; use of central communications. 3. Increased use of electronic seals, automation of customs processes.
Increase Security of Goods through the entire Transportation System	3, 11	1. Enforcement/ security incident response is handled on case-by-case basis.	1. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 2. Coordination / communication between enforcement and judicial systems; homeland security initiative.
Improve Consistency of Freight Information Standards	4	1. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2.Increased use of electronic seals, automation of customs process, etc.
Commercial Vehicle Operations	4	1. Numerous Check points for inspection.	1. Need for Weigh-in-motion type scales and uniformity in enforcement and pricing standards. 2. Central system to reduce delays.
Road Pricing and Revenue Management	7	None	1. Standard/uniform pricing strategies. 2. Revenue management systems
Traffic Management	1,2,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali	1. Enhanced Traffic Management and Operations.
Incident Management	1,2,6,8	None	1. Freeway monitoring and Incident detection systems. 2. Enhanced incident response coordination.

Region 1 - Central Region to Nogales and Mexicali			
Need	**Applicable Domains**	**Existing**	**Needed – Region 1**
Public Transport Management	1,5	1. Limited application AVL for train system	1. Co-ordination and sharing of traveler information. 2. Communication between various agencies
Enhanced Multimodal Transportation Accessibility	1,5	None	1. Communication between various agencies and private service providers for rural areas.
Air Quality Preservation	9	None	1. Demand management and emissions reduction programs to reduce impact of transportation system on environment.
Traveler Information	1	None	1. Need for information sharing and standard information distribution for traveler information purposes

Region 2 - Guadalajara to Pacific ports			
Need	**Applicable Domains**	**Existing**	**Needed – Region 2**
Reduce Accidents, Fatalities and Injuries on the Roadway Network	2,3,6,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali 3. Emergency Management is handled by jurisdictional agencies	1. Enhanced Traffic Management and Operations 2. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 3. Central Communications /Dispatch coordination for Emergency Management
Increase Security at Border Crossings	4, 11	1. Secured Electronic Environment for Traveler's Rapid Inspection (SENTRI). 2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased coordination between security agencies; use of central communications. 3. Increased use of electronic seals, automation of customs processes.
Increase Security of Goods through the entire Transportation System	3, 11	1. Enforcement/ security incident response is handled on case-by-case basis.	1. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 2. Coordination / communication between enforcement and judicial systems; homeland security initiative.

Region 2 - Guadalajara to Pacific ports			
Need	**Applicable Domains**	**Existing**	**Needed – Region 2**
Improve Consistency of Freight Information Standards	4	1. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased use of electronic seals, automation of customs process, etc.
Commercial Vehicle Operations	4	1. Numerous Check points for inspection.	1. Need for Weigh-in-motion type scales and uniformity in enforcement and pricing standards. 2. Central system to reduce delays.
Road Pricing and Revenue Management	7	None	1. Standard/uniform pricing strategies. 2. Revenue management systems
Traffic Management	1,2,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali	1. Enhanced Traffic Management and Operations.
Incident Management	1,2,6,8	None	1. Freeway monitoring and Incident detection systems. 2. Enhanced incident response coordination.
Public Transport Management	1,5	1. Limited application AVL for train system	1. Co-ordination and sharing of traveler information. 2. Communication between various agencies
Enhanced Multimodal Transportation Accessibility	1,5	None	1. Communication between various agencies and private service providers for rural areas.
Air Quality Preservation	9	None	1. Demand management and emissions reduction programs to reduce impact of transportation system on environment.
Traveler Information	1	None	1. Need for information sharing and standard information distribution for traveler information purposes

Region 3 - Central Region to Monterrey			
Need	**Applicable Domains**	**Existing**	**Needed – Region 3**
Reduce Accidents, Fatalities and Injuries on the Roadway	2,3,6,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications.	1. Enhanced Traffic Management and Operations 2. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users

Region 3 - Central Region to Monterrey			
Need	**Applicable Domains**	**Existing**	**Needed – Region 3**
Network		2. Traffic Control Systems in urban areas including Mexicali 3. Emergency Management is handled by jurisdictional agencies	or control vehicle operations. 3. Central Communications /Dispatch coordination for Emergency Management
Increase Security at Border Crossings	4, 11	1. Secured Electronic Environment for Traveler's Rapid Inspection (SENTRI). 2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased coordination between security agencies; use of central communications. 3. Increased use of electronic seals, automation of customs processes.
Increase Security of Goods through the entire Transportation System	3, 11	1. Enforcement/ security incident response is handled on case-by-case basis.	1. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 2. Coordination / communication between enforcement and judicial systems; homeland security initiative.
Improve Consistency of Freight Information Standards	4	2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased use of electronic seals, automation of customs process, etc.
Commercial Vehicle Operations	4	1. Numerous Check points for inspection.	1. Need for Weigh-in-motion type scales and uniformity in enforcement and pricing standards. 2. Central system to reduce delays.
Road Pricing and Revenue Management	7	None	1. Standard/uniform pricing strategies. 2. Revenue management systems
Traffic Management	1,2,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali	1. Enhanced Traffic Management and Operations.
Incident Management	1,2,6,8	None	1. Freeway monitoring and Incident detection systems. 2. Enhanced incident response coordination.
Public Transport Management	1,5	1. Limited application AVL for train system	1. Co-ordination and sharing of traveler information. 2. Communication between various agencies
Enhanced Multimodal Transportation	1,5	None	1. Communication between various agencies and private service providers for rural areas.

Region 3 - Central Region to Monterrey			
Need	**Applicable Domains**	**Existing**	**Needed – Region 3**
Accessibility			
Air Quality Preservation	9	None	1. Demand management and emissions reduction programs to reduce impact of transportation system on environment.
Traveler Information	1	None	1. Need for information sharing and standard information distribution for traveler information purposes

Region 4 - Central region to Chihuahua			
Need	**Applicable Domains**	**Existing**	**Needed – Region 4**
Reduce Accidents, Fatalities and Injuries on the Roadway Network	2,3,6,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali 3. Emergency Management is handled by jurisdictional agencies	1. Enhanced Traffic Management and Operations 2. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 3. Central Communications /Dispatch coordination for Emergency Management
Increase Security at Border Crossings	4, 11	1. Secured Electronic Environment for Traveler's Rapid Inspection (SENTRI). 2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased coordination between security agencies; use of central communications. 3. Increased use of electronic seals, automation of customs processes.
Increase Security of Goods through the entire Transportation System	3, 11	1. Enforcement/ security incident response is handled on case-by-case basis.	1. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 2. Coordination / communication between enforcement and judicial systems; homeland security initiative.
Improve Consistency of Freight Information Standards	4	1. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased use of electronic seals, automation of customs process, etc.

Region 4 - Central region to Chihuahua			
Need	**Applicable Domains**	**Existing**	**Needed – Region 4**
Commercial Vehicle Operations	4	1. Numerous Check points for inspection.	1. Need for Weigh-in-motion type scales and uniformity in enforcement and pricing standards. 2. Central system to reduce delays.
Road Pricing and Revenue Management	7	None	1. Standard/uniform pricing strategies. 2. Revenue management systems
Traffic Management	1,2,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali	1. Enhanced Traffic Management and Operations.
Incident Management	1,2,6,8	None	1. Freeway monitoring and Incident detection systems. 2. Enhanced incident response coordination.
Public Transport Management	1,5	1. Limited application AVL for train system	1. Co-ordination and sharing of traveler information. 2. Communication between various agencies
Enhanced Multimodal Transportation Accessibility	1,5	None	1. Communication between various agencies and private service providers for rural areas.
Air Quality Preservation	9	None	1. Demand management and emissions reduction programs to reduce impact of transportation system on environment.
Traveler Information	1	None	1. Need for information sharing and standard information distribution for traveler information purposes

Region 5 - Central Region to Yucatan Peninsula			
Need	**Applicable Domains**	**Existing**	**Needed – Region 5**
Reduce Accidents, Fatalities and Injuries on the Roadway Network	2,3,6,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali 3. Emergency Management is handled by jurisdictional agencies	1. Enhanced Traffic Management and Operations 2. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 3. Central Communications /Dispatch coordination for Emergency Management

Region 5 - Central Region to Yucatan Peninsula			
Need	**Applicable Domains**	**Existing**	**Needed – Region 5**
Increase Security at Border Crossings	4, 11	1. Secured Electronic Environment for Traveler's Rapid Inspection (SENTRI). 2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased coordination between security agencies; use of central communications. 3. Increased use of electronic seals, automation of customs processes.
Increase Security of Goods through the entire Transportation System	3, 11	1. Enforcement/ security incident response is handled on case-by-case basis.	1. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 2. Coordination / communication between enforcement and judicial systems; homeland security initiative.
Improve Consistency of Freight Information Standards	4	1. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased use of electronic seals, automation of customs process, etc.
Commercial Vehicle Operations	4	1. Numerous Check points for inspection.	1. Need for Weigh-in-motion type scales and uniformity in enforcement and pricing standards. 2. Central system to reduce delays.
Road Pricing and Revenue Management	7	None	1. Standard/uniform pricing strategies. 2. Revenue management systems
Traffic Management	1,2,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali	1. Enhanced Traffic Management and Operations.
Incident Management	1,2,6,8	None	1. Freeway monitoring and Incident detection systems. 2. Enhanced incident response coordination.
Public Transport Management	1,5	1. Limited application AVL for train system	1. Co-ordination and sharing of traveler information. 2. Communication between various agencies
Enhanced Multimodal Transportation Accessibility	1,5	None	1. Communication between various agencies and private service providers for rural areas.

Region 5 - Central Region to Yucatan Peninsula			
Need	**Applicable Domains**	**Existing**	**Needed – Region 5**
Air Quality Preservation	9	None	1. Demand management and emissions reduction programs to reduce impact of transportation system on environment.
Traveler Information	1	None	1. Need for information sharing and standard information distribution for traveler information purposes

Region 6 - Central Region to Chiapas			
Need	**Applicable Domains**	**Existing**	**Needed – Region 6**
Reduce Accidents, Fatalities and Injuries on the Roadway Network	2,3,6,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Oaxaca 3. Emergency Management is handled by jurisdictional agencies	1. Enhanced Traffic Management and Operations 2. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 3. Central Communications /Dispatch coordination for Emergency Management
Increase Security at Border Crossings	4, 11	1. Secured Electronic Environment for Traveler's Rapid Inspection (SENTRI). 2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased coordination between security agencies; use of central communications. 3. Increased use of electronic seals, automation of customs processes.
Increase Security of Goods through the entire Transportation System	3, 11	1. Enforcement/ security incident response is handled on case-by-case basis.	1. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 2. Coordination / communication between enforcement and judicial systems; homeland security initiative.
Improve Consistency of Freight Information Standards	4	1. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased use of electronic seals, automation of customs process, etc.

Region 6 - Central Region to Chiapas			
Need	**Applicable Domains**	**Existing**	**Needed – Region 6**
Commercial Vehicle Operations	4	1. Numerous Check points for inspection.	1. Need for Weigh-in-motion type scales and uniformity in enforcement and pricing standards. 2. Central system to reduce delays.
Road Pricing and Revenue Management	7	None	1. Standard/uniform pricing strategies. 2. Revenue management systems
Traffic Management	1,2,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali	1. Enhanced Traffic Management and Operations.
Incident Management	1,2,6,8	None	1. Freeway monitoring and Incident detection systems. 2. Enhanced incident response coordination.
Public Transport Management	1,5	1. Limited application AVL for train system	1. Co-ordination and sharing of traveler information. 2. Communication between various agencies
Enhanced Multimode Transportation Accessibility	1,5	None	1. Communication between various agencies and private service providers for rural areas.
Air Quality Preservation	9	None	1. Demand management and emissions reduction programs to reduce impact of transportation system on environment.
Traveler Information	1	None	1. Need for information sharing and standard information distribution for traveler information purposes

Region 7 - Central Region			
Need	**Applicable Domains**	**Existing**	**Needed – Region 7**
Reduce Accidents, Fatalities and Injuries on the Roadway Network	2,3,6,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexico City 3. Emergency Management is handled by jurisdictional agencies	1. Enhanced Traffic Management and Operations 2. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 3. Central Communications /Dispatch coordination for Emergency Management

Region 7 - Central Region			
Need	**Applicable Domains**	**Existing**	**Needed – Region 7**
Increase Security at Border Crossings	4, 11	1. Secured Electronic Environment for Traveler's Rapid Inspection (SENTRI). 2. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased coordination between security agencies; use of central communications. 3. Increased use of electronic seals, automation of customs processes.
Increase Security of Goods through the entire Transportation System	3, 11	1. Enforcement/ security incident response is handled on case-by-case basis.	1. Enhancement of safety, security and efficiency in vehicle operations, by in-vehicle warnings and assistances to users or control vehicle operations. 2. Coordination / communication between enforcement and judicial systems; homeland security initiative.
Improve Consistency of Freight Information Standards	4	1. Free and Secure Trade (FAST)	1. Uniformity of information standards and security services at the international borders. 2. Increased use of electronic seals, automation of customs process, etc.
Commercial Vehicle Operations	4	1. Numerous Check points for inspection.	1. Need for Weigh-in-motion type scales and uniformity in enforcement and pricing standards. 2. Central system to reduce delays.
Road Pricing and Revenue Management	7	None	1. Standard/uniform pricing strategies. 2. Revenue management systems
Traffic Management	1,2,8	1. Majority of the traffic management systems involve coordinated signal networks along with CCTV and DMS applications. 2. Traffic Control Systems in urban areas including Mexicali	1. Enhanced Traffic Management and Operations.
Incident Management	1,2,6,8	None	1. Freeway monitoring and Incident detection systems. 2. Enhanced incident response coordination.
Public Transport Management	1,5	1. Limited application AVL for train system	1. Co-ordination and sharing of traveler information. 2. Communication between various agencies
Enhanced Multimodal Transportation Accessibility	1,5	None	1. Communication between various agencies and private service providers for rural areas.

Region 7 - Central Region			
Need	**Applicable Domains**	**Existing**	**Needed – Region 7**
Air Quality Preservation	9	None	1. Demand management and emissions reduction programs to reduce impact of transportation system on environment.
Traveler Information	1	None	1. Need for information sharing and standard information distribution for traveler information purposes

5.4.3 Summary of Future Needs

As discussed earlier, some initial ITS systems have been successfully deployed across Mexico.

- Traffic signal control systems of varying types are found in most large urban areas,
- Mexico has worked well with the U.S. on various port and border crossing initiatives
- Electronic toll collection is available on most toll roads
- The Green Angels program is available on most federal roads

However, throughout Mexico's regions there were similar issues raised concerning transportation services. To summarize, these include the following:

- A need for increased safety and security, especially with commercial vehicles
- A need for urban incident management
- A need for basic traveler information
- A need for effective management of the passenger transit concessions and systems

Chapter 8 provides a more formal weighting of potential ITS solutions relative to the needs presented above and earlier in Chapter 3.

As with other countries, ITS deployment in Mexico to date has been mostly implemented on a local basis or by individual agencies or authorities, and not necessarily integrated with other systems. Each of these systems are deployed based on specific regional or agency / authority operational or technical needs. As agencies secure funding, they implement those systems that have the greatest potential benefits.

The issues identified above have not been significantly addressed with the systems deployed to date. This is understandable in light of the nature of the ITS projects deployed to date. First, the needs above address larger-scale issues than have been not been typically addressed with basic traffic control or electronic toll collection system projects, or are addressed to a limited extent. Secondly, the deployment costs are significant (e.g., traffic management systems on limited-access highways involving closely-spaced traffic sensors, cameras and telecommunications networks).

Planning is additionally hampered in Mexico by the lack of a formal process for studying, funding, and implementing projects. The shortened deployment cycle in Mexico as presented in Chapter 4 allows for projects to move rapidly from concept to implementation.

However, as less time is spent at the conceptual level following the above standardized process, ITS projects tend to be programmed and implemented as "stand-alone" activities. In order to address the needs described in this Chapter, a more holistic approach is required that encompasses a variety of public agencies, travel modes, information sources, and resultant technology projects which together result in an integrated ITS solution. This is made possible by the development of a National ITS Architecture along with an Action Plan for implementation of national, regional and local ITS projects. These activities are documented later in this Final Report.

CHAPTER 6
Economic & Financial Analysis

This Chapter reviews the economic and financial aspects of potential ITS deployment activities on the Mexican transportation network. The report is intended to help to provide a preliminary picture of the benefits-to-costs comparison and financial options of the ITS in Mexico.

6.1 OVERVIEW

The analysis presented in this chapter was developed on a preliminary basis (using the ITS Service Domains presented in Chapter 5), and revised during the course of the architecture development based on the more specific services and then the program definitions which are documented in Chapter 10. What is presented in this Chapter provides an overview of potential benefits based on different types of representative ITS deployments throughout the country. Naturally, specific deployments in specific regions or on individual roads will require more detailed analysis based on local traffic and origin-destination data.

The key data sources for assessing the economic and financial aspects of a Nationwide ITS system for Mexico include SCT, US Department of Transportation's ITS Benefits and Costs Database; and other existing data sources as well as project information sourced from the Architecture Team.

The main activities carried out by the Architecture Team include:

- Identification and quantification of likely benefits from candidate ITS programs
- Comparison of these benefits with expected costs
- Identification of components of the preliminary financial plan (how should this be funded for deployment?)
- Identification of risks associated with the proposed ITS projects (what could impact costs or benefits?)

6.2 ECONOMIC COST/BENEFIT ANALYSIS

Mexico has enjoyed the benefits of several ITS-related programs in recent years. Traffic signal control systems and video monitoring in urban areas, incident management using motorist aid patrols (Green Angels), joint border crossing projects with the U.S., etc. have been deployed in a variety of locations throughout the nation.

Each of the above projects required some degree of quantitative or qualitative assessment in order to establish their feasibility. To address national deployment of ITS, a more structured analysis of costs and benefits are required, particularly in addressing national or regional benefits as well as programmatic benefits, which may involve a variety of ITS applications and users.

The Mexico National ITS Architecture is intended to support projects providing a wide range of benefits, contributing to improving mobility between the major business and population centers throughout Mexico. These benefits include reductions in delay and travel time for persons and goods, air quality improvements, and reduction in fuel consumption. The costs examined in this section include not only the initial capital expenses, but also the annual operations and maintenance costs.

6.2.1 Approach

The National ITS Architecture defines the functional subsystems and communications links which are needed to exchange data and information for ITS deployment. The Architecture does not define where ITS is to be deployed, nor does it define the extent to which it will be deployed. Nor does the Architecture define the exact technologies or products that will be used to carry out the services.

Therefore, for the purpose of a National ITS Architecture, the benefits and costs are best developed at a very high level, with representative benefits developed for a series of candidate or "typical" projects which may be implemented based on a national architecture, using established data based on the state-of-the-practice (in other words, systems which have been successfully deployed elsewhere and are used frequently throughout the world).

The most common and easy-to-understand benefits measure is in *highway delay savings*, with another key measure of environmental importance being *air quality improvements.* While these do not always translate directly into monetary benefits, the indirect benefits due to improved societal health do have tangible benefits, including increased life expectancy (including earning power for those individuals).

These benefits are developed at an annual level, and compared with costs which are annualized based on system lifecycle (e.g., 10 years), including initial capital, design and investment costs, along with annual operations and maintenance costs. Expansion of representative projects to cover the national road network where relevant and appropriate is done to provide estimate of the overall costs of an ITS program, which in turn is compared with its associated benefits.

Contrasting a "no-build" strategy with a "build – ITS Architecture" strategy generates useful benefit-cost comparison measures. This comparison takes two basic forms:

- Subtraction of discounted benefits and costs (Net present value, or NPV)
- Ratio (benefits divided by costs)

These outputs are summarized in Exhibit 6.1 below.

Exhibit 6.1.
Overview of Benefits-Costs Analysis Outputs

Type of Benefits	Costs	Analysis Outputs
• Highway time savings • Air quality savings	• Capital costs • Operations and maintenance expenses	• Benefit-cost ratio • Net present value

6.2.2 Representative Programs

Four representative programs representing a broad array of ITS applications were defined for Benefits-Cost assessments. They correspond to the primary areas of regional need presented in Section 5.4.3 (Summary of Future Needs) below:

- A need for increased safety and security, especially with commercial vehicles
- A need for urban incident management
- A need for basic traveler information
- A need for effective management of the passenger transit concessions and systems

The four representative programs are presented below and are related to the Service Domains presented in Chapter 5 as follows:

- Traveler information system (internet-based)
  - Related to *Traveler Information* domain
- Incident management program (green angels)
  - *Related to Traffic Management and Operations* domain
- Electronic freight information system
  - Related to *Freight Transport and Safety and Security* domains
- Public transport ITS enhancements.

- Related to *Public Passenger Transport* domain

The above activities would cover five of the total eleven Service Domains. As much work has been done with respect to urban traffic control systems and to a lesser extent, electronic toll collection, in Mexico, it was determined that such benefits would mainly occur regardless of National ITS Architecture deployment status. There would be more detailed, incremental benefits that may be related to detailed technology improvements or standardization activities.

However, the analysis presented here provides a more conservative, measured means of establishing potential benefits, which the Architecture Team considers to be more realistic. Each of the above representative programs include incremental improvements which will be facilitated considerably through development of a National ITS Architecture and related program.

Quantitative benefits are described below along with the appropriate measures of effectiveness incorporated into the quantitative analysis.

6.2.2.1 Benefits of the Traveler Information System

By keeping motorists updated about congestion-causing road construction and accidents, this system will lead to travel time savings for both passenger and freight vehicles. The derivation of the benefits associated with the implementation of the traveler info system is based on the combination of person-vehicle-hours traveled, average adjusted time savings expected for this information system, average hourly wage rates, and certain assumptions listed below.

6.2.2.2 Benefits of the Incident Management Program

Thanks to this program roadways will be cleared of incident related vehicles and debris in shorter periods of time. This leads to travel time reductions, which are derived by combining person-vehicle-km-traveled, average incident frequency, average incident time reductions expected from this application, and average hourly wages, and certain assumptions listed below. The focus here is on travel time savings; there are however other kinds of benefits (e.g., increased safety, potential savings of injuries and lives attributable to faster response times, etc.) that could also occur, but were not quantified here.

6.2.2.3 Benefits of the Electronic Freight Information System

This system will facilitate faster processing of regular truck inspections on the Mexican highway corridors. The benefits of this system are estimated based on average truck volumes, average inspection frequency, estimated average time reductions per inspection resulting from this application, average hourly wages, and certain assumptions listed below.

6.2.2.4 Benefits of the Public Transport ITS Enhancements

Integrated scheduling and coordination (Automated Vehicle Location - AVL) system for rural bus services connecting rural communities and nearby cities is expected to lead to time savings for bus users. These time savings are computed using person-vehicle-hours-traveled, estimated average time reductions from this program, average hourly wages, and various assumptions as addressed below.

6.2.3 Estimation of Benefits

Forecast of benefits may typically be limited by the availability of input data. Since data limitations applied in this case, a series of assumptions had to be made. Key assumptions and input data are listed below:

- The 20-year time horizon (2006 to 2025)
- Values are in 2004 US Dollars
- Corridor travel characteristics and patterns are based on SCT data

- For the derivation of forecasts beyond year 2010, the trend growth rates from the 1996-2010 are applied

- Corridors are identified as follows:
  - México City – Nuevo Laredo 1,147 KM
  - México City – Nogales/Tijuana 2,821 KM
  - Querétaro – Ciudad Juárez 1,629 KM
  - Acapulco – Tuxpan 396 KM
  - Puebla – Progreso 1,215 KM
  - Mazatlán – Matamoros 1,182 KM
  - Manzanillo – Tampico 999 KM
  - Acapulco – Veracruz 766 KM
  - Veracruz – Monterrey 1,292 KM
  - Transpeninsular (Tijuana – Los Cabos) 1,686 KM
  - Altiplano 578 KM
  - Puebla – Cuidad Hidalgo 1,031 KM
  - Circuito Transítsmico 464 KM
  - Circuito Turístico Peninsular 1,246 KM

- Accident data is based on 2004 Police data (Anuario Estadístico Edición 2004, Seguridad y Orden Público). Average ratio of "non-crash incidents" to "crash incidents" (accidents) is based on the report titled "Incident Management Assistance Patrols: Assessment of Investment Benefits and Costs." Carolina Transportation Program. Authored by A. Khattak & N. Rouphail. 2005; and a conservative adjustment resulting in a ratio of 3.6 "non-crash incidents" to "crash incidents"

- Values of time are assumed to be approximated by average wages
  - Wage data is based on International Labour Office, Laborsta, Labor Force Survey
  - Average annual growth rate of 2% is assumed

- Exchange rate of MN$12 (12 pesos) per US$1 is assumed

- The time savings resulting from the program applications are based on the results of comparable applications elsewhere listed in the US Department of Transportation's ITS Benefits and Costs Database, and conservative adjustments (multiplication by 0.5, in other words reducing the calculated time savings benefits by ½ in order to reflect different roadway geometrics and alternate route availability relative to the US roadway network)

- Emissions-related data include: 1) Cost of vehicle pollution based on inflation-adjusted values from the article titled *On the Costs of Air Pollution from Motor Vehicles* by K. Small and C. Kazimi in Journal of Transport Economics and Policy, 1995, Vol. 2 ;and 2) Average emission reduction from ITS based on *Benefits and Costs of Full Operations and ITS Deployment (Seattle, Cincinnati, Tucson) by* FHWA, and conservative adjustments (0.5., or half the calculated benefit, taking into account different alternate route availability and land use / environmental requirements relative to the U.S., as discussed further in Chapter 7)

- Average vehicle occupancy rates are assumed to be 1.5, and 20, for passenger cars and buses, respectively.

- Average number of relevant truck inspections per trip along a representative corridor (i.e., Mexico City –Nuevo Laredo) is assumed to be 2

- Real long-term discount rate of 5% is assumed.

Exhibit 6.2 illustrates the estimated benefits of four programs as summed and displayed below. The sum of these benefits is forecasted at US$204 million in year 2006, increasing to US$454 million by 2015, and to US$610 million by 2025.

Exhibit 6.2
Summary of Annual ITS Benefits (Selected Years, US$ millions)

	Year		
	2006	2015	2025
Passenger			
Traveler Information System			
Time Savings	$101	$172	$316
Incident Management Program			
Time Savings	$23	$37	$64
Public Transport Enhancements			
Time Savings	$34	$59	$108
Subtotal (passenger)	$159	$268	$488
Freight			
Electronic Freight Information System			
Time Savings	$6	$ 10	$ 17
Traveler Information System			
Time Savings	$17	$ 43	$ 60
Incident Management Program			
Time Savings	$1.8	$3.0	$5.4
Subtotal (freight)	$25	$56	$82
Emmission Reductions	$20	$28	$39
Total Benefits	**$204**	**$454**	**$610**

6.2.4 Estimation of Costs

For each of the projects, a matrix of twenty-year costs was developed. The costs included capital, personnel, and operations and maintenance (O & M). In many of these projects, it was assumed that one metropolitan area would immediately deploy one system, and that other major metropolitan areas would follow over the next few years.

The costs are developed for the same representative projects as used in the benefits estimations. Several costs are developed. They include the following:

- Major capital purchases necessary for the project. This would include field equipment and computer systems. Office equipment and other administrative costs would be included in the facilities category.

- Facilities costs include any new building and the initial equipment necessary to staff the building.
- Personnel are separated into two main categories – managerial and staff. The intent is to better reflect costs. In many circumstances, it is assumed that the new staff will be employed by an existing public agency. The assumption is that there is no need to create an executive level staff or administrative staff. They would be provided elsewhere in the organization.
- O&M costs refer to major operational costs and the replacement of field equipment and computer systems. Other items are considered incidental to these calculations. Major operational costs include items such as maintaining or leasing communications networks. For capital equipment, it is assumed that major pieces of computer systems will have portions life-cycled every year so that all equipment is replaced every four years and a single larger purchase is not necessary.

The key assumptions for costs are also identified for benefits. Input data is provided from selected vendors and by examining previous similar systems from around the world.

6.2.4.1 Costs of the Traveler Information System

The main components of the Traveler Information System are a computer system and the staff to operate it. The initial costs relate to the purchase of the hardware and the development of the software. It is assumed that the office responsible for this work will reside in an existing office, but new staff would be required to manage and operate the center. Annual operating costs will include significant communications costs. Initially most communications will be by voice over phone, but it is expected that this will migrate to dedicated data links.

6.2.4.2 Costs of the Incident Management Program

The largest cost associated with this program is the purchase of the vehicles and the necessary facilities to house and maintain the vehicles. The life cycle of the vehicles is very short – maybe 3 to 4 years. For ease of calculation, it is assumed that a new program is not fully staffed at the beginning, but will purchase a portion of the trucks every year for four years. Thereafter, approximately ¼ of the fleet is replaced every year. O&M costs include fuel, tires, and other maintenance on the vehicle fleet.

6.2.4.3 Costs of the Electronic Freight Information System

This system consists of remote computers and the software that ties them together. It was assumed that computers would be provided to customs staff and police at borders, ports and in select locations. There would be only 1 or 2 computers provided at each location. Staffing and administration would be similar to that of the Traveler Information System. It is also assumed that the system is focused on replicating the existing forms, not creating a new process for data collection and management.

6.2.4.4 Costs of the Public Transport ITS Enhancements

The costs for this project involves deploying an off the shelf system from a selected vendor on all concessioned vehicles. Additionally, there are management staff requirements similar to the Traveler Information System and the Electronic Freight Information projects.

6.2.5 Benefits to Costs Comparison

The values of the benefits and costs presented in this section are based on a standard discounted cash flow (DCF) approach. The DCF is an extended stream of flows, as in Equation 1.

Equation 1:

$$PV = \Sigma C_t / (1 + r)^t$$

Where:

PV	=	Present value
C_t	=	Cash flow
r	=	Discount rate - opportunity cost of capital
t	=	Time period

Discounted flows are calculated over the project lifecycle of 20 years. For comparisons, capital, operating and maintenance costs are weighted against to the projected benefits stream. A five-percent real discount rate is used in this study.

From the DCF of the costs and benefits, the net present value (NPV) is calculated. The NPV is the measurement of the combined value of all the flows, positive and negative, associated with a project, at a given point in time. For this study, the NPV includes the capital costs, the operating and maintenance costs, and the monetized value of different benefits. If a NPV is positive, then the investment it represents is worth more than it costs. If the NPV is negative, the project costs more than the benefits it generates.

For the purposes of the current analysis, the implementation schedule with operations is assumed to start in 2006. The capital costs used in this analysis included expenditures of nearly US$425 million (undiscounted). The operating and maintenance costs over the twenty years were computed to be approximately US$352 million (undiscounted). The sum of present value of the capital and operating and maintenance cost is forecasted to be US$452 million.

Exhibit 6.3
Benefits to Costs Comparison Summary ($US millions)

	PV ($Millions)
Benefits	
Passenger	
Traveler Information System	
Time Savings	$2,138
Incident Management Program	
Time Savings	$460
(Rural) Public Transport	
Time Savings	$730
Subtotal (passenger)	$3,328
Freight	
Electronic Freight Information System	
Time Savings	$124
Traveler Information System	
Time Savings	$382
Incident Management Program	
Time Savings	$38
Subtotal (freight)	$543
Emmission Reductions	$339
Total Benefits	**$4,209**
Costs	
Traveler Information System	$5
Incident Management Program	$172
(Rural) Public Transport	$268
Electronic Freight Information System	$7
Total Project Costs	**$452**
Total Benefits less Total Costs (NPV)	**$3,757**

On the benefits side, the 20-year discounted present value of total savings from the programs is forecasted at about $4.2 billion. Exhibit 6.3 summarizes the present value of the benefit and cost items and the NPV of the benefit/cost comparison.

Based on the analysis, a benefits-to-costs (BC) ratio of **9.3** is generated. This ratio of benefits to costs indicates that the Mexico ITS Architecture is expected to have a positive impact on the national economy. The benefit analysis estimates that implementation of the ITS Architecture will generate nearly US$3.8 billion in net economic benefits or NPV to the Country over the 20-year project lifecycle. It should be noted that these results can be deemed conservative, and they do not include safety benefits and some other potential benefits such as agency operational improvements. The analyses described above are preliminary, and may require more detailed data incorporation in future phases of ITS system studies.

6.3 Preliminary Financial Plan

The financial plan consists of capital and operating plans as well as cash flows. The plan provides for the investment in the initially proposed programs using a combination of government and other funds over the project's 20-yr lifespan.

The financial plan includes four distinct parts. These are:

- Capital Cost
- Operating and Maintenance Cost
- Financing
- Integrated Financial Model

The starting point to the financial plan development is the estimation of the projects' capital requirements. These include those items discussed above in Section 6.2.4.

6.3.1 Capital Costs

The 20-year capital costs are estimated to total about US$425 million or about US$700 million in inflation-escalated terms over the 20 year period. These estimates are broken down by the representative programs and component categories and are shown in Exhibits 6.4, and 6.5, respectively.

Exhibit 6.4
Project Capital Cost Estimates by ITS Program (Millions of US$)

ITS Program	Capital
Nationawide Traveler Information	$0.3
Green Angels Expansion	$62
Bus AVL	$363
Electronic Manifest for cargo	$0.6
	$425

Exhibit 6.5
Project Capital Cost Estimates by Category (Millions of 2004$US)

Category	*Cost ($Millions)*
Capital	
Facilities (Garage)	$10
Vehicles	$52
Equipment	$363
Hardware	$0.3
Software	$0.6
	$425

6.3.2 Operating & Maintenance Costs

The estimates of the operating and maintenance (O & M) costs were also developed using the components described in Section 6.2.4. The 20-year total O & M cost estimate is about US$352 million or $609 million in inflation-escalated terms over the 20-year period. These estimates are broken down by the early winner programs and component category and are shown in Exhibits 6.6, and 6.7, respectively.

Exhibit 6.6
Project O & M Cost Estimates by Program (Millions of US$)

ITS Program	O & M Costs
Nationawide Traveler Information	$7
Green Angels Expansion	$240
Bus AVL	$94
Electronic Manifest for cargo	$10
	$352

Exhibit 6.7
Project O & M Cost Estimates by Category (Millions of US$)

Category	*Cost ($Millions)*
O & M	
Personnel	$181
Equipment	$142
Facilities	$28
	$352

The 20-year sum of the total capital and O & M expenditures is estimated to be about $777 million (US$ based on 2004 prices), or about US$1.3 billion in inflation-escalated terms over a 20-year period.

6.3.3 Financing Options

A financial plan for Intelligent Transportation System deployment in Mexico faces the issues related to growing infrastructure and technology needs drawing from limited revenue sources. A brief summary of potential financing options for the ITS Architecture project is provided below.

Firstly, based on the nature of the proposed ITS applications and their preliminary revenue generation potential, it appears that despite their rather significant overall benefits to Mexico, there are no definite sources of revenue that can be attributed to them. For instance, there may be some revenue that can be produced by advertising on the internet website on which the traveler information will be posted, or advertising on vehicles used in the applications. This is however a relatively new phenomenon that is still being tried elsewhere and provides no sufficient data to produce reliable estimates of revenue at this time.

Additionally, just as cost has been broken into several subcategories, so can revenue. In general, the money for ITS and operations come in two forms – capital and operations. The vast majority of ITS projects that would be included in a national program have been publicly funded. Many transportation companies (i.e., shippers and carriers) have implemented ITS as they individually determine that the increased costs are outweighed by the increases in operational efficiencies. Sometimes the public sector projects have private sector participation, although this is usually again tied to a perceived improvement in operations.

In this instance, capital funding is associated with all costs necessary to create and operate a project during its initial period. This can include one or two years of staffing, utilities, etc. Many institutions are more likely to aid in an initial implementation. This is because there is a potential for some return on investment depending on how the market and society react over the deployment period, and because this does not lock them into a long term financial commitment.

As a consequence of lack of evidence to generate concrete revenues, the ITS applications may also face considerable difficulty in finding sources of equity financing. Traditionally in Mexico, investments in infrastructure and its operation have been exclusively a government responsibility, thus there were no options for private involvement. Recently private investment has been allowed, increasingly, to participate in all stages of infrastructure. However limited, there may be some interest among the different vendors or suppliers of the ITS equipment and services and/or expertise in the project field or even trucking companies in equity participation. They may choose to invest in the project not necessarily anticipating great financial returns from this specific project, but for example for name recognition, or research and development or testing purposes. Nevertheless this is still rather uncertain. Therefore, a conservative approach would suggest limited funds from that source at this time. This limits the financing options to international development agencies, and the domestic government sources. Below is a summary of the potential sources.

6.3.3.1 Multilateral Development Agencies

As countries around the world struggle to pay for new infrastructure, there is a renewed interest in transportation financing initiatives and technical assistance support by many of the multilateral development agencies such as the World Bank Group and the Inter-American Development Bank, and others. These institutions provide low-interest loans, interest-free credit, and grants to countries like Mexico. For qualified projects typical multilateral institution loan financing falls in the 20-50 percent range. It could be assumed here that if the project is deemed justified, it may be able to obtain financing of about 25 percent of its total capital expenditures. There are also loan guarantees that can make the financing terms more attractive/affordable (e.g., resulting in lower interest rates) that could be provided by the different agencies.

6.3.3.2 Government Revenues and Loans

The government may need to provide the financing for the rest of the costs. Due to limitations of identifiable revenue sources of the ITS applications, this financing is going to likely come from some dedicated funds or general obligation bonds rather than dedicated revenue bonds. There are however some financing schemes that could serve to back up the bonds and may be applied here. These would include 1) motor fuel taxes; 2) motor vehicle taxes; 3) toll charges. 1) Motor fuel charges in the form of either a fixed amount per unit of fuel or price percentage could be added to the different types of fuel; 2) A sales tax could be added to the price of new vehicles. These can then be dedicated to this and possibly other types of projects.; and 3) Although it is not currently envisioned, it may be possible to introduce a surcharge to the existing or new toll road collections that would provide an earmarked source of revenue for the ITS deployment.

New sources of infrastructure funding have recently emerged. Although they are still in their relative infancy and not focused on technological investments, they may be of potential application to ITS. The existing potential funding mechanisms in Mexico for technological projects include:

NAFINSA (Nacional Financiera)

A development banking institution with the mandate to promote the overall development and modernization of the industrial sector with a regional approach; stimulate the development of financial markets and act as financial agent of the Federal Government in the negotiation, contracting and management of credits from abroad. Nafinsa carries out its operations in accordance with financing criteria applicable to development banks, channeling its funds mainly through commercial banks and non-banking financial intermediaries. The principal sources of Nafinsa's resources are loans from international development institutions such as the International Bank for Reconstruction and Development (IBRD) and the Inter-American Development Bank (IDB), lines of credit from foreign banks and the placement of securities in the international and domestic markets.

Crédito PYME

- Focuses on working capital needs or acquisition of fixed assets such as machinery, equipment and buildings, and technological development and improvement of environmental quality.
- Available for firms as well as for entrepreneurs.
- Funds are channeled through two commercial banks (Santander and Banorte) and some credit conditions vary depending on the bank chosen by the lendee.
- This line of credit is supported by a joint effort between NAFINSA and the Secretariarìa de Economìa (formerly Secretarìa de Comercio y Fomento Industrial: SECOFI).
- It is not a mortgage based security. The only guarantor is the principal investor (lendee). Normally guarantee ratio is 1:1.
- Lendee can be an ongoing concern or a newly created entity.
- Credit can be up to 80% of investment, with a maximum repayment period of 60 months.
- One time commission: 1.5% plus VAT.
- Maximum amount borrowed is 11.6 million Pesos (about 1 million Dollars).
- Fixed or floating interest rate.
- Financing can be structured either in Mexican Pesos or in US Dollars.

BANOBRAS

- Niche for equipment related with emergencies and security.
- Specifically associated with radio communications for surveillance and emergency, as well as for special equipment.
- Eligible lendees are federal, state and municipal (local) governments, as well as private concessionaries of public services (such as transportation services).

FORTEM II (funded by IDB)

- Focused on transportation and urban traffic projects (specific characteristics of the projects need to be discussed with Banobras in order to determine eligibility of the project).
- Eligible lendees are only municipal governments
- Candidates are required to be rated, or have as guarantor its corresponding State Government.
- Maximum amount of financing is $100 million equivalent US Dollars.
- Must be structured as a dual-currency credit, where the Mexican Pesos component lies in a range between 25%-50% of total.
- Interest rate for the above mentioned Mexican Pesos component has a reference rate of one-year CETES (Mexican equivalent to T-Bills in USA), plus 200 to 300 bp
- Repayment period: 25 years.

CONACYT (Consejo Nacional de Ciencia y Tecnología)

This is a support program for new venture creation based on scientific and technological research and development.

- Maximum amount of credit: MN$7 million (Approximately US$600,000).

- Credit cannot exceed 20% of total investment.
- The technology to be applied must have already been proven, should be copy- righted and entirely developed.
- Focused on, among others strategic sectors: Information Technology (IT), and Electronics and Telecommunications.
- The credit can be applied to working capital needs, fixed assets, or consultancy.

Fiscal subsidies (tax shield)

- Available according to a decree issued on September 24, 2004, by the Secretaría de Hacienda y Crédito Público (Ministry of Finance).
- The investment must be qualified by CONACYT in order to be elegible for fiscal subsidy.
- Maximum amount of the subsidy is 30% of investment.

Securities Placed By Municipalities

- It is a relatively recent financial vehicle.
- Focused mainly on waste management, water supply and disposal, public supermarkets, and urban transportation.
- Guarantees are the federal funds assigned to municipalities.
- This financial instrument requires approval by the State Congress.

Although the above-listed potential sources are meant to cover the capital expenditures, some of them may also be used to pay for the operating and maintenance expenses that otherwise would require government subsidy financing.

6.3.4 Integrated Financial Model

This subsection summarizes the integrated financial model developed for the "representative programs." The model presented here starts with a set of key assumptions, and shows the relevant financial statements (i.e., income statement, balance sheet, and cash flows). It should be noted that the model is developed to serve as a preliminary base from which further analyses and other scenarios can be build.

6.3.4.1 Key Assumptions

Key financial model assumptions are as follows:

- Average annual inflation rate: 4%
- Depreciation; calculated using the straight line method with annual depreciation rates of 25% and 3.3% for vehicles and equipment, and buildings categories, respectively.
- Debt vs. Equity: debt (bonds) 90%, equity 10%.
- Debt:
  - Source Breakdown: domestic sector 75.0%, multilaterals 25.0%
  - Long-term interest rate: domestic Sector 14%, multilaterals 10%
  - Min capital reserve as % of debt: 10%
  - Issuance costs: 1.5%
- Revenue:
  - Advertising & other as % of O & M:5%
  - Assumed interest rate on capital reserves: 9% calculated on average annual (mid-yr) balances

- Public sector subsidy
- Tax rate: 35%

6.3.4.2 Results

This subsection includes the projected income statement, balance sheet, and cash flow statements for the base scenario. The statements for the base case are shown in Exhibits 6.8 through 6.10 below.

As can be seen from the projected financial statements, the project is not forecasted to generate sufficient sales to cover the different O & M and overhead expenses. Consequently, this annual shortfall will need to be filled with other sources such a public sector subsidy. By 2009, such subsidies would be an average of US$35 million, although they would fluctuate based on the equipment life cycle to as high as $78 million in some years. Dedication of revenues from tolls, taxes, user fees to offset this additional annual cost should be considered with respect to widespread deployment of the representative programs described here. It is noted that such subsidies are offset by the annual benefits (approximately $210 million) to the public, although that is not an easily recognizable direct contribution to the government treasury, merely a measure of comparative value.

Exhibit 6.8
Projected Income Statement for the Four Representative ITS Programs (Millions $US)

Program Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Calendar Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
REVENUES																				
Various (e.g. advertising)	$ 0.11	$ 0.16	$ 0.34	$ 0.51	$ 0.67	$ 0.95	$ 1.14	$ 1.36	$ 1.56	$ 1.69	$ 1.79	$ 1.91	$ 1.98	$ 2.06	$ 2.15	$ 2.23	$ 2.32	$ 2.41	$ 2.51	$ 2.61
Interest on capital reserve balances	0.59	1.41	1.62	1.10	0.99	1.55	1.82	1.28	1.03	1.90	2.94	2.97	2.05	1.93	1.89	1.21	1.34	1.40	0.09	0.09
Other (e.g., government)	11.45	11.74	15.42	35.44	34.40	41.30	48.98	62.28	69.79	74.50	79.23	70.59	76.92	82.62	85.22	88.52	91.05	93.70	97.85	101.60
TOTAL REVENUES	**$ 12.16**	**$ 13.31**	**$ 17.38**	**$ 37.05**	**$ 36.06**	**$ 43.81**	**$ 51.94**	**$ 64.92**	**$ 72.38**	**$ 78.09**	**$ 83.96**	**$ 75.47**	**$ 80.95**	**$ 86.61**	**$ 89.26**	**$ 91.96**	**$ 94.71**	**$ 97.51**	**$ 100.45**	**$ 104.30**
DIRECT COSTS																				
Operating & Maintenance	$ 2.24	$ 3.27	$ 6.71	$ 10.27	$ 13.49	$ 19.04	$ 22.70	$ 27.14	$ 31.17	$ 33.73	$ 35.88	$ 38.15	$ 39.67	$ 41.26	$ 42.91	$ 44.63	$ 46.41	$ 48.27	$ 50.20	$ 52.21
TOTAL DIRECT COSTS	**$ 2.24**	**$ 3.27**	**$ 6.71**	**$ 10.27**	**$ 13.49**	**$ 19.04**	**$ 22.70**	**$ 27.14**	**$ 31.17**	**$ 33.73**	**$ 35.88**	**$ 38.15**	**$ 39.67**	**$ 41.26**	**$ 42.91**	**$ 44.63**	**$ 46.41**	**$ 48.27**	**$ 50.20**	**$ 52.21**
GROSS INCOME	**$ 9.91**	**$ 10.03**	**$ 10.66**	**$ 26.78**	**$ 22.57**	**$ 24.76**	**$ 29.23**	**$ 37.77**	**$ 41.21**	**$ 44.36**	**$ 48.08**	**$ 37.32**	**$ 41.28**	**$ 45.35**	**$ 46.35**	**$ 47.33**	**$ 48.30**	**$ 49.24**	**$ 50.25**	**$ 52.10**
OVERHEAD EXPENSES																				
Depreciation	$ 6.01	$ 6.18	$ 6.86	$ 21.09	$ 16.99	$ 19.30	$ 23.91	$ 29.60	$ 33.32	$ 36.79	$ 40.86	$ 30.51	$ 34.91	$ 39.50	$ 41.06	$ 42.69	$ 44.38	$ 46.14	$ 47.97	$ 49.87
Interest expense	3.90	3.86	3.80	5.69	5.58	5.46	5.33	8.17	7.89	7.57	7.22	6.82	6.37	5.86	5.29	4.64	3.92	3.11	2.28	2.23
TOTAL OVERHEAD COSTS	**$ 9.91**	**$ 10.03**	**$ 10.66**	**$ 26.78**	**$ 22.57**	**$ 24.76**	**$ 29.23**	**$ 37.77**	**$ 41.21**	**$ 44.36**	**$ 48.08**	**$ 37.32**	**$ 41.28**	**$ 45.35**	**$ 46.35**	**$ 47.33**	**$ 48.30**	**$ 49.24**	**$ 50.25**	**$ 52.10**
NET INCOME BEFORE TAX	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Corporate tax	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
NET INCOME	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Distributable Dividends	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
RETAINED EARNINGS	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Cumulative $ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -

Exhibit 6.9
Projected Balance Sheet for the Four Representative ITS Programs (Millions $US)

	1 2006	2 2007	3 2008	4 2009	5 2010	6 2011	7 2012	8 2013	9 2014	10 2015	11 2016	12 2017	13 2018	14 2019	15 2020	16 2021	17 2022	18 2023	19 2024	20 2025
ASSETS																				
CURRENT ASSETS																				
Cash	$ 13.09	$ 18.16	$ 17.76	$ 6.88	$ 15.38	$ 19.13	$ 21.29	$ 7.21	$ 15.72	$ 26.50	$ 38.76	$ 27.29	$ 18.25	$ 24.62	$ 17.40	$ 9.44	$ 20.44	$ 10.73	$ 1.00	$ -
Accounts Receivable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Current Assets	$13.09	$18.16	$17.76	$6.88	$15.38	$19.13	$21.29	$7.21	$15.72	$26.50	$38.76	$27.29	$18.25	$24.62	$17.40	$9.44	$20.44	$10.73	$1.00	$0.00
LONG-TERM ASSETS																				
Property & Equipment																				
Buildings	$ 2.16	$ 2.16	$ 6.84	$ 6.84	$ 6.84	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11	$ 12.11
Accumulated Depreciation	(0.07)	(0.14)	(0.37)	(0.60)	(0.83)	(1.23)	(1.64)	(2.04)	(2.44)	(2.85)	(3.25)	(3.65)	(4.06)	(4.46)	(4.86)	(5.27)	(5.67)	(6.07)	(6.48)	(6.88)
Vehicles and Equipment	23.74	24.42	26.52	83.46	90.80	100.01	120.54	200.25	222.45	245.54	282.36	320.66	360.49	401.91	444.99	489.79	536.39	584.84	635.24	687.65
Accumulated Depreciation	(5.94)	(12.04)	(18.67)	(39.54)	(56.30)	(75.20)	(98.70)	(127.90)	(160.81)	(197.19)	(237.65)	(267.75)	(302.26)	(341.36)	(382.01)	(424.30)	(468.27)	(514.00)	(561.57)	(611.03)
Net Total Property & Equipment	$ 19.90	$ 14.40	$ 14.32	$ 50.17	$ 40.51	$ 35.69	$ 32.31	$ 82.41	$ 71.30	$ 57.61	$ 53.57	$ 61.36	$ 66.28	$ 68.20	$ 70.22	$ 72.33	$ 74.55	$ 76.87	$ 79.30	$ 81.85
TOTAL ASSETS	**$ 32.99**	**$ 32.56**	**$ 32.08**	**$ 56.85**	**$ 55.89**	**$ 54.81**	**$ 53.60**	**$ 89.62**	**$ 87.02**	**$ 84.11**	**$ 92.33**	**$ 88.65**	**$ 84.53**	**$ 92.82**	**$ 87.62**	**$ 81.77**	**$ 94.99**	**$ 87.61**	**$ 80.31**	**$ 81.85**
LIABILITIES & EQUITY																				
CURRENT LIABILITIES																				
Accounts Payable	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Short-Term Debt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.00	11.87
Total Current Liabilities	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.00	$ 11.87
LONG-TERM LIABILITIES																				
Long-Term Debt	$ 29.65	$ 29.22	$ 28.74	$ 43.59	$ 42.63	$ 41.55	$ 40.33	$ 63.86	$ 61.26	$ 58.34	$ 55.07	$ 51.39	$ 47.27	$ 42.63	$ 37.43	$ 31.58	$ 25.01	$ 17.63	$ 9.33	$ 0.00
Total Long-Term Liabilities	$ 29.65	$ 29.22	$ 28.74	$ 43.59	$ 42.63	$ 41.55	$ 40.33	$ 63.86	$ 61.26	$ 58.34	$ 55.07	$ 51.39	$ 47.27	$ 42.63	$ 37.43	$ 31.58	$ 25.01	$ 17.63	$ 9.33	$ 0.00
Shareholders' Equity																				
Capital Stock	$ 3.34	$ 3.34	$ 3.34	$ 13.26	$ 13.26	$ 13.26	$ 13.26	$ 25.76	$ 25.76	$ 25.76	$ 37.26	$ 37.26	$ 37.26	$ 50.19	$ 50.19	$ 50.19	$ 69.98	$ 69.98	$ 69.98	$ 69.98
Retained Earnings	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Shareholder Equity	$ 3.34	$ 3.34	$ 3.34	$ 13.26	$ 13.26	$ 13.26	$ 13.26	$ 25.76	$ 25.76	$ 25.76	$ 37.26	$ 37.26	$ 37.26	$ 50.19	$ 50.19	$ 50.19	$ 69.98	$ 69.98	$ 69.98	$ 69.98
TOTAL LIABILITIES & EQUITY	**$ 32.99**	**$ 32.56**	**$ 32.08**	**$ 56.85**	**$ 55.89**	**$ 54.81**	**$ 53.60**	**$ 89.62**	**$ 87.02**	**$ 84.11**	**$ 92.33**	**$ 88.65**	**$ 84.53**	**$ 92.82**	**$ 87.62**	**$ 81.77**	**$ 94.99**	**$ 87.61**	**$ 80.31**	**$ 81.85**

Exhibit 6.10
Projected Cash Flow Statement for the Four Representative ITS Programs (Millions $US)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Operating Cash Flow																					
IS	Net Income	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
IS	(+) Depreciation	6.01	6.18	6.86	21.09	16.99	19.30	23.91	29.60	33.32	36.79	40.86	30.51	34.91	39.50	41.06	42.69	44.38	46.14	47.97	49.87
BL	(+-) Accounts Receivable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BL	(+,-) Accounts Payable	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Operating Cash Flow		$ 6.01	$ 6.18	$ 6.86	$ 21.09	$ 16.99	$ 19.30	$ 23.91	$ 29.60	$ 33.32	$ 36.79	$ 40.86	$ 30.51	$ 34.91	$ 39.50	$ 41.06	$ 42.69	$ 44.38	$ 46.14	$ 47.97	$ 49.87
Investing Cash Flow																					
	(+,-) Buildings	$ (2.16)	$ -	$ (4.68)	$ -	$ -	$ (5.26)	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	(+,-) Vehicles and Equipment	(23.74)	(0.67)	(2.11)	(56.94)	(7.34)	(9.21)	(20.53)	(79.71)	(22.20)	(23.09)	(36.82)	(38.30)	(39.83)	(41.42)	(43.08)	(44.80)	(46.59)	(48.46)	(50.40)	(52.41)
Net Investing Cash Flow		$ (25.90)	$ (0.67)	$ (6.79)	$ (56.94)	$ (7.34)	$ (14.48)	$ (20.53)	$ (79.71)	$ (22.20)	$ (23.09)	$ (36.82)	$ (38.30)	$ (39.83)	$ (41.42)	$ (43.08)	$ (44.80)	$ (46.59)	$ (48.46)	$ (50.40)	$ (52.41)
Financing Cash Flow																					
BL	(+) Issuance of Debt Short	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1.00	$ 11.87
BL	(+) Issuance of Debt Long	30.03	-	-	15.70	-	-	-	25.84	-	-	-	-	-	-	-	-	-	-	-	-
BL	(+) Issuance of Equity	3.34	-	-	9.93	-	-	-	12.50	-	-	11.49	-	-	12.93	-	-	19.79	-	-	-
BL	(-) Amortization of Debt	(0.36)	(0.43)	(0.48)	(0.65)	(0.96)	(1.08)	(1.22)	(2.32)	(2.60)	(2.92)	(3.27)	(3.67)	(4.13)	(4.63)	(5.20)	(5.85)	(6.57)	(7.38)	(8.30)	(9.33)
BL	(-) Redemption of Equity/Dividends	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Net Financing Cash Flow		$ 32.99	$ (0.43)	$ (0.48)	$ 24.77	$ (0.96)	$ (1.08)	$ (1.22)	$ 36.02	$ (2.60)	$ (2.92)	$ 8.22	$ (3.67)	$ (4.13)	$ 8.30	$ (5.20)	$ (5.85)	$ 13.22	$ (7.38)	$ (7.38)	$ 2.54
Beginning Cash		$ -	$ 13.09	$ 18.16	$ 17.76	$ 6.68	$ 15.38	$ 19.13	$ 21.29	$ 7.21	$ 15.72	$ 26.50	$ 38.76	$ 27.29	$ 18.25	$ 24.62	$ 17.40	$ 9.44	$ 20.44	$ 10.73	$ 1.00
Net Cash for Period		13.09	5.07	(0.41)	(11.07)	8.69	3.75	2.16	(14.08)	8.51	10.78	12.26	(11.46)	(9.04)	6.37	(7.22)	(7.96)	11.00	(9.70)	(9.73)	(0.00)
Ending Cash		$ 13.09	$ 18.16	$ 17.76	$ 6.68	$ 15.38	$ 19.13	$ 21.29	$ 7.21	$ 15.72	$ 26.50	$ 38.76	$ 27.29	$ 18.25	$ 24.62	$ 17.40	$ 9.44	$ 20.44	$ 10.73	$ 1.00	$ 1.00

6.4 Risk Analysis

The analysis above has determined a set of options for the Mexico National ITS project that would provide funding to support the construction, operation and maintenance of the ITS Architecture. The financial analysis assumes substantial federal government participation in the construction of the project. The magnitude of this investment demands that there be some indication of commitment to this important initiative. Although the analysis describes a likely scenario based on the funding, financing and cost assumptions presented above, there are a number of technical, quality, liability and financial risks that could influence the project. They include:

- Operating & maintenance costs
- Capital Cost
- Financial Risk
- Capital Funding Availability
- Interest Rates
- Dedicated revenues
- Inflation

The risks are summarized for the four representative programs below.

6.4.1 National Traveler Information System

This project is relatively low cost, uses readily available technologies, and similar efforts (at least web pages) have been implemented in numerous locations. Technically, there is very little risk. Web sites are not difficult to create and maintain. As phone lines are to be used initially, so there is no risk involved with communication problems. In terms of quality, there is no precedent, or benchmark, to compare. However, if successful, this project will have considerable public visibility. This introduces a real risk that an expected level of service must be maintained. This will gradually impact operations costs. Further expansion of the system will rely on the ability to obtain real-time information from other systems, including probe data from electronic toll collection, flow data from traffic management systems, etc.

Concerning uncertainties, the greatest uncertainties rest on the institutional relationships. The traveler information system depends on information from other sources (ETC, traffic management systems, mainly law enforcement). There is currently have no national real-time information sharing, so no precedent exists in Mexico. If the participants are unwilling to share information, the system will not have sufficient information to realize its benefits. Institutional coordination and project buy-in is essential to mitigate this risk.

6.4.2 Incident Management (Green Angels) Program Expansion

This project, while it requires a high degree of investment (purchase and O & M for vehicles, plus staff support) would not be expected to carry substantial risk. The cost structure assumed an initial deployment in one city with future deployments depending on the success of the first.

Technically, there is very little new technology being employed through this program. The vehicles and the fleet management systems are production models and proven technologies. There is some risk that the system will not perform if there is not sufficient investment in quality vehicles and if the drivers are not properly trained. Considering that the Green Angels program is well established in the rural areas, there should be sufficient experience to mitigate this risk. There are some important differences between the rural and urban applications. Most notably, the need for quicker response and the increased traffic the staff will have to deal with. These and other factors need to be considered in the purchase of equipment and driver training.

While there is a substantial capital investment necessary, the vast majority is for physical equipment that can be sold to recover a portion of the investment. Again, this provides less actual risk than many other

projects. There may be some liability risks. Depending on Mexican tort laws, there may be a need for some laws to protect the agencies from liability in terms of what they may do to clear an incident more quickly (e.g., drag a car on its side to the side of the road). These should be similar to protection provided to current police, fire, and ambulance staff and agencies.

6.4.3 Electronic Freight Information System

There are some risks in the development of the electronic freight information system. While the system is supposed to replicate existing paper forms, all software development carries some level of risk with it. This is also increased due to the use of field readers (laptops or wireless personal digital assistants). Any time electronic equipment is to be distributed outside of the controlled office environment, there are a myriad of additional risks that apply. It is assumed that wireless communications should not be a problem since it is wireless only locally, and then can use the internet for central communications. Total financial commitment is limited for this project.

The largest risks on this project are institutional. Specifically, both customs officials and truck drivers and companies need to be involved in the development and eventual operations of this project. These two groups often have conflicting needs and concerns. So the product must meet everyone's expectations, or the demonstration will have a difficult time showing success.

Mitigation of the above risks could be accomplished through utilizing similar systems being deployed in the U.S., which would reduce software development costs (but not integration costs). NAFTA-compliant carriers would not be required to implement additional paperwork – the project would instead permit the manifest / inspection data to be shared with other agencies in Mexico.

6.4.4 Rural Public Transport Enhancements

This project carries a fair amount of financial and institutional risk. The equipment is specialized but contains many off-the-shelf products (notably AVL and dispatch systems) would be distributed to a large fleet of concessioned vehicles. Therefore, there is little salvage value to the equipment, and since it is physically not under the purchasing agency's control, a great risk that they may never recover the equipment. The equipment and systems are generally off the shelf production units, so technical development is minimal. However, the success of the operation requires the participation, education, and involvement of literally thousands of private sector concessions. The amount of effort required to manage these concessions is currently substantial. Adding many carriers who are currently unlicensed would also add costs. While the system will eventually provide the managers with increased and efficient capabilities to better manage the concessions, there would be a large educational effort required in the first few initial years. Without a well-developed deployment plan (including institutional changes regarding public transport concessions by SCT), there is some degree of risk that the end product will not be used efficiently.

6.5 Summary

In conclusion, the above-described preliminary analyses of the four representative winner programs of National ITS Architecture in Mexico show contrasting views of economic versus financial feasibility.

From the economic analysis standpoint their implementation would bring about various benefits that when combined generate results relative to the costs (e.g., in terms of high benefits-to-costs ratio and NPV) that indicate a positive impact on the economy and a strong net benefit gain.

However, the financial feasibility results appear much weaker. They proposed projects do not seem to have a strong revenue generating potential, and consequently the financial statements show significant shortfalls that would need to be filled with public sector subsidies. Such subsidies would, in terms of value, be less costly than the equivalent benefits to the public.

A risk identification analysis was also performed, and it shows that most of the risks (especially the technical, quality, and liability) are generally manageable, with the exception of Rural Public Transport, which, while likely to be a highly beneficial program for rural travelers, carries large costs and significant institutional risks due to needed changes in management and operational policies by SCT.

CHAPTER SEVEN
Environmental Benefits

Chapter 2 of this document identified many of the basic characteristics of Mexico, including population, demographics, economic and travel data. This Chapter will review another set of national characteristics, those of the environment. The Chapter will then assess the potential benefits of implementing ITS relative to the Mexican environment. This will help to provide a more complete picture of the impact ITS will have on the Mexican transportation system.

7.1 OVERVIEW

In addressing the environmental impacts relative to ITS in Mexico, many of the benefits were quantified in a manner which allowed them to be related to the financial benefits as discussed in Chapter 6.

The data sources for assessing the environmental benefits of a Nationwide ITS system for Mexico include specific members of the Architecture Team, notably SCT and subconsultant Suma Sinergia. Specific sources relative to environmentally-related ITS benefits include the U.S. Department of Transportation's ITS Deployment Assessment System (IDAS) Impact Estimation Methodologies guidelines; along with the Organization for Economic Cooperation and Development, Environmental Performance Reviews. Due to the magnitude of a National ITS Architecture deployment, existing environmental issues and benefits are general in nature, and are best generalized in a similar manner to the description and assessment of four representative programs in Chapter 6. Other more detailed studies completed in Mexico have examined air quality issues, particularly in many of the large urban areas. It is not within the scope of this project to approach that very high level of detail. Rather, the purpose is to identify potential environmental benefits of ITS and to determine where possible the benefits and positive impacts to the environment owing to implementation of potential intelligent transportation systems and services.

Thus, this Chapter provides the following:

- Describes the general environmental state or condition of Mexico on national basis.
- Identifies the likely benefits from ITS systems
- Identifies the likely social benefits from deployed ITS technologies.
- Identifies a long-term environmental management monitoring program.
- Summarizes environmental concerns of ITS deployment.
- Summarizes overall environmental benefits.

7.2 ENVIRONMENTAL STATE

Environment is defined by the Merriam-Webster dictionary as "the aggregate of social and cultural conditions that influence the life of an individual or community". Within the transportation community, the aspect of the environment which is most commonly impacted is air quality, and that impact occurs as a result of the actual vehicle operations. Thus, operational improvements to transportation can have corresponding air quality improvements. However, other environmental issues, typically related to the physical roadway itself, include alterations to the geology and to fauna, particularly as the facility may affect animal life and safety.

This report will examine all aspects of environment at a relatively high level. However, as ITS mainly entails improvements in transportation operations, as opposed to physical changes to transportation facilities, much of the discussion will be related to air quality.

7.2.1 National Basis

Addressing the environmental issues at the national level is different than addressing them at the regional level. While the issues are very much the same, their relative importance changes depending on national

or regional perspective. This section will examine the state of the environment across Mexico on a national basis.

7.2.1.1 Urbanization

In 2000, Mexico had a population of 97,500,000, of which, 65.7 million (7 out of 10) live in urban areas. Total urban population grew at a rate of 2.5% per year between 1990 and 2000, while rural population has decreased (overall national population growth is 1.1%). Two main trends are noted:

- The fastest growing cities are Tijuana and Ciudad Juárez, both cities on the U.S. border, each with over 4% annual growth.
- The central region surrounding Mexico City is fast consolidating into vast megalopolis, as all the cities that surround it keep growing at a high rate, specially Toluca, Cuernavaca, Pachuca, Tlaxcala, and San Juan del Río.

Tijuana and Ciudad Juárez are also fast becoming very important manufacturing centers. However, the environment of these cities shares more connectivity with their neighbors north of the border in the U.S. than with other urban areas in Mexico, although the border cities in the northeast (Reynosa, Matamoros, and Nuevo Laredo) are closely connected to Monterrey.

7.2.1.2 Natural and Economic Resources

The nation has abundant minerals, such as silver, copper, sulphur, lead, and zinc. Mexico is ranked among the top ten countries in the world for its massive petroleum reserves. Over MN$1.75 trillion worth of goods was exported in 2002, including oil and gas, agricultural products, and manufactured goods. Mexico also has a prosperous maquiladora industry, where products are assembled inexpensively at United States owned plants, then exported back to the United States and elsewhere. The foreign plant owners profit from the lower cost of doing business in Mexico, and Mexicans gain jobs.

The North American Free Trade Agreement (NAFTA) came into effect on January 1, 1994. This agreement establishes a set of rules for the maquiladora industry and trade between the United States, Mexico and Canada. The export boom it generated was exceptional, leading to the tripling of Mexico's exports between 1994 and 2000. Exports to the United States grew to account for 25 percent of Mexico's economy, which went up from 13 percent in 1993, and made up 80 percent of Mexico's export revenues. By 2000, 70 percent of Mexico's foreign investment and 80 percent of tourism was coming from the United States Maquiladoras. The maquiladora industries contributed half of Mexico's exports, and were NAFTA's most immediate beneficiaries, employing 1.3 million people, compared to the 546,000 in 1993. The legal framework provided by NAFTA had led to a resurgence of the investment community's confidence in Mexico, which brought in billions of dollars in foreign investment, as well as wages.

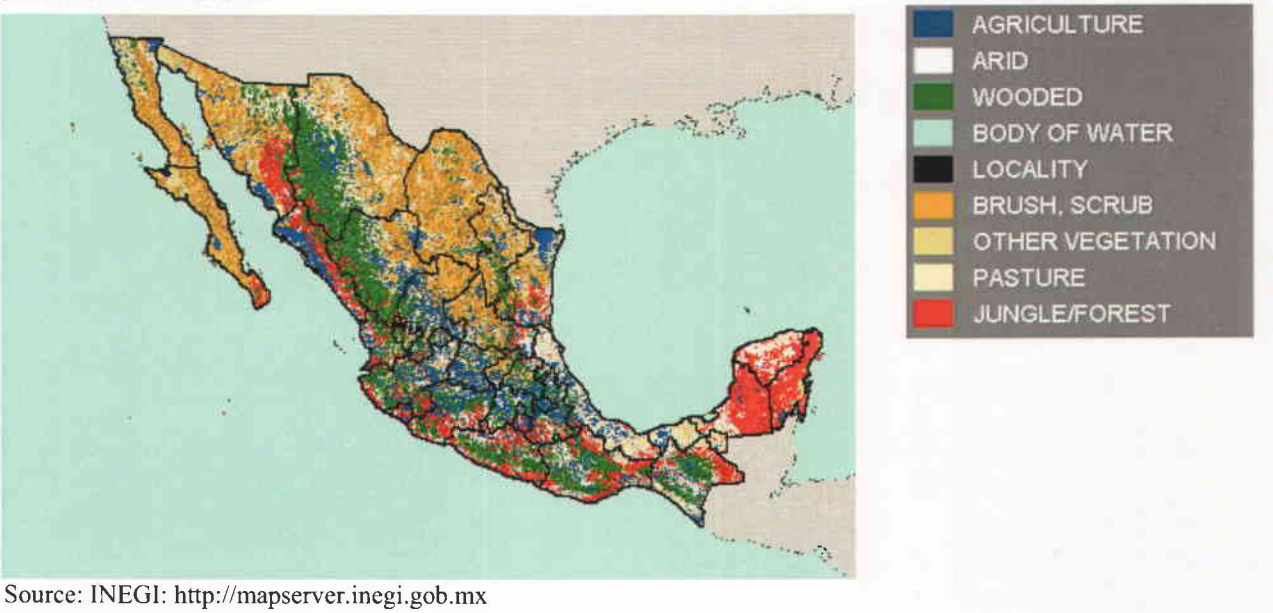
7.2.1.3 Physical Environment

Mexico is experiencing rapid economic and population growth which has spawned extreme pressures on the physical environment, including high levels of pollution and, in a number of cases, unsustainable utilization of natural resources. Two major areas of concern have been fresh water depletion and deforestation throughout the country, with groundwater scarce and polluted in northern Mexico, and limited in the central and southeast portions of the country. Pollution of rivers, deterioration of agricultural land, and lowering of ground level in the central valley as a result of groundwater depletion are also notable.

Mexico's ecological and natural resources are diverse and abundant ranging from the desert region in northern Mexico that includes the Sonoran Desert and Sea of Cortez, to the mountains of central Mexico and the tropics in southern Mexico. Mexico has designated National Parks and Reserves throughout the country and natural resources such as volcanoes, caves, coastal areas, rainforests, jungles, mangroves, and deserts.

Exhibit 7.1 provides a map illustrating the natural state of different areas throughout the country.

Exhibit 7.1
Natural Environment



Source: INEGI: http://mapserver.inegi.gob.mx

7.2.1.4 Regulatory Issues

One concern raised by opponents of NAFTA was that increased trade would lead to further environmental degradation in Mexico, as companies would move their operations to Mexico to avoid strict environmental enforcement in the United States. Since NAFTA has been in place, Mexico has begun a serious effort to enforce its environmental laws for new companies, thus diminishing any encouragement for firms to relocate to Mexico to avoid environmental regulatory enforcement.

Mexico's principal environmental law is the General Law of Ecological Balance and Environmental Protection, which has been in effect since 1988. The law provides a general framework within which all state laws and federal regulations must comply, including regulations governing air pollution, hazardous waste and materials transport, environmental impact assessment and motor vehicle emissions. These regulations are implemented by means of media-specific, quantitative standards called Mexican Official Standards (NOMs). These standards are principally based on U.S. standards.

7.2.1.5 Air Quality

Air pollution has significantly declined overall in urban areas during the last ten years, including Mexico City. However, exposure to air pollution remains a severe threat to public health. Extremely high pollution episodes have become rare, but the number of days on which air quality standards are exceeded has remained unchanged. According to the Mexican Health Secretariat, more than a third of Mexico's disease affliction is the result of environmental factors, the most severe being air pollution. Ambient air quality standards for PM_{10} are exceeded up to 30% of the year in all metropolitan areas.

Though especially pressing in Mexico's largest cities, air pollution also has intensified along the border with the United States due to the rapid growth occurring in the border region. A recent study found that respiratory ailments related to air pollution were the cause of death for at least half of the more than 2,800 minors who died in the northern border city of Ciudad Juárez. Pollutants from a number of sources including motor vehicles, power plants and industrial facilities, agricultural operations, mining, dust from unpaved roads, open burning of trash have affected urban and regional air quality along the Mexico/U.S.

border. Emissions from traffic congestion at the border are of particular concern as the traffic growth at the border continues to climb.

7.2.1.6 Transportation

Automobile ownership in Mexico is on the rise with car sales now over 1 million per year. Today, thousands of Mexican families have the possibility of acquiring a new vehicle due to better incomes, financing, vehicle quality and price. Over 95% of passengers and 80% of freight are currently carried by road. Inter-urban traffic mainly consists of private cars, trucks, and buses.

Many of Mexico's inhabitants use public transportation regularly. In many communities large and small, there are multiple carriers and services which are not coordinated (particularly bus operations) and as a result operations are less efficient than they could be. The presence of unregulated door-to-door services from rural areas to city centers occurs because the current operational structure for public transport services in rural areas may not optimally serve those communities not on major highways.

7.2.2 Regional Basis

In Chapter 2, the following seven regions and related corridors were defined;

1) Central region to Nogales and Mexicali
2) Guadalajara to Pacific ports
3) Central region to Chihuahua
4) Central region to Monterey
5) Central region to Yucatan peninsula
6) Central region to Chiapas
7) Central region

The seven regions are oriented along transportation corridors. Much of the travel in Mexico is along these specific corridors, most of them radial to Mexico City. This section will examine the environmental state relative to these regions with respect to population and economy, physical environment, air quality, and transportation.

7.2.2.1 Population and Economy

The border region is home to more than 11.8 million (2004), with approximately 6.3 million in the U.S. and 5.5 million in Mexico. Approximately 90% of the population resides in 14 paired sister cities, with the rest living in small towns or rural communities. Projected population growth rates in the border region exceed anticipated national average growth rates in both countries, in some cases by more than 40%.

Trade with the U.S. and Canada has tripled since the implementation of the North American Free Trade Agreement (NAFTA) in 1994, including construction of a number of factories in border areas which provide shipment of goods to the United States. The U.S. captures over 80% of Mexico's output, making the U.S. the largest trading partner with Mexico. The economy is largely impacted by the performance of the U.S. economy as a result. However, industry in Mexico has been growing at nearly a 5% annual rate. Hermosillo, located in the state of Sonora, has been transformed into an important industrial metropolis due to being the location of a Ford automobile assembly plant, as well as being a center of commercialization and provision of a rich agricultural zone.

Exhibit 7.2
Regional Populations

Region	Population
1 – Central to Nogales/Mexicali	7,665,221
2 – Guadalajara to Pacific ports	11,770481
3 – Central Region to Chihuahua	11,184,793
4 – Central Region to Monterrey	6,799,463

5 – Central Region to Yucatan Peninsula	12,024,666
6 – Central Region to Chiapas	10,439,306
7 – Central Region	37,599,482

The northern regions (1, 3, and 4) are dominated by the trade with the U.S. Regions 2 and 5 contain significant tourism and large seaports. Again, the trade is most often with the U.S. Region 6 is one of the poorest in Mexico being more agricultural and bordering Guatemala. Region 7 contains Mexico City and many of the urban areas throughout the country. As most of the natural resources within Mexico are not in this region, it requires significant movement of goods to the region.

7.2.2.2 Environment

The Mexico/U.S. border region is one of the most dynamic in the world. It extends more than 2000 miles from the Gulf of Mexico to the Pacific Ocean and 62.5 miles on each side of the international border. The region includes large deserts, numerous mountain ranges, rivers, wetlands, large estuaries, and shared aquifers. The region has various climates, a remarkable biological diversity including many rare and native species, and national parks and protected areas.

Many ports of entry are in or near large urban areas, and increased commercial traffic in the region impacts the entire community. Booming commerce has meant rapid and haphazard urbanization in Mexico. As a result of regional environmental degradation, some border residents suffer from environmental health problems, including respiratory diseases.

7.2.2.3 Air Quality

Most of Mexico's larger cities have air quality issues due to congestion, climate and geography. These cities include: Mexico City Metropolitan Area, Guadalajara, Monterrey, Toluca Valley, Ciudad Juarez, Tijuana-Rosarito, and Mexicali. The Mexican/U.S. border region is dealing with air quality issues related to cross border congestion.

Mexico City's air quality is among the most severe air pollution cases in the world. Situated within the crater of an extinct volcano, Mexico City is about 2,240 meters above sea level. The lower atmospheric oxygen concentrations at this altitude cause deficient fuel combustion in engines and a greater release of carbon monoxide and other compounds. Intense sunlight turns these into higher than normal smog levels. In turn, the smog prevents the sun from heating the atmosphere enough to penetrate the inversion layer covering the city. The two pollutants that are the most troublesome and difficult to control are ozone and small particles that can damage the health of human beings because they penetrate deeply into the lungs.

According to the World Health Organization (WHO), Mexico City's air averages 179 mg per cubic meter of suspended particulates, well above the WHO 90 mg maximum recommendation. Guadalajara exceeds pollution limits 90% of the year due largely to vehicle emissions.

Growth at the Mexico/U.S. border is contributing to decline of air quality in the region. In the Tijuana-San Diego area, commercial trucks account for only 4% of roadway use but are responsible for 80% of PM_{10} and 25% of NO_x in the atmosphere. Although substantial gains have been made, air quality is still a major concern throughout the border region.

7.2.2.4 Transportation

In Mexico City the dominant mode of passenger transport has clearly shifted from large diesel-fuelled buses (40-50 seats) to small petrol-fuelled models (5 to 10 seats). Small buses now account for 60% of passenger-kilometers while the remaining 40% includes the subway (17%), taxis (11%), large buses (11%) and trolley buses (1%). As mentioned before, public transportation in Mexico's large cities is not efficient and passengers routinely experience long delays and wait times.

There is frequent traffic congestion at the Mexican/US border. Border locations with routine congestion include: Laredo, San Ysidro, Nogales, El Paso, Brownsville and Calexico. Cross-border traffic has soared

by 170% since NAFTA went into effect, with over 2.4 million truck crossings in 1999 alone. There are 25 ports of entry along the Mexico/US border that process commercial vehicle traffic, but seven of those ports carry 91% of cross-border truck traffic. This booming cross-borer trade aggravates traditional border transportation bottlenecks, resulting in unprecedented congestion at border crossings.

7.3 Likely Benefits of ITS

Environmental benefits can be realized in many ways. In general, environmental benefits can always be identified as some means of improving the quality of life for Mexicans. This will often be quantified in terms of air quality. Other expected benefits will include a reduction in travel delays and decreases in accidents, injuries, and fatalities (related to transportation). Many of these benefits have been quantified in Chapter 6. This report will summarize those issues.

7.3.1 Short Term Benefits

A number of short term benefits include increases in employment, number of transportation users, and other potential ITS systems benefits. Short term employment benefits include construction jobs associated with the building of a new ITS infrastructure, and full time ITS professional jobs related to the maintenance and operation of the ITS systems and infrastructure. User benefits include the increased efficiency of the roadway network which in turn leads to greater efficiencies in the movement of good within the network. Another expected user benefit is the ability of ITS tools to reduce the accident clearance times, especially for those traveling in the vicinity of the accident. This also serves as a long term benefit (see below).

7.3.2 Long Term Benefits

Clearly the most obvious long term benefits of potential ITS applications include the overall reduction of emission pollutants and associated improved air quality, reduced fuel consumption, and the overall improved efficiency of the transportation system and the associated quality of life improvement for the motoring public and their increased safety. Travel times will be reduced, economic savings will occur, and overall mobility will be enhanced.

Long term benefits are described below.

7.3.2.1 Better Accident Response

Certain ITS applications will provide motorists with better accident response times. Once an accident occurs and traffic begins to slow, or stop, the associated congestion becomes worse the more time that passes. Emergency services will be notified of the accident sooner, get to the accident site quicker, and provide motorist with alternative routes to detour the accident site to reduce congestion. Over time, motorists will experience an increased confidence and peace of mind knowing that help will arrive on the scene. Congestion associated with the accident will be less and result in a reduction in emissions and fuel usage from idling vehicles. Overall safety of stranded motorists will be improved as well with better accident response times as there will be less time for people to be exposed to possible criminal activity aimed at the stranded motorist. In the event of an accident that involves a hazardous material spill, quicker accident response will reduce the environmental exposure by providing quicker cleanup of the potential contaminate.

7.3.2.2 Streamlined Border Operations

There are many ITS applications that can be utilized at the border to streamline operations. Such things as electronic manifests, variable message sign boards, and electronic tagging and sealing of trucks can result in benefits to border operations. Obviously, less congestion at the border would result in a reduction of vehicle emissions and fuel consumption. Delays at the border cost the Mexican and U.S. economies millions of dollars a year in wasted resources and lost productivity. Businesses that routinely ship goods across the border would benefit economically from a more streamlined border. There are many workers

who live in the border region who work on the other side of the border. A less congested border crossing would allow for a more free flow of these workers and reduce the stress associated with the daily congestion of the border. Border stations are currently looking at ways to expand capacity to store more trucks and cars to prevent backups onto the highway system which is an obvious safety issue on both sides of the border. As many of the congested border crossings are located in urban areas, it would be necessary to relocate businesses and residences to allow for the border station expansion. A more streamlined border crossing may prevent the need for expanding some of these border crossings and associated impacts and use of resources.

7.3.2.3 Air Quality

Intelligent Transportation Systems can benefit the environment by providing automated systems to ensure vehicles take the most efficient route, which saves fuel and green house gas emissions. The fuel economy is improved, and other toxins are reduced, such as particulates, carbon monoxide, and hydrocarbons that affect human health, cause smog and damage the environment. ITS technologies may assist in regulating transport demands by encouraging an increase in the usage of public transport, higher vehicle occupancy, and appropriate parking pricing policies. Everyday congestion is reduced along with associated emissions through the smoothing of traffic flow due to the use of dynamic traffic control systems. Abnormal congestion and associated emissions are reduced due to the fast and accurate response to incidents and accidents. ITS applications to prevent delay at toll booths have reduced average CO emissions by 72%, hydrocarbons by 83%, and NO_x by 45% per mile of impacted operation. Driver behavior adjusted on a daily basis due to Smart Traveler Information reduced VOCs by 25%, NO_x by 1.5%, and CO by 33%.

7.3.3 Identify Likely Social Benefits

ITS applications typically reduce traffic congestion, improve transportation efficiency, provide economic savings, and improve overall quality of life for the motoring public. Likely social benefits from an ITS system that accomplishes these goals would include the following.

7.3.3.1 Economic Savings

In improving overall operations, ITS has demonstrated an ability to reduce travel times and accidents. With better fuel economy and less property damage, this results in a reduction in vehicle operating costs. The individual may not realize the real cost savings at the time. However, the reduction in fuel will have a direct impact on available funds for other consumables, and the reduction in accidents will be realized over the life of a vehicle. Considering the population in the urban areas, the total benefit to society is considerable.

7.3.3.2 Potential Economic Development Due to Increased Travel Efficiencies

With increased efficiency of the transportation network, most areas around the world see an increase in economic development. Most simply, this can be equated to a decision by individuals that rather than realize the benefits of a reduced travel time, they will instead use the savings to increase their travel. This may mean purchasing a home further removed from the center of a city, or traveling further to shop or vacation. In any case, the decision translates to new economic spending. Conversely, improvements in public passenger transport through tools such as bus rapid transit services, passenger information systems, improved transfer connections, etc, can result in retaining and improving the number of customers. This increases system efficiency. Further, large concentrations of public transport users living or working near a passenger station create economic opportunities for what is often called "transit-oriented development", where land use is specifically modified to support higher-density yet higher-quality housing, office and retail space in the vicinity of the passenger station.

7.3.3.3 Employment Opportunities Within ITS Industry

Almost by definition, ITS tries to gain efficiencies in the system through the use of technology. In general, ITS is not a labor intensive industry. However, it is a new industry to much of Mexico. Therefore, as ITS deployment increases, there will be a need for increased operators, technicians, installers, etc.

7.3.3.4 Increased Level of Safety for Motoring Public

Most of ITS projects are focused on more efficient transportation. The greatest inefficiencies are those related to non-recurring incidents which are most often vehicle accidents. Most ITS projects either directly or indirectly attempt to reduce the number and severity of incidents. This results in an increased level of safety for the public.

ITS can also be effective in eliminating hazards from unsafe commercial vehicles. This concern had been expressed at most of the regional meetings. Increased inspections, better training, increased ability to monitor commercial vehicles all aid in creating a safer driving environment for all. This also applies to passenger transit vehicles. The increased monitoring is typically balanced with increased efficiencies (giving the operator an incentive to participate), but a general increase in safety remains a primary transportation goal.

In recent years, there has been a greater correlation between incident management and accident reduction with personal security. ITS can often play a role through coordination with Police. The focus of ITS remains safety, as the focus of law enforcement often remains security. That is, it will not likely become a primary responsibility of ITS to provide personal security – however, the use of on-board cameras and silent alarm buttons, in conjunction with GPS-based location systems, can more quickly isolate a situation and result in a more immediate response.

7.3.3.5 Preservation of Historical Sites

There are also cultural aspects to improving the travel environment. One component that is important to Mexico is the preservation of historical sites, whether they are Aztec ruins or colonial Spanish architecture. ITS can be used to help restrict or limit vehicles from certain areas, through use of congestion pricing and electronic (non-stop tolling). The decrease in traffic and pollution allows all Mexicans to better enjoy their heritage and help improve their quality of life.

7.3.3.6 Increased Mobility and Access To Services

The potential for better access to services including jobs, shopping, health care, etc. is related to the potential for economic development. Again, with reductions in travel times and increases in efficiencies, people are more likely to travel further to these destinations.

7.3.3.7 Overall Health Benefits from Improved Air Quality

The potential health benefits of reducing air emissions are substantial. According to the OECD, Mexico City studies have shown a close correlation between urban air pollution and pulmonary diseases, aging processes in the lungs and respiratory infections. In large metropolitan areas a large percentage of the population is frequently exposed to PM_{10} concentrations exceeding current standards. This contributes to respiratory disease as well as increased mortality. Besides being ozone precursors, volatile organic compounds (VOCs) are directly toxic to humans.

7.4 Environmental Management Monitoring Program

Mexico has made significant progress in their air quality monitoring program and in implementing measures to reducing air quality emissions. According to the OECD Environmental Performance Reviews (2003), progress has been made regarding the development of a national air quality monitoring program. A National Information System on Air Quality (SINAICA) was established in the second half of the

1990s. Currently 23 cities have permanent monitoring systems, including major cities (Mexico City, Guadalajara, Monterrey, Toluca) and cities along the northern border (Ciudad Juarez, Tijuana, Mexicali). Air Quality improvement programs (PROAIRE) are in place in the seven largest. SINAICA was to be fully operational in 2004 and will provide the general public real time access to air quality information according to city, pollutant and concentration.

Mexico is committed to continued improvements in air quality across the country, as evident in their desire to implement ITS applications, and should continue to monitor air quality in large cities and along the border. Air management recommendations from OECD include the following:

- Further develop and implement traffic management in urban areas
- Better enforcement of vehicle inspections
- Give a higher priority to pollutants with significant impacts on human health
- Further develop the air management capacity of states and municipalities

The first two items relate directly to transportation. The second two relate at least indirectly to transportation. The first item has the potential to provide great improvements in air quality, but is not classified as part of an Environmental Management Monitoring Program, but rather would be better classified under general traffic management. It obviously deserves mention in the environmental potion and the two areas should cooperate with each other, but technically they remain separate programs. One area where Traffic Management could be helpful is in installing environmental monitoring equipment. The GERTRUDE system in Monterrey (see discussion in Chapter 5) has the capability to directly use environmental data to modify signal timing.

The second item can be included under an Environmental Management Monitoring Program. While ITS can be used to help identify at risk vehicles, the majority of this work is better related to the licensing responsibilities of SCT. Required inspections for older vehicles in all states and urban areas and real penalties for failing to meet standards is probably the single greatest potential for improving air quality.

The potential traffic and ITS applications for the third point depend on what pollutants are identified as having the more significant impact on human health. If they are pollutants from mobile sources such as vehicles, then ITS may be of assistance. If they are fixed sources from industrial areas, then ITS has less potential to help.

The last point again depends on what programs are being pursued by the states and municipalities. If they are more in line with testing and enforcement of older vehicles, then ITS has less of a role. If they relate to greater monitoring and possible real-time actions, then ITS can help. Additionally, Traffic Management Centers are ideal for monitoring the environmental equipment due to their typical staffing, dedicated communications infrastructure, and potential for managing traffic to help alleviate a situation.

CHAPTER EIGHT
Development of a National ITS Architecture – Systems Services and Capabilities

This chapter provides the details of how the Mexico ITS National Architecture was defined. A true Systems Engineering approach was used. This analysis used all aspects of the previous chapters in defining the needs and identifying the stakeholders. The end result is a national ITS Architecture for Mexico that is completely compatible with the U.S. Architecture, but unique to the needs of Mexico.

This begins with the basic descriptions of the fundamental services associated with the Mexico National ITS Architecture. The Mexico National ITS Architecture is service based as defined by recent work with ISO concerning international ITS architecture efforts. Much of the background can be found in ISO report 14813-1. The U.S. Architecture team is a participant in this effort. While many of the terms are different, the approach is the same.

8.1 OVERVIEW

The development of the ITS Architecture utilizes the overall vision, goals and objectives for Mexico ITS as described in the early chapters. An initial set of user services for ITS deployment are defined and will serve as the basic underpinnings of the Mexico National ITS Architecture.

The items used in creating this report are based on the previous insight that was provided in regional workshops, from steering committee meetings, and from independent discussions with various transportation stakeholders in Mexico. Specific work on ISO Technical Report 14813-1 (revised) was used as a basis along with specific definitions used in the U.S., Canadian, Japanese, and European ITS Architectures which offer consistency with the proposed services in Mexico. In this regard, we can assure that it is not necessary to "reinvent the wheel" when deploying ITS in Mexico. At the same time, the decision to not merely create an "extension" of the U.S. National ITS Architecture is based on the institutional and functional characteristics of Mexico's transportation system as well as the distinct nature of transportation needs within the country.

The services are related to physical entities and subsystems in the National Architecture framework and a series of service definitions, functional components, information flow descriptions and communications requirements are defined. Additionally, a "regional organizational architecture" for statewide and regional applications will map the defined ITS functions to specific agencies and identifies information flows between these agencies. The data flows between ITS components will be depicted in the logical architecture. Finally, mechanisms to carrying out ITS functions will be examined in the "physical architecture" framework for statewide and regional applications.

8.2 TASK METHODOLOGY

During the Systems Engineering approach, the architecture team examined the various existing ITS Architectures. The final choice was to use the terminology and framework from the more recent ISO efforts. The implication was to change the documentation from the beginning of the task.

The Mexico National ITS Architecture begins with the ISO services. As a service based architecture, the terminology is different from those developed on Market Packages. A traditional architecture would start with market packages and develop functional requirements. As a service based architecture, the approach is similar in concept, but different in terminology.

As part of the Systems Engineering approach, the first step is to identify the users and providers. Then, the service groups and Initial Services under each domain are more fully developed. Example

technologies are demonstrated for each service. The service groups are equivalent to market packages, while the services are equivalent to the functional requirements.

WSA used this information and identified those applications relevant to the ITS Vision developed in Chapter 3. The application areas include various areas of interest (national, regional, corridor-specific, rural, etc.) and are the basis for identifying ITS projects and a nation-wide ITS Architecture with regional components in Tasks 7 and 8.

The WSA Team identified candidate technologies required to carry out the services presented in this task. Technologies were identified in each area and considered the Mexico ITS Goals and Objectives and a variety of deployment issues such as highway/automobile relationships, GPS standards and limitations, traveler information communications systems, and inter-jurisdictional information integration, especially along the US-Mexico border.

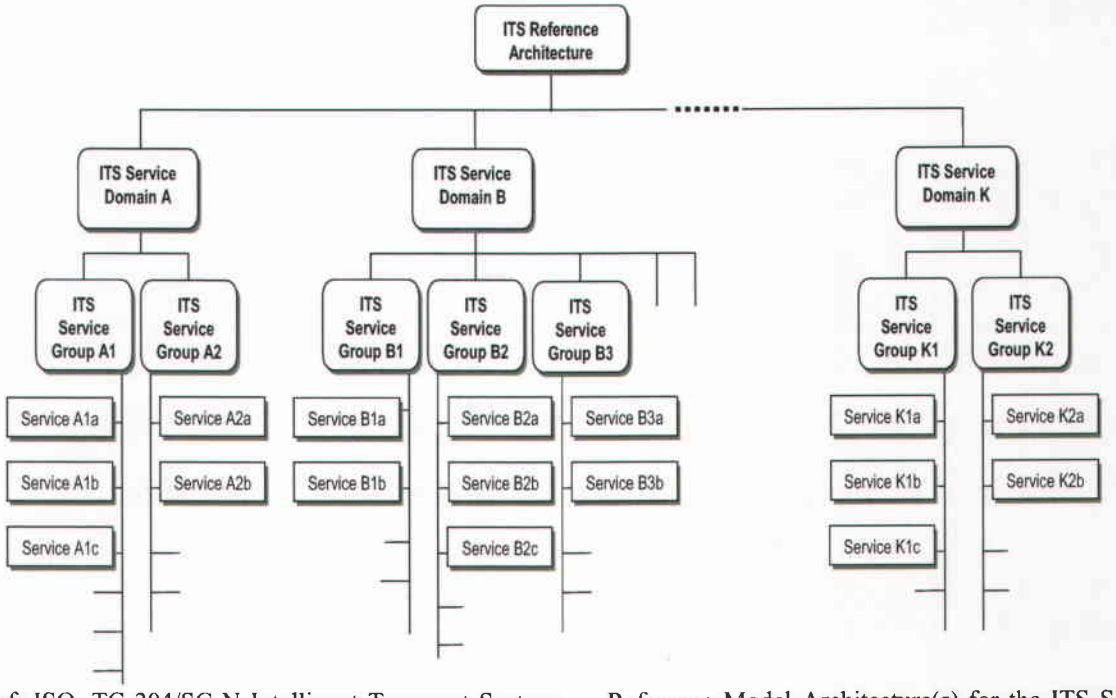
The candidate technologies were classified according to technological applicability and resulted in the selection of technical components applicable on a nationwide as well as for other areas of interest (national, regional, corridor-specific, rural, and/or functional). A two-step screening process was used to map technologies to base information and analyze for effectiveness.

8.3 Fundamental Services

This section provides the basic descriptions of the fundamental services associated with the Mexico National ITS Architecture. The Mexico National ITS Architecture is based upon definitions of services for users and for transportation providers. These services define how the Architecture will be structured. The services define the technologies that providers will make available and consumers will use. The services are built upon the needs identified in the earlier tasks.

The following diagram introduced in chapter 5 illustrates the hierarchy of service definitions. ITS Service Domains are at the highest level, with further breakdowns of ITS Service Groups and finally, ITS services.

Exhibit 8.1
Fundamental Services Framework



Ref: ISO TC 204/SC N Intelligent Transport Systems — Reference Model Architecture(s) for the ITS Sector — Part 1: ITS Fundamental Services

With a service based Architecture, everything begins with matching the 11 Service Domains back to the inventory, goals and objectives. This illustrates several issues. First, that the existing efforts are contained within a Service Domain. Second, that the Service Domains are adequate to address the anticipated future needs. Third, that the Service Domains address each of the goals and objectives identified in Chapter 3. This match was provided in Chapter 5.

An inventory of ITS systems was provided in Chapter 2. This inventory was collected through both research and meetings with the stakeholders at the regional workshops. Through these efforts, a number of existing ITS activities were identified within Mexico. These efforts were generally initiated as stand alone projects to meet a specific individual need. In Chapter 5, the existing activities were matched to the 11 service domains. The following table summarizes the ISO ITS Service Domains that were previously defined to many of the current ITS activities within Mexico.

Table 8.1
Support of ITS Service Domains by Current Operational Activities

ITS Service Domains	Nature of Support by Current Activities
(SN) National Security	• Joint border crossing efforts with the U.S. • Random cargo inspections • Protection at ports and points of entry
(SP) Road Transport Related Personal Safety	• Several cargo security initiatives
(SE) Emergency Services	• Green Angels program with all tollway concessions • Red Cross

ITS Service Domains	Nature of Support by Current Activities
(SV) Vehicle Services	• Some private personal security
(TC) Freight Transport	• Initiatives with the U.S. at the border for speeding processing • Container tracking and security • Several efforts at ports
(PE) Transport-related Electronic Payment	• IAVE • Other electronic toll collection • Some smart card electronic transit payment systems
(GOT) Traffic Management and Operations	• Arterial signal operations in numerous cities
(GI) Disaster Response Management and Coordination	• Green Angles • Red Cross
(MA) Weather and Environmental Conditions Monitoring	• Air quality monitoring in some cities • National weather service
(TP) Public Passenger Transportation	• Some electronic payment systems • Fixed rail management • Some bus fleet management
(IV) Traveler Information	• Sporadic use of VMS • Local public broadcasting of major incidents • Media coverage of major incidents and general congestion

While some of these existing services completely match the Service Domain in operation, most only partially support these services. There was some discussion in earlier chapters of the gap in services. The following table was built from the goals and objectives, as well as the existing inventory for Mexico. It lists some potential additional activities that can better provide for the goals identified. The intent is to illustrate a long term vision for Mexico as the ITS Architecture is being developed. This will help to create an ITS Architecture that meets all of the needs of Mexico.

Table 8.2
Needed Improvements to Support Recommended ITS Service Domains

ITS Service Domains	Additional Recommended Activities
(SN) National Security	• Increased integration with U.S. agencies to benefit both countries • Sharing of vehicle databases to allow both countries to track suspect vehicles • Additional tools for police agencies to protect critical infrastructure • Increased ability to monitor port operations for illegal activity • Increased ability to find hazardous and dangerous goods being transported through Mexico
(SP) Road Transport Related Personal Safety	• Mayday systems • Use of ITS to better manage traffic at high accident locations

ITS Service Domains	Additional Recommended Activities
	• Increased surveillance
(SE) Emergency Services	• Integration across agencies to allow for increased information sharing and coordination • Use of "Lojack" type vehicle recovery services • Fleet management of emergency responders to provide quicker and more efficient responses • Coordination and integration with traffic management operators for additional resources • Fleet tracking of hazardous materials and other high-value goods
(SV) Vehicle Services	• Mayday systems on vehicles to allow for faster notification and better location information in rural areas • Hidden location system for quick recovery of stolen vehicles • Enhanced vision systems for mountainous night driving • Driver aids in commercial vehicles such as alertness warning systems • Lane departure warning systems on vehicles
(TC) Freight Transport	• Use of technology at Intermodal yards for quicker processing of customs and management forms • Use of technology at border crossings for quicker processing of customs and management forms • Container tracking and warehousing systems • Integration with Customs databases • Remote vehicle monitoring for fleet management for carriers • Use of electronic forms for customs work and cargo tracking
(PE) Transport-related Electronic Payment	• Installation of one roadway toll technology across all of Mexico • Integration and cooperation allowing for one central toll payment system • Additional uses for road pricing (e.g., parking, etc.) • Increased use of transit payment systems to make transit more efficient
(GOT) Traffic Management and Operations	• The Green Angel program needs to be expanded into all urban areas • Signal systems need to be integrated with other operators to allow for better management of traffic • Active monitoring and management of all federal roads and other limited access facilities • High Occupancy Vehicle lanes and signal improvements • Use of ITS in and around work zones to promote

ITS Service Domains	Additional Recommended Activities
	safety • Create comprehensive agency-wide incident management programs
(GI) Disaster Response Management and Coordination	• Increased integration among response agencies • Increased real time information to aid in response • Increased monitoring ability • Increased ability to mobilize and transport needed equipment and personnel
(MA) Weather and Environmental Conditions Monitoring	• Additional environmental measuring systems • Use of environmental triggers to affect transportation management • Integration of weather information with traffic management efforts • Integration of national weather information into national traveler information
(TP) Public Passenger Transportation	• AVL for rural paratransit • Increased fleet management to increase safety • Connection protection between routes • Traveler information en route or at stops • Integration with electronic tolling
(IV) Traveler Information	• Create a national database for traveler information • integrated with federal and state police for real time incident information • Integrate with all transportation operators for incidents, maintenance, and construction • Web based for ease of sharing with the media, cable television, private information providers, and other operating agencies

It is anticipated that all *service domains* will be supported as a result of the Mexican National ITS Architecture deployment. Some *services* within those domains may not be included in the ITS Architecture. It is recognized that many of the services will remain either niche services or with limited deployment for many years to come. This is primarily due to their high cost and focused functions.

8.4 ITS Users and Providers

The International Standards Organization Technical Committee number 204 (ISO TC204) defines an ITS user as follows:

"One who interacts with ITS service providers in order to benefit from an ITS service"

In general one may say that the ITS user is a "partner", one who receives an ITS service through interaction with the ITS system by way of an ITS External Interface. These external interfaces (partners) and the external users define the boundary of the ITS sector. These users of ITS services may be human or systems. They have elsewhere been described as "Those who want the benefit of ITS systems, those who use ITS systems, those who manufacture or operate ITS systems, and those who regulate, control Transport using ITS systems". They may simultaneously use the services of non-ITS systems, and ITS systems may use non-ITS specific components (e.g. GPS or cellular telephones) as part of an ITS system. Many of the providers are actually users of ITS services also.

To better define the National Architecture, it is important to define the potential Users (referred to as external "Entities" in the US National Architecture) and "Providers" (referred to as internal "Actors" in the US National Architecture). The definition of Users and Providers will specifically address various portions of the transportation demographic in Mexico.

For Users, this specifically includes various types of private travelers (e.g., commuters, recreational travelers, professional drivers, freight carriers, commercial and retail entities who utilize specific transport services, e.g., delivery.

For Providers, this includes the public authorities and stakeholders involved in this Architecture effort, along with other public entities and authorities throughout the country, whether on the Federal level or at the State / Regional level. For State / Regional entities, the various authorities for transport and law enforcement operations may differ, so in those cases, a more generic definition of the Provider may be presented in keeping with the concept of a "Model" State/Regional deployment effort. In essence, this will require individual states and regions to be able to tailor their own architecture development efforts to meet their needs yet remain consistent with the National Architecture.

8.4.1 ITS Users

Based on review of transportation services and demographics throughout Mexico, "Users" were identified and can be summarized in the following classifications:

FREIGHT AND COMMERCE

- Truck drivers
- Airlines
- Fleet operators
- Carriers (truckers)
- Carriers (railroads)
- Carriers (Barge and ocean)
- Carriers (Ferry)
- Shippers

➢ **INDIVIDUAL**

- Business travelers
- Tourists
- Commuters
- Car drivers
- Bus drivers
- Taxi drivers
- Truck drivers
- Elderly drivers
- Motorcyclists
- Pedestrians
- Bicyclists
- Handicapped travelers

➢ **GOVERNMENT/TRANSPORT OPERATORS**

- Public officials (elected)
- Public officials (appointed)
- Unidad de Autopistas de Cuota – SCT (Tollroads)
- D.G. de Planeación y Centros – SCT (planning)
- Caminos y Puentes Federales (CAPUFE) and private concessions
- D.G. de Tarifas, Transporte Ferroviario y Multimodal – SCT
- Administración General de Aduanas (AGA)
- Dirección General de Autotransporte Federal – SCT
- Aeropuertos y Servicios Auxiliares (ASA)
- Administraciones Portuarias Integrales – SCT
- Highway Agencies (State)
- Toll Road Operators (state concessions)
- Traffic Operations Departments
- Secretaria de Turismo (SECTUR) – Angeles Verdes

➢ **LAW ENFORCEMENT / EMERGENCY SERVICES**

- Policia Federal Preventiva (PFP)
- State Police
- Other Law Enforcement
- Red Cross

8.4.2 ITS Providers

The following provides a list of specific national actors as well as more generic state / regional actors in which ITS activities will be accomplished and information utilized to support transportation activities. These generally include government agencies and authorities, private transportation providers, and other entities who generate and/or utilize specific data to be used for ITS.

8.4.2.1 National Providers

National Providers generally include those agencies that provide information for nationally-significant activities, including freight and intermodal activities, international border crossings and immigration, nationwide electronic tolling, national transportation policy and coordinated emergency management. They can either be solely public-sector or involved as national concessionaire or interested party with respect to transportation services.

Table 8.3 – National ITS Providers

➢ Agency Name	➢ Responsibility	➢ Scope
➢ Secretaria de Turismo (SECTUR) – Angeles Verdes	➢ Assist highway travelers providing minor mechanical services	➢ Main federal highways
➢ Policia Federal Preventiva (PFP)	➢ Law enforcement on federal transportation infrastructure (highway, seaports, airports)	➢ Federal transportation infrastructure

Agency Name	Responsibility	Scope
Instituto Nacional de Migración (INM)	Immigration law enforcement	Points of Entry (POEs)
Comisión Nacional del Agua (CNA)	Provides weather conditions	Federal
Administración General de Aduanas (AGA)	International trade enforcement	Federal transportation infrastructure - POEs
Caminos y Puentes Federales (CAPUFE) and private concessions	Toll highway and bridge operations	Federal highway system
Dirección General de Autotransporte Federal – SCT	Federal motor carrier (freight and passengers) regulations, registration and enforcement. Commercial driver licensing.	Federal highway system (inspection stations)
Cruz Roja	Provides first, rescue and ambulance services	National coverage
Secretaría de la Defensa Nacional (SEDENA)	National Army – Fire arms law enforcement. Check points scattered through out the country, on highways mainly.	National coverage
Procuraduría Federal de Protección del Ambiente (PROFEPA)	Environmental law enforcement, including vehicle emissions.	Federal
Secretarái del Medio Ambiente y Recursos Naturales	Environmental regulations	Federal
Administraciones Portuarias Integrales – SCT	Landlords at main seaports	Seaports

Agency Name	Responsibility	Scope
Aeropuertos y Servicios Auxiliares (ASA)	Used to manage airport facilities. Now, there are several concessions to operate groups of airports	Airports
D.G. de Tarifas, Transporte Ferroviario y Multimodal – SCT	Regulates railways and intermodal operations and oversees rail concessions (TFM, FERROMEX, ...)	Railways and intermodal facilities
Unidad de Autopistas de Cuota – SCT	Toll highway infrastructure planning and concessions	Main federal highway system
Dirección General de Protección y Medicina Preventiva en el Transporte – SCT	Medical checkups to commercial vehicle and other mode of transport operators and follow up	Federal
D.G. de Planeación y Centros – SCT	Transportation planning (all modes)	Federal
Dirección General de Conservación de Carreteras – SCT	Federal highway maintenance	
D.G. de Carreteras Federales - SCT	Construction of federal highways	Federal
Dirección General de Politicas de Telecomunicaciones - SCT	Promote efficient telecommunications developing polices to increase the supply network	Federal
Dirección General de Servicios Técnicos - SCT	Technical assistance for any transportation facility. Maintains AADT datasets for the federal highway system and some state highways	Federal

➢ Agency Name	➢ Responsibility	➢ Scope
➢ Secretaría de Agricultura, Ganadería, Desarrollo Rural y Alimentación. (SAGARPA)	➢ Food law enforcement at POEs	➢ Federal

8.4.2.2 State / Regional Providers

State providers generally are involved with specific state and regional transportation management activities, and are focused on localized and regionalized operational issues, taking into consideration national and international technology standards, as well as national transportation policies. As this tends to represent a cross-section of state and regional needs, a more "generic" description of state and regional providers is included below.

Table 8.4 – State/Regional ITS Providers

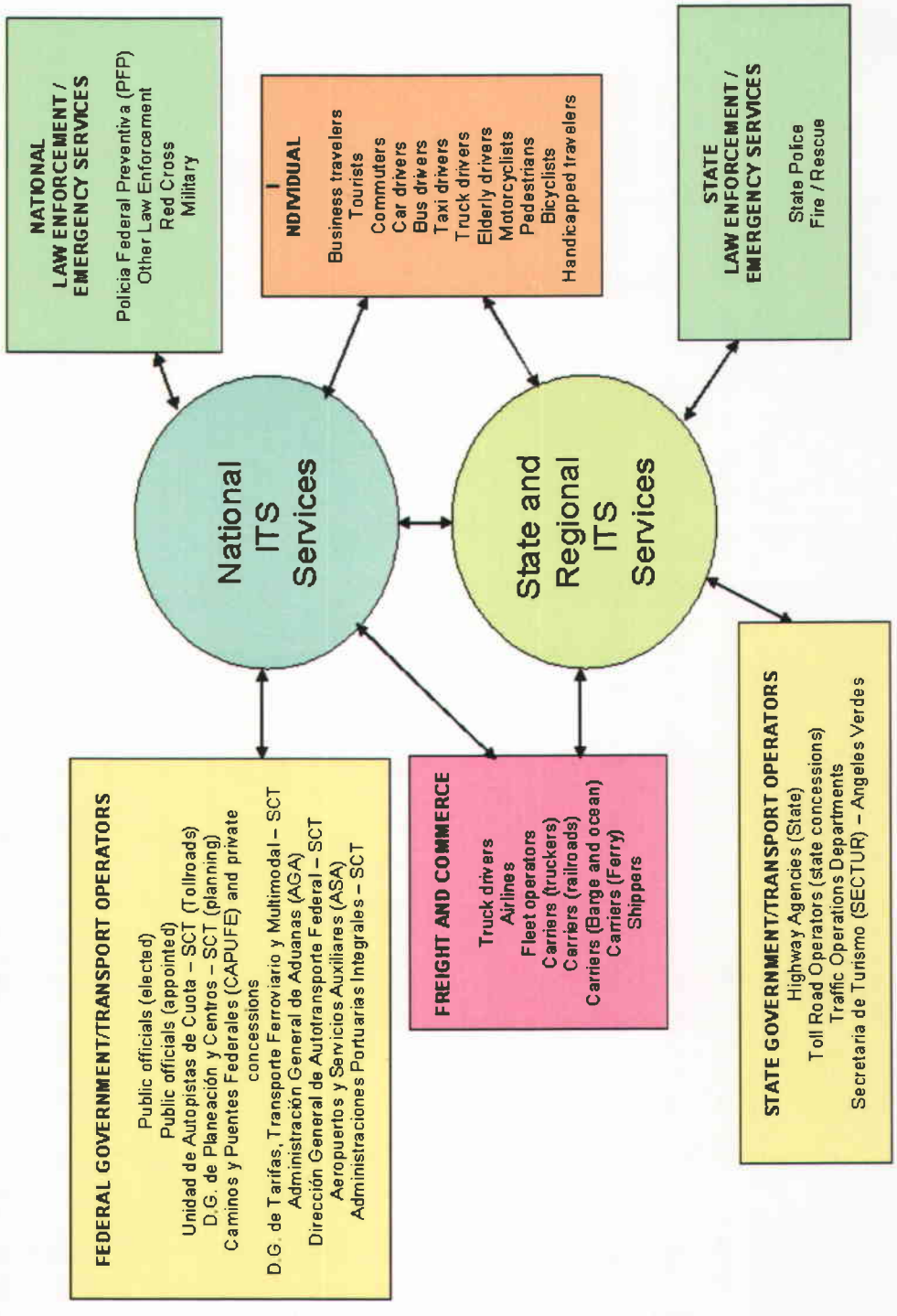
➢ Agency Name	➢ Responsibility	➢ Scope
➢ Centros SCT	➢ Undertakes all the SCT responsibilities in each state	➢ Federal presence in each state
➢ Toll highway state concessionaires	➢ Operate and maintain toll highways	➢ State
➢ Highway/transportation infrastructure departments	➢ Planning, design construction and maintenance of highway/transportation infrastructure facilities	➢ State
➢ Traffic operations departments	➢ Traffic operation law enforcement	➢ Municipal
➢ Public transportation departments	➢ State controls and grants authorization/concession to provide public transportation services in cities/regions within the state	➢ State

8.4.3 National Architecture Context Diagrams

Based on the Users defined above, a national "Context Diagram" is shown in Exhibit 8.2. This context diagram summarizes the potential interfaces to system users that could be attempted through the National Architecture, from the perspective of national services and state / regional services. One of the unique aspects of this context diagram is the definition of interfaces between Federal-level activities and State/Regional activities. It is noted that, if transportation activities were to be decentralized in the future (e.g., more transportation planning, policy and funding responsibilities occurred at the state and regional

level), it would be possible to develop a more "traditional" context diagram in which only one system ("ITS") were illustrated.

Exhibit 8.2
Mexico National ITS Context Diagram



8.5 ITS Services and Service Groups

ITS Service Groups represent the next delineation of the various sectors of ITS activity represented by the Domains. The delineation specifically addresses different types of activities carried out within the Domain. Below, they are defined by themselves, and then further defined by the services within that Service Group.

This section provides a listing of each of the ITS Services initially developed for the Mexico National ITS Architecture. The services are structured based on "Service Domains" (large-scale functional descriptions which correlate to overall transportation needs), "Service Groups" (which identify more specific functional strategies, and "ITS Services" (which specifically address the Service Group strategies in terms of targeted users and providers).

The hierarchy of all ITS Services considered for the Mexico National ITS Architecture, is summarized below in Exhibits 8.3a through 8.3k, reflecting each of the eleven ITS Service Domains. Because the Architecture is oriented toward present and future deployment, it was deemed important to accommodate, but not necessarily describe, all future uses of ITS in Mexico beyond what is known or expected.

Exhibit 8.3a
National Security

(SN) National Security	SN.1 Monitoring and control of suspicious vehicles	SN-101a Vehicle hazmat and explosives monitoring at the border
		SN-101b Vehicle hazmat and explosives monitoring mobile application
	SN.2 Utility or pipeline monitoring	SN-201 Pipeline and Utility Hazmat / explosives monitoring
		SN-202 Emergency Notification to Key Agencies
	SN.3 Coordination of National Assets	SN-301 National Data Collection and Sharing
		SN-302 National Multi-agency Cooperation

Exhibit 8.3b
Personal Safety

(SP) Road Transport Related Personal Safety	SP.1 Public travel security	SP-101 Silent Alarm
		SP-102 Mayday Alert for Public Transport
		SP-103 Intrusion Detection
		SP-104 Public Transport Surveillance
	SP.2 Safety enhancements for vulnerable road users	SP-201 Non-motorized vehicle and pedestrian monitoring systems

- SP.3 Safety enhancements for disabled road users
  - SP-202 Systems to Monitor Public Sector Fleet Vehicles
  - SP-301 Intersection monitoring of specialized conveyances (e.g. wheelchairs, carts)
  - SP-302 Driver warnings for specialized conveyances
- SP.4 Intelligent junctions and Links
  - SP-401 Intelligent Intersection
  - SP-402 Oncoming vehicle advance warning (for non-signalized junction)
  - SP-403 In-vehicle signage and warning systems

Exhibit 8.3c
Emergency Services

- (SE) Emergency Services
  - SE.1 Transport related emergency notification and personal security
    - SE-101 Automated Mayday Dispatch
    - SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring
  - SE.2 Emergency vehicle management
    - SE-201 Emergency Vehicle Fleet Tracking
    - SE-202 Emergency Vehicle - Traffic Management Coordination
  - SE.3 Hazardous materials & incident notification
    - SE-301 Hazmat Vehicle Tracking
    - SE-302 Automated Hazmat Mayday
    - SE-303 Hazmat Preclearance

Exhibit 8.3d
Vehicle Services

- (SV) Vehicle Services
  - SV.1 Transport-related vision enhancement
    - SV-101 In-vehicle Driver Vision Management
  - SV.2 Automated vehicle operation
    - SV-201 Automated Highway Operation
    - SV-202 Automated Low-Speed Maneuvering
    - SV-203 Precision Docking for Public Transport Vehicles
    - SV-204 Automated Cruise Control

SV.3 Collision avoidance	SV-301 Longitudinal Collision Avoidance
	SV-302 Lateral Collision Avoidance
	SV-303 Intersection Collision Avoidance
SV.4 Safety readiness	SV-401 Vehicle Internal Systems Monitoring
	SV-402 Vehicle External Conditions Monitoring
SV.5 Pre-crash restraint deployment	SV-501 Pre-crash Restraint Deployment

Exhibit 8.3e
Freight Transport

(TC) Freight Transport	TC.1 Commercial vehicle administrative processes	TC-101 Automated Credential Filing
		TC-102 Automated Commercial Vehicle Administration
		TC-103 Automated Border Crossing
	TC.2 Freight transport fleet management	TC-201 Commercial Vehicle Fleet Tracking
		TC-202 Commercial Vehicle Fleet Dispatching
		TC-203 Freight Container Tracking
	TC.3 Intermodal information management	TC-301 Vehicle and container arrival information exchange
		TC-302 Customer freight information access
	TC.4 Management and control of intermodal centers	TC-401 Intermodal Center Facility Management
		TC-402 Intermodal Vehicle and Container Control
	TC.5 Management of dangerous freight	TC-501 Dangerous Goods movement data sharing
		TC-502 Dangerous Goods movement data registry
		TC-503 Dangerous Goods movement fleet coordination

- TC-504 Dangerous Goods movement police / safety coordination

TC.6 Automated roadside safety inspection
- TC-601 Remote access to commercial vehicle safety data
- TC-602 Monitor Vehicle Loads

TC.7 Commercial vehicle on-board safety monitoring
- TC-701 Commercial Vehicle Internal Systems Monitoring
- TC-702 Commercial Vehicle Driver Alertness Monitoring

Exhibit 8.3f
Electronic Payment

(PE) Transport-related Electronic Payment

PE.1 Transport-related electronic financial transactions
- PE-101a Electronic Transit Fare Payment (Light Rail)
- PE-101b Electronic Transit Fare Payment (bus concessions)
- PE-102 Electronic Toll Collection
- PE-103 Electronic Parking Payment
- PE-104 Electronic services payment (e.g., traveler information, reservations)
- PE-105 Electronic distance-based road user fee payment services

PE.2 Integration of transport related electronic payment services
- PE-201 Integration of multi-jurisdictional electronic payment systems
- PE-202 Integration of Regional Multi-modal Payment Systems

Exhibit 8.3g
Traffic Management and Operations

(GOT) Traffic Management and Operations

GOT.1 Traffic control
- GOT-101 Traffic Monitoring
- GOT-102 Surface Street Control
- GOT-103 Freeway Control
- GOT-104 Preferential Treatment for Traffic Control
- GOT-105 Reversible Lane Management

	GOT-106 Traffic Information Dissemination
	GOT-107 Coordination of Surface Street and Freeway Control
	GOT-108 Intermodal Highway Junction Management
	GOT-109 Parking Management
	GOT-110 Work Zone Traffic Management
GOT.2 Demand management	GOT-201 Variable Road Pricing
	GOT-202 Access Management
	GOT-203 High-Occupancy lane management
	GOT-204 Air Quality Based Transport Management
GOT.3 Transport infrastructure maintenance management	GOT-301 Roadway Construction and Maintenance Management
	GOT-302 Weather related Maintenance
	GOT-303 Pavement Management
	GOT-304 Bridge Management
	GOT-305 Automated Road Management
	GOT-306 Work Zone Safety Management
	GOT-307 Utility and Infrastructure Management
GOT.4 Transport-related incident management	GOT-401 Incident On-Site Motorist Assist
	GOT-402 Incident On-Site Traffic Management
	GOT-403 Incident and Event Coordination
	GOT-404 Hazardous Materials Monitoring and Management
	GOT-405 Incident Monitoring and Confirmation
	GOT-406 Incident Response and Clearance

Exhibit 8.3h
Disaster Response Management and Coordination

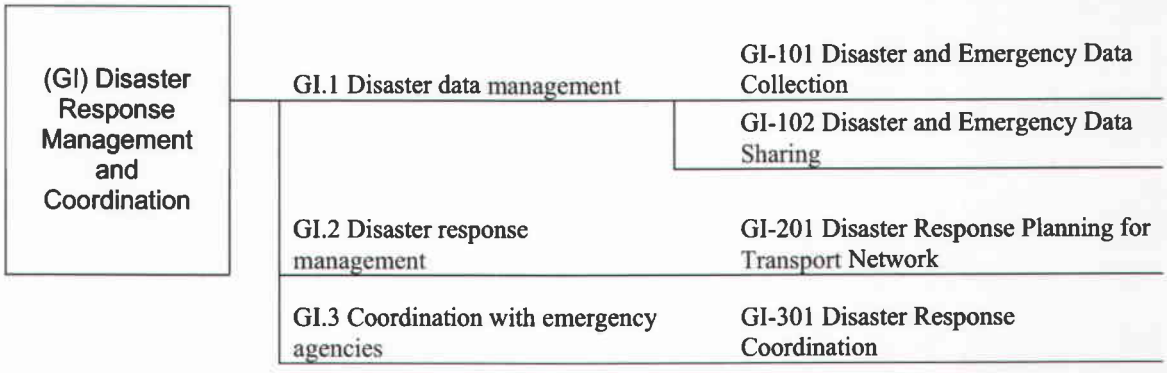


Exhibit 8.3i
Weather and Environmental Conditions Monitoring

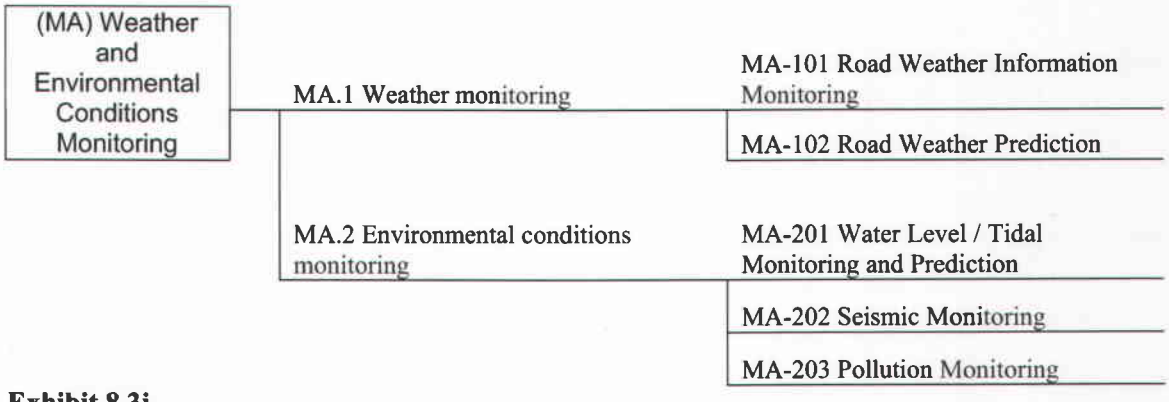


Exhibit 8.3j
Public Passenger Transportation

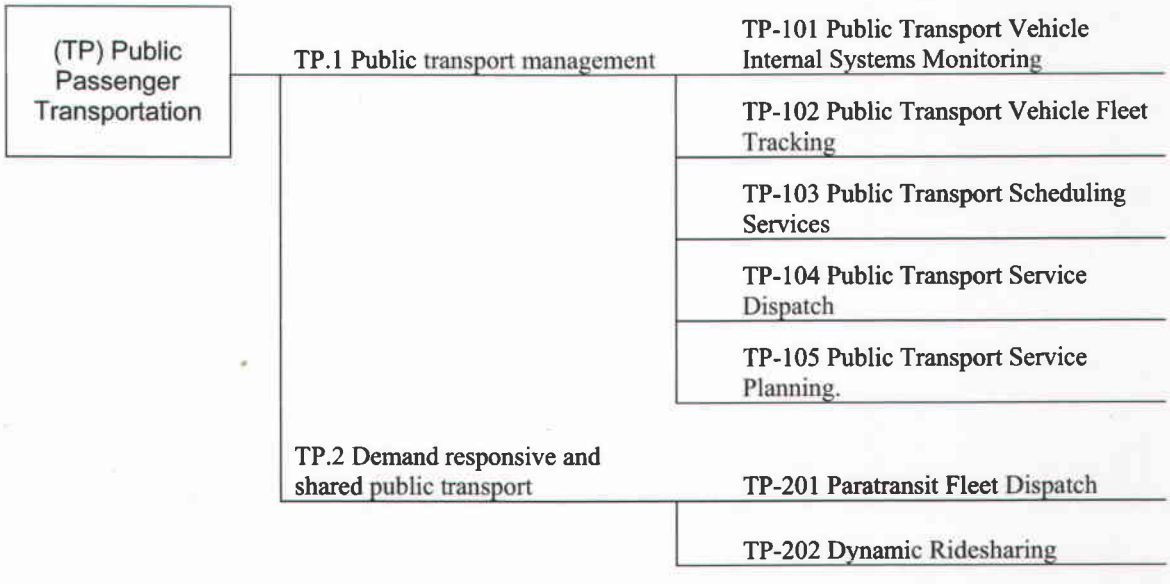


Exhibit 8.3k
Traveler Information

- (IV) Traveler Information
  - IV.1 Pre-trip Information
    - IV-101 Pre-Trip Information - Traffic and Roadway
    - IV-102 Pre-Trip Information - Public Transport
    - IV-103 Pre-Trip Information – Commercial Vehicle
    - IV-104 Pre-Trip Information – Personal Interactive
    - IV-105 Pre-Trip Information – Multimodal Routing Opportunities and Real Time Information
  - IV.2 On-trip Information
    - IV-201 On-Trip Information - Roadside
    - IV-202 On-Trip Information – In-vehicle signing
    - IV-203 On-Trip Information - Public Transport Vehicle
    - IV-204 On-trip Information – Parking information
    - IV-205 On-Trip Information through mobile devices
  - IV.3 Travel services information
    - IV-301 Travel Services Information - In-Vehicle
    - IV-302 Travel Services Information - Personal Interactive
    - IV-303 Travel Services Information - Dedicated Location
  - IV.4 Route Guidance & navigation-Pre trip
    - IV-401 Dynamic In-Vehicle Route Guidance and Navigation Programming/setup
    - IV-402 Integrated Multi-Modal Trip Guidance
    - IV-403 Pedestrian and Bicycle Route Guidance
  - IV.5 Route guidance & navigation-On trip
    - IV-501 Autonomous In-Vehicle Navigation
    - IV-502 Dynamic In-Vehicle Route Guidance and Navigation (based on real-time network information)
    - IV-503 Integrated Multi-Modal Trip Guidance

	IV-504 Pedestrian and Bicycle Route Guidance
IV.6 Trip planning support	IV-601 Current Traffic Flow Data from Traffic Control Systems
	IV-602 Current Utilization Levels from Public Transport Information Systems
	IV-603 origin and destination data from route guidance systems or vehicle probes
	IV-604 route choice data from route guidance systems or vehicle probes
	IV-605 travel demand data from pre-trip information systems

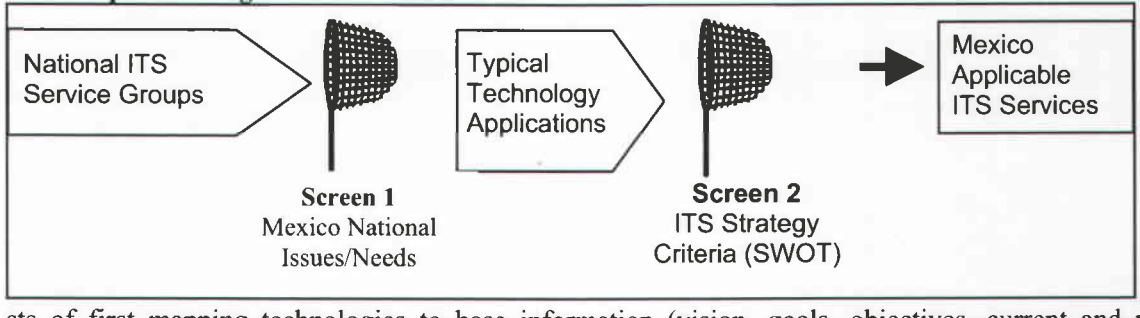
8.6 Screening ITS Technologies

The list of services created encompasses the complete list of potential services. Not all are necessarily appropriate for the Mexican ITS Architecture. To determine which services are applicable, a screening process was used. This process identified those services that are most relevant to Mexico, and was used as an input into the initial program.

8.6.1 The Screening Process

The screening process identifies and evaluates ITS Strategies in a two-step process as shown in Exhibit 8.4. Various criteria are used to evaluate the technologies discussed to date to determine if a particular service group can be deployed in Mexico. ITS Strategies that pass the screening process will support the themes and issues identified for Mexico to date.

Exhibit 8.4
Two-Step Screening Process



The two-step screening process consists of first mapping technologies to base information (vision, goals, objectives, current and planned conditions), and then applying a criteria screen of the technologies which will include regional and national capabilities to support ITS deployments and operations. The screening process provided rationale to evaluate, select and prioritize ITS Strategies for Mexico. The purpose of this process was to ensure that ITS Strategies selected for consideration are appropriate and applicable to the transportation issues identified in Chapter 3 and that they have the highest potential to be implemented.

The screening process began with the Mexico National ITS Service Groups. These service groups were matched to the specific needs of Mexico. Based on this input from the initial tasks, typical ITS technology applications for Mexico were first identified. The WSA Team then matched the candidate technologies to various ITS strategy criteria. The candidate technologies were classified according to technological

applicability and will result in the selection of technical components applicable on a nationwide as well as for other areas of interest (national, regional, corridor-specific, rural, and/or functional).

The second screening was based informally on a SWOT (Strength, Weakness, Opportunity, and Threat) analysis. The stakeholders created the criteria developed in the second screening. They also chose the relative weights for each criterion. This allows the second screening to take applicable technologies and services, and rank them according to the specific needs and interests of Mexico.

8.6.2 The Initial Screening

The first screen begins with the ITS needs identified in chapter 3. In this screening, the objectives are matched to Service Groups. The intent of this screening is to make sure that each identified ITS Service Group, and any additional technology or equipment groupings that are necessary to address all the transportation issues identified in Mexico, are matched to a need and objective.

There were 12 needs and 28 objectives identified in chapter 3. These were matched to the 129 initial services to determine which services were not matched. Those that did not match were dropped from further consideration.

8.6.3 The Second Screening

The second screen uses a weighted evaluation to determine the relative value of each of the remaining services. The stakeholders developed the criteria and their respective weights. Each service is then mapped to the criteria to determine how well they address each.

The following table matches the service that were identified against the six evaluation criteria. As an example, the values for the first row (SN-101a Vehicle hazmat and explosives monitoring at the border) represent how well this service addresses the needs of Mexico. As a purchased system, it is relatively "off the shelf" and therefore ranks well on the operational feasibility criteria. However, as it is specific to certain types of cargo, it ranks poorly against how it meets the needs of all of Mexico. As the ranking factors are applied to the weights, a total score is developed.

Exhibit 8.5
Weighted Evaluation Tool

Criteria:		Degree addresses issues (safety, security, cargo, time, cost)	Total Public Sector Costs (lower cost = higher rank)	Operational Feasibility (technically and institutionally)	Population/Sector Benefits (how many people directly and indirectly)	How quickly can it be deployed	Extent Service Enables Others	TOTAL
Weights (Total to 100):		16	21	20	17	19	7	100
ITS Service Groups	**Services**	1-5						
SN.1 Monitoring and control of suspicious vehicles	**SN-101a Vehicle hazmat and explosives monitoring at the border**	2	2	4	2	3	4	273
SN.1 Monitoring and control of suspicious vehicles	**SN-101B Vehicle hazmat and explosives monitoring mobile application**	3	2	4	3	3	4	306
SN.3 Coordination of National Assets	**SN-301 National Data Collection and Sharing**	3	2	2	4	2	5	271
SN.3 Coordination of National Assets	**SN-302 National Multi-agency Cooperation**	3	3	3	3	2	4	288
SP.1 Public travel security	**SP-101 Silent Alarm**	5	3	3	2	4	3	334
SP.1 Public travel security	**SP-102 Mayday Alert for Public Transport**	5	3	3	5	4	4	392
SP.1 Public travel security	**SP-104 Public Transport Surveillance**	5	3	2	5	4	3	365
SP.2 Safety enhancements for vulnerable road users	**SP-202 Systems to Monitor Public Sector Fleet Vehicles**	3	2	4	2	4	4	308
SP.4 Intelligent junctions and Links	**SP-401 Intelligent Intersection**	4	2	2	2	2	4	246
SE.1 Transport related emergency notification and personal security	**SE-101 Automated Mayday Dispatch**	5	3	3	3	4	4	358
SE.1 Transport related emergency notification and personal security	**SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring**	5	3	2	2	3	3	295
SE.2 Emergency vehicle management	**SE-201 Emergency Vehicle Fleet Tracking**	4	2	4	4	4	3	351

Criteria:		Degree addresses issues (safety, security, cargo, time, cost)	Total Public Sector Costs (lower cost = higher rank)	Operational Feasibility (technically and institutionally)	Population/Sector Benefits (how many people directly and indirectly)	How quickly can it be deployed	Extent Service Enables Others	TOTAL
Weights (Total to 100):		16	21	20	17	19	7	100
ITS Service Groups	**Services**	1-5						
SE.2 Emergency vehicle management	**SE-202 Emergency Vehicle - Traffic Management Coordination**	5	1	2	4	1	4	**256**
SE.3 Hazardous materials & incident notification	**SE-301 Hazmat Vehicle Tracking**	3	3	2	3	4	3	**299**
SE.3 Hazardous materials & incident notification	**SE-302 Automated Hazmat Mayday**	3	3	3	4	3	3	**317**
SE.3 Hazardous materials & incident notification	**SE-303 Hazmat Preclearance**	2	3	2	1	2	2	**204**
SV.2 Automated vehicle operation	**SV-204 Automated Cruise Control**	1	3	5	1	2	1	**241**
SV.3 Collision avoidance	**SV-301 Longitudinal Collision Avoidance**	3	3	2	1	2	1	**213**
SV.3 Collision avoidance	**SV-302 Lateral Collision Avoidance**	3	3	2	1	2	1	**213**
SV.4 Safety readiness	**SV-401 Vehicle Internal Systems Monitoring**	2	3	5	3	3	2	**317**
TC.1 Commercial vehicle administrative processes	**TC-101 Automated Credential Filing**	4	2	3	4	3	3	**312**
TC.1 Commercial vehicle administrative processes	**TC-102 Automated Commercial Vehicle Administration**	4	2	3	4	3	3	**312**
TC.1 Commercial vehicle administrative processes	**TC-103 Automated Border Crossing**	4	3	5	4	4	4	**399**
TC.2 Freight transport fleet management	**TC-201 Commercial Vehicle Fleet Tracking**	4	3	4	2	4	4	**345**
TC.2 Freight transport fleet management	**TC-202 Commercial Vehicle Fleet Dispatching**	5	3	4	3	3	4	**359**
TC.2 Freight transport fleet management	**TC-203 Freight Container Tracking**	4	3	4	3	4	4	**362**

Criteria:		Degree addresses issues (safety, security, cargo, time, cost)	Total Public Sector Costs (lower cost = higher rank)	Operational Feasibility (technically and institutionally)	Population/Sector Benefits (how many people directly and indirectly)	How quickly can it be deployed	Extent Service Enables Others	TOTAL
Weights (Total to 100):		16	21	20	17	19	7	100
ITS Service Groups	**Services**	1-5						
TC.3 Intermodal information management	**TC-301 Vehicle and Container Arrival Information Exchange**	4	4	4	3	4	4	**383**
TC.3 Intermodal information management	**TC-302 Customer Freight Information Access**	3	3	4	4	3	2	**330**
TC.4 Management and control of intermodal centers	**TC-401 Intermodal Center Facility Management**	4	3	5	4	4	3	**392**
TC.4 Management and control of intermodal centers	**TC-402 Intermodal Vehicle and Container Control**	4	3	3	4	2	4	**321**
TC.5 Management of special freight	**TC-501 Special Goods Movement Data Sharing**	3	3	3	2	3	4	**290**
TC.5 Management of special freight	**TC-502 Special Goods Movement Data Registry**	3	3	4	2	3	4	**310**
TC.5 Management of special freight	**TC-503 Special Goods Movement Fleet**	3	3	3	2	2	3	**264**
TC.5 Management of special freight	**TC-504 Special Goods Movement Police/Safety Coordination**	4	2	3	2	3	3	**278**
TC.6 Automated roadside safety inspection	**TC-601 Remote Access to Commercial Vehicle Safety Data**	5	3	2	4	3	4	**336**
TC.6 Automated roadside safety inspection	**TC-602 Monitoring Vehicle Loads**	4	4	4	4	5	4	**419**
TC.7 Commercial vehicle on-board safety monitoring	**TC-701 Commercial Vehicle Internal Systems Monitoring**	4	3	5	3	3	4	**363**
TC.7 Commercial vehicle on-board safety monitoring	**TC-702 Commercial Vehicle Driver Alertness Monitoring**	4	3	3	3	2	2	**290**
PE.1 Transport-related electronic financial transactions	**PE-101a Electronic Transit Fare Payment (Light Rail)**	3	3	4	3	4	4	**346**
PE.1 Transport-related electronic financial transactions	**PE-101b Electronic Transit Fare Payment (bus concessions)**	3	3	2	3	2	4	**268**

Criteria:		Degree addresses issues (safety, security, cargo, time, cost)	Total Public Sector Costs (lower cost = higher rank)	Operational Feasibility (technically and institutionally)	Population/Sector Benefits (how many people directly and indirectly)	How quickly can it be deployed	Extent Service Enables Others	TOTAL
Weights (Total to 100):		16	21	20	17	19	7	100
ITS Service Groups	**Services**	1-5						
PE.1 Transport-related electronic financial transactions	**PE-102 Electronic Toll Collection**	4	3	4	4	4	4	379
PE.1 Transport-related electronic financial transactions	**PE-103 Electronic Parking Payment**	2	3	2	2	1	3	209
PE.2 Integration of transport related electronic payment services	**PE-202 Integration of Regional Multi-modal Payment Systems**	1	2	2	3	1	3	189
GOT.1 Traffic control	**GOT-101 Traffic Monitoring**	4	2	4	4	3	5	346
GOT.1 Traffic control	**GOT-102 Surface Street Control**	4	3	4	5	4	4	396
GOT.1 Traffic control	**GOT-103 Freeway Control**	4	3	4	4	4	5	386
GOT.1 Traffic control	**GOT-104 Preferential Treatment for Traffic Control**	5	3	2	4	2	2	303
GOT.1 Traffic control	**GOT-105 Reversible Lane Management**	4	3	2	4	2	1	280
GOT.1 Traffic control	**GOT-106 Traffic Information Dissemination**	4	4	3	5	3	4	378
GOT.1 Traffic control	**GOT-107 Coordination of Surface Street and Freeway Control**	3	2	2	3	2	4	247
GOT.1 Traffic control	**GOT-108 Intermodal Highway Junction Management**	3	2	2	2	1	2	197
GOT.1 Traffic control	**GOT-109 Parking Management**	2	3	2	2	2	1	214
GOT.1 Traffic control	**GOT-110 Work Zone Traffic Management**	4	4	4	5	4	3	410
GOT.2 Demand management	**GOT-201 Variable Road Pricing**	3	3	3	4	4	4	343
GOT.2 Demand management	**GOT-202 Access Management**	4	2	2	4	1	2	247

Criteria:		Degree addresses issues (safety, security, cargo, time, cost)	Total Public Sector Costs (lower cost = higher rank)	Operational Feasibility (technically and institutionally)	Population/Sector Benefits (how many people directly and indirectly)	How quickly can it be deployed	Extent Service Enables Others	TOTAL
Weights (Total to 100):		16	21	20	17	19	7	100
ITS Service Groups	**Services**	1-5						
GOT.2 Demand management	**GOT-204 Air Quality Based Transport Management**	1	3	2	4	3	3	265
GOT.3 Transport infrastructure maintenance management	**GOT-301 Roadway Construction and Maintenance Management**	3	3	4	4	4	4	363
GOT.3 Transport infrastructure maintenance management	**GOT-303 Pavement Management**	4	4	5	4	4	1	399
GOT.3 Transport infrastructure maintenance management	**GOT-304 Bridge Management**	4	4	5	4	4	1	399
GOT.3 Transport infrastructure maintenance management	**GOT-305 Automated Road Management**	3	2	2	3	2	1	226
GOT.3 Transport infrastructure maintenance management	**GOT-306 Work Zone Safety Management**	4	4	4	5	4	3	410
GOT.3 Transport infrastructure maintenance management	**GOT-307 Utility and Infrastructure Management**	3	3	3	3	3	2	293
GOT.4 Transport-related incident management	**GOT-401 Incident On-Site Motorist Assist**	5	2	3	5	4	5	378
GOT.4 Transport-related incident management	**GOT-402 Incident On-Site Traffic Management**	4	4	4	5	5	4	436
GOT.4 Transport-related incident management	**GOT-403 Incident and Event Coordination**	5	4	4	5	4	5	440
GOT.4 Transport-related incident management	**GOT-404 Hazardous Materials Monitoring and Management**	3	2	2	4	3	3	276
GI.2 Disaster response management	**GI-201 Disaster Response Planning for Transport Network**	3	4	4	5	4	4	401
GI.3 Coordination with emergency agencies	**GI-301 Disaster Response Coordination**	3	2	2	5	2	5	288
MA.1 Weather monitoring	**MA-101 Road Weather Information Monitoring**	3	4	4	3	4	4	367

Criteria:		Degree addresses issues (safety, security, cargo, time, cost)	Total Public Sector Costs (lower cost = higher rank)	Operational Feasibility (technically and institutionally)	Population/Sector Benefits (how many people directly and indirectly)	How quickly can it be deployed	Extent Service Enables Others	TOTAL
Weights (Total to 100):		16	21	20	17	19	7	100
ITS Service Groups	**Services**	1-5						
MA.2 Environmental conditions monitoring	**MA-201 Water Level / Tidal Monitoring and Prediction**	3	3	3	4	3	3	**317**
MA.2 Environmental conditions monitoring	**MA-203 Pollution Monitoring**	2	3	4	4	3	2	**314**
TP.1 Public transport management	**TP-101 Public Transport Vehicle Internal Systems Monitoring**	3	2	3	3	3	5	**293**
TP.1 Public transport management	**TP-102 Public Transport Vehicle Fleet Tracking**	4	2	3	3	2	5	**290**
TP.2 Demand responsive and shared public transport	**TP-201 Paratransit Fleet Dispatch**	3	2	3	4	3	4	**303**
TP.2 Demand responsive and shared public transport	**TP-202 Dynamic Ridesharing**	4	4	3	4	3	4	**361**
IV.1 Pre-trip Information	**IV-101 Pre-Trip Information - Traffic and Roadway**	4	5	4	5	5	5	**464**
IV.1 Pre-trip Information	**IV-102 Pre-Trip Information - Public Transport**	4	3	3	5	4	5	**383**
IV.2 On-trip Information	**IV-201 On-Trip Information - Roadside**	4	3	4	4	4	4	**379**
IV.2 On-trip Information	**IV-203 On-Trip Information - Public Transport Vehicle**	3	3	4	4	4	4	**363**
IV.3 Travel services information	**IV-302 Travel Services Information - Personal Interactive**	3	3	2	2	2	4	**251**
IV.3 Travel services information	**IV-303 Travel Services Information - Dedicated Location**	3	4	3	4	3	4	**345**
IV.6 Trip planning support	**IV-602 Current Utilization Levels from Public Transport Information Systems**	3	3	3	4	3	4	**324**

8.6.4 Match to Current Practices and Gaps

In the initial screening, it was demonstrated that all goals and objectives are addressed with at least one Service Group. Earlier in this chapter, each Service Group was matched to both Users and Providers. Therefore, there are no gaps within the architecture itself. There are gaps in terms of differences between desired services and existing services.

8.7 Basic Architecture Framework

Considerable work has already been accomplished relative to ITS Architectures around the world. The stated intent of this project was that the WSA Team would take the best and most appropriate portions of each to create an ITS Architecture that was most appropriate for Mexico and applicable to the other ITS Architectures – especially the U.S. Architecture.

8.7.1 International Overview of ITS Architecture

The Service Domains identified earlier were based on the use of the ISO Transport Information and Control Systems (TICS) Reference Architecture (ISO Technical Report 14813), an effort begun in the late 1990's and most recently updated in 2004. The principal advantage of applying the ISO Reference Architecture is that it provides a broad view of "Fundamental Services" that can serve as the base for more detailed national and regional applications. To date, both the European ITS Framework Architecture and the Australian ITS Architecture have begun with the ISO reference.

However, the first national ITS architecture effort (which predated the ISO initiative) was in the United States. The US National ITS Architecture program began in 1993 and the first published version of the National Architecture was released in 1996. The functional requirements upon which the architecture is based are defined through "User Services", which later contributed to the development of ISO Fundamental Services. Japan, Taiwan, and Canada have used key elements of the US architecture in their development processes.

There are fundamental differences in the various approaches taken for the US, European and ISO architectures. The basic areas of comparison with regard to the Mexico National ITS Architecture are:

- Functional Description: Ability to support operational and system objectives
- Organizational Flexibility: Flexibility with respect to organizational framework
- Connectivity: Consists of two elements:
  - Ability to integrate legacy systems
  - Definition of standards and communications framework

The following is a brief comparison of the various ITS Architectures in use today around the world.

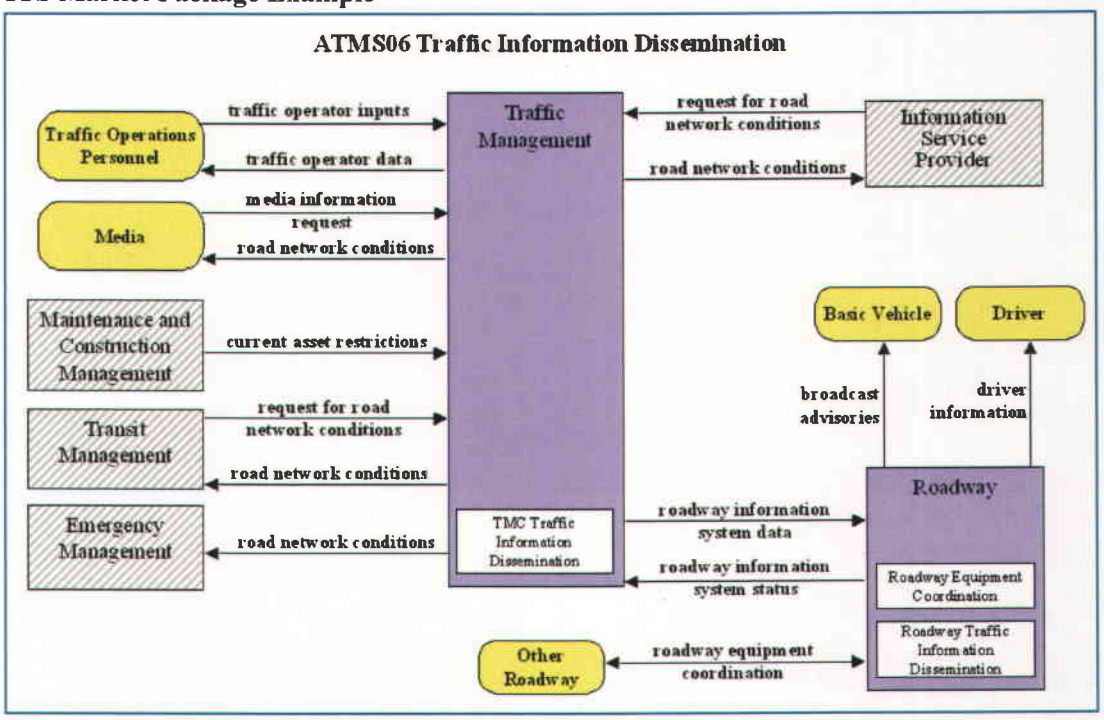
8.7.2 US National ITS Architecture

The US National ITS Architecture contains the following elements, which describe the user requirements and system functionality:

- *User Service Requirements:* Define the basic services and their user requirements as the basis for architecture development, which may be mapped to operational objectives.
- *Functional Definition:* Provides detailed definition of "processes" within the context of a "Logical Architecture" (i.e., focusing on functional rather than physical elements), along with data flows and data stores (e.g., database components) that link and support each process.
- *Physical Definition:* The physical architecture defines components that can be used or grouped together to form defined systems or identify potential products to be developed in support of ITS deployment in the U.S. Nineteen functional subsystems are defined, which are made up of "building blocks" known as equipment packages. Each equipment package supports groups of similar processes and data flows as discussed above. When combined into various functional

groupings, these equipment packages form "Market Packages", which provide a concise functional description of specific architecture activities, and are often used as a basis for regional ITS deployments in the U.S. Exhibit 3.1 provides an example Market Package diagram for Traffic Information Dissemination.

Exhibit 8.6
ITS Market Package Example

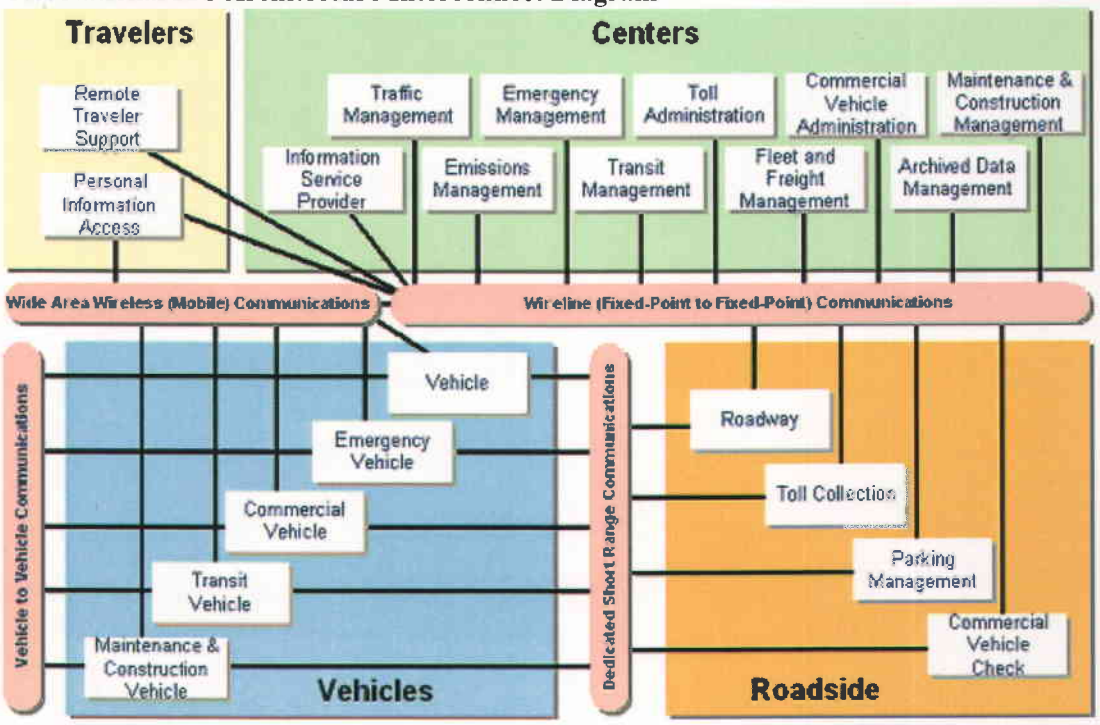


8.7.2.1 Organizational Flexibility

The US National ITS Architecture is based on a complex hierarchy of Federal, State, County and Local transportation organizations, involving operation of surface roads and/or public transport, as well as private sector or public sector information service providers. The links between these elements are clearly defined as the basis for the extensive amount of standards development activity that has occurred to date in the U.S. The overall framework for ITS components is defined in terms of the "Architecture Interconnect Diagram", also known as the "sausage diagram". This framework identifies all agency operational components into a class ("Centers"), connected to other classes of physical elements, including Roadway elements, Vehicle elements, and Traveler elements.

Exhibit 8.6 illustrates the interconnect diagram, which also includes key communications elements, categorized as wireline, wireless, dedicated short-range, wide-area, and vehicle-to-vehicle communications. The diagram generally oversimplifies the actual relationships between transportation authorities in the U.S. and links to specific roadway and vehicle components.

Exhibit 8.7
U.S. National ITS Architecture Interconnect Diagram



8.7.3 European ITS Framework Architecture

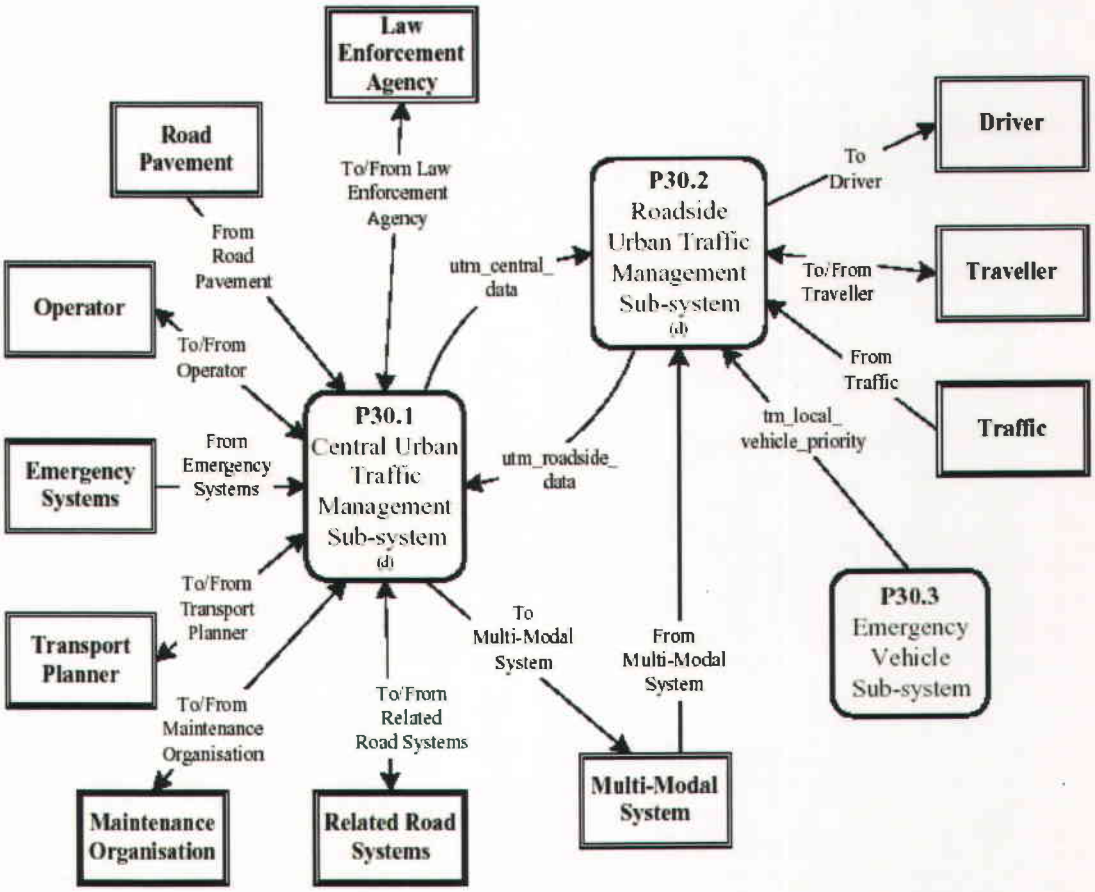
The European ITS Framework Architecture contains the following elements, which describe the user requirements and system functionality:

- *User Needs:* Define groups of high-level user requirements as the basis for architecture development, which may be mapped to operational objectives. Services are classified into "groups", and address transport management, administration and law enforcement activities, which is a broader scope than is covered under the US architecture.
- *Functional Definition:* The methodology used by the European architecture, as with the US architecture, is based on process control definitions. The "functional architecture" provides a technology-independent definition of functional and data relationships that support the above user needs. The functional definitions also include definitions of data flows connecting the various functions.
- *Physical Definition:* The physical definition of the European architecture is largely a procedural framework for developing physical architectures. The procedures are illustrated by numerous "example systems", resembling existing regional or pan-European applications, and illustrating the ability to distribute system functions and sub-functions in different manners, without defining specific functional modules such as in the US architecture.

8.7.3.1 Organizational Flexibility

The European ITS Framework Architecture does not prescribe centralized and roadside frameworks. However, the "example systems" provide definitions that clearly define central, roadside, in-vehicle and other classes of components. However, these definitions are vague and do not prescribe interfaces between systems or identify discrete standards for interfacing between systems or users.

Exhibit 8.8
"Example System" – Urban Traffic Management System (P30) from European ITS Framework Architecture



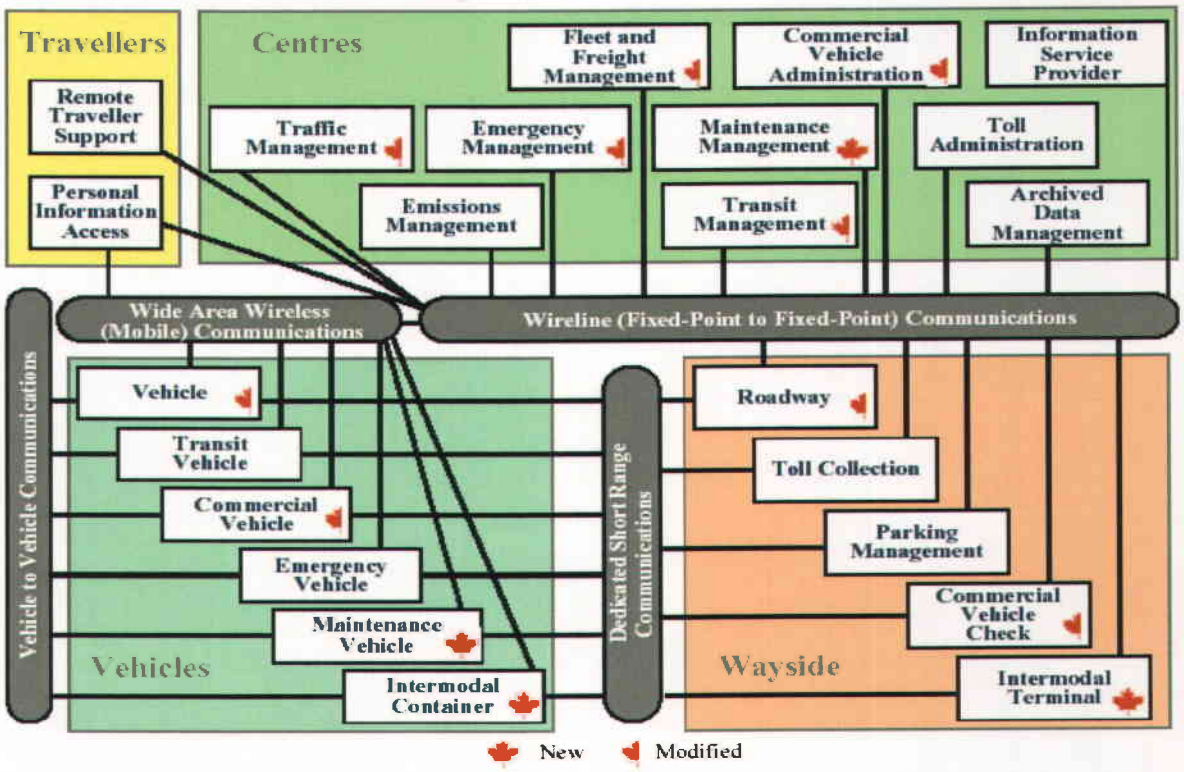
8.7.4 Canadian National ITS Architecture

The Canadian National ITS Architecture is substantially and philosophically similar to the U.S. National ITS Architecture. From the Canadian National ITS Architecture Executive Summary, the explanation is as follows:

"In general, the Canadian effort subsumes all of the U.S. National ITS Architecture work and extends and modifies it to provide new services and areas of coverage and to reflect differences between the nations and the existence of new and different stakeholders. Since there is much commonality between the technical definitions of the two Architectures, it is important to understand the explicit relationships.

The organization of the Canadian transportation agencies and their operations is similar to those in the U.S. , but there is additional emphasis on environmental, intermodal and law enforcement activities. This is reflected in Exhibit 8.4, the Canadian Architecture interconnect diagram, as "new" or "modified" subsystems relative to the U.S. Architecture.

Exhibit 8.9
Canadian Architecture Interconnect Diagram



Again, in terms of usefulness and appropriateness of the Canadian Architecture to Mexico, the same analysis provided for the U.S. National ITS Architecture applies.

8.7.5 ISO TICS Reference Architecture

The TICS Reference Architecture was developed as the basis for development of international standards for functional and data elements, rather than as an "international ITS architecture", though it contains some basic elements that provide an initial framework for a national architecture as well as a model for describing user-oriented functions. TICS differs from the US and European (as well as most other architecture initiatives) in its nature by relying on "use cases" which describe relationships between functions and users.

The 'ITS service domains and groups' serve as a framework for developing ITS-related concepts of operation, which in turn lead to the definition of the appropriate requirements and standards necessary to deploy specific ITS applications. As the definition of transportation activities that utilize ITS tools has broadened, the original 'fundamental services' developed by TC 204 have been revised and expanded into 'ITS service domains and groups'.

8.7.6 Comparison Between US / Canadian / European and TICS Architectures

The US and Canadian Architectures represent a North American framework that can serve as a base from which to develop the physical aspects of the Mexico National ITS Architecture, so as not to "reinvent the wheel". However, the functional definitions which underpin the physical framework need to take into consideration the broader needs of travel in Mexico. In addition, the responsibilities and organization of transportation providers in Mexico is fundamentally different than in the U.S. and Canada. In this regards, the ISO Fundamental Services serve as a useful base, given they reflect not just North American and European applications, but also some specialized services as developed in Asia (including Japan, Korea

and Taiwan in particular). This includes the needs of law enforcement, pedestrians, bicyclists and other users. It is noted that these services are in preliminary final form, and are not yet formally adopted, although they have been vetted extensively with the various international members of ISO.

8.7.7 Major Differences Between Mexico and Other North American ITS Architectures

Mexico has a rather unique institutional structure compared to the U.S. and Canada. This uniqueness is described as follows:

- Unlike the U.S. and Canada, the Mexican Federal government (through SCT) maintains a significant operational role in the national highway system.
- Much of the limited-access road network in Mexico (the equivalent of the U.S. Interstate Highway system) consists of toll facilities, most (but not all) of which are operated by a separate organization, CAPUFE, under direction of SCT.
- State transportation agencies and authorities in Mexico will maintain a network of state primary highways which feed from the Federal highways.
- Public transport is highly decentralized and, particularly for intercity bus operations, privatized but highly-regulated (more so than in the U.S.).
- There is much less standardization in terms of data exchange and coordination between Mexican States, including vehicle registration information, police information, and other activities.
- As with transportation, there is extensive segmentation of Police activities, with Federal and State Police maintain jurisdictions on corresponding road facilities and the State overseeing regional and local activities.

From a physical system and technical operations perspective, there are several additional differentiators between Mexico and the U.S. and Canada:

- Mexico overall has a less-developed roadway and rail infrastructure.
- In general, political control is more centralized but technology standardization and programming is less coordinated than US or Canada

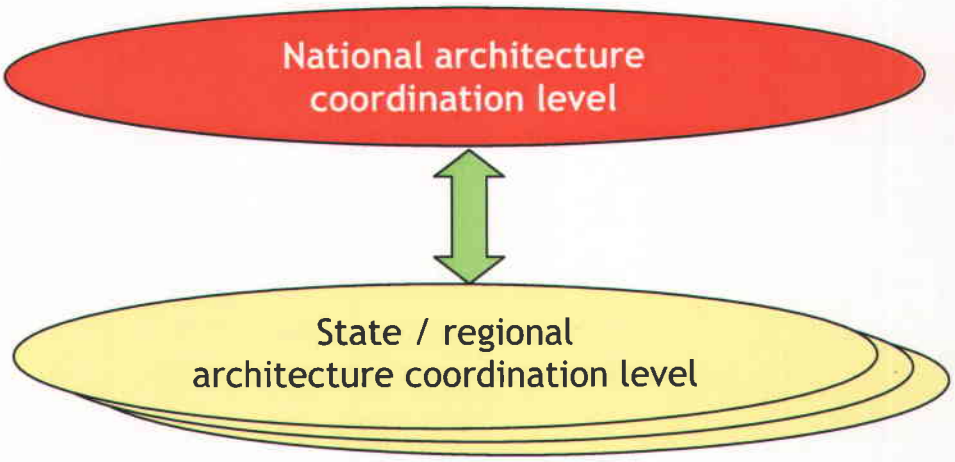
8.7.8 National Architecture Framework

In general, Mexico has a very centralized administration, but much of the deployment of technologies is accomplished at the local level. The strong role by the Federal government (SCT and Police) even within states and regions (due in particular to maintenance of Federal primary highways) is notable, along with the presence of CAPUFE for national toll road operations. Because of the strong national coordination, combined with some clear need for improved coordination between State agencies and between States and the Federal government, there appears to be a need for two types of central coordination for transportation operational activities.

In essence, what would be developed under the Mexico National ITS Architecture effort would be a framework for national connectivity (the ***National Coordination Level***) and a "Model Regional Architecture" (the ***State / Regional Coordination Level***).

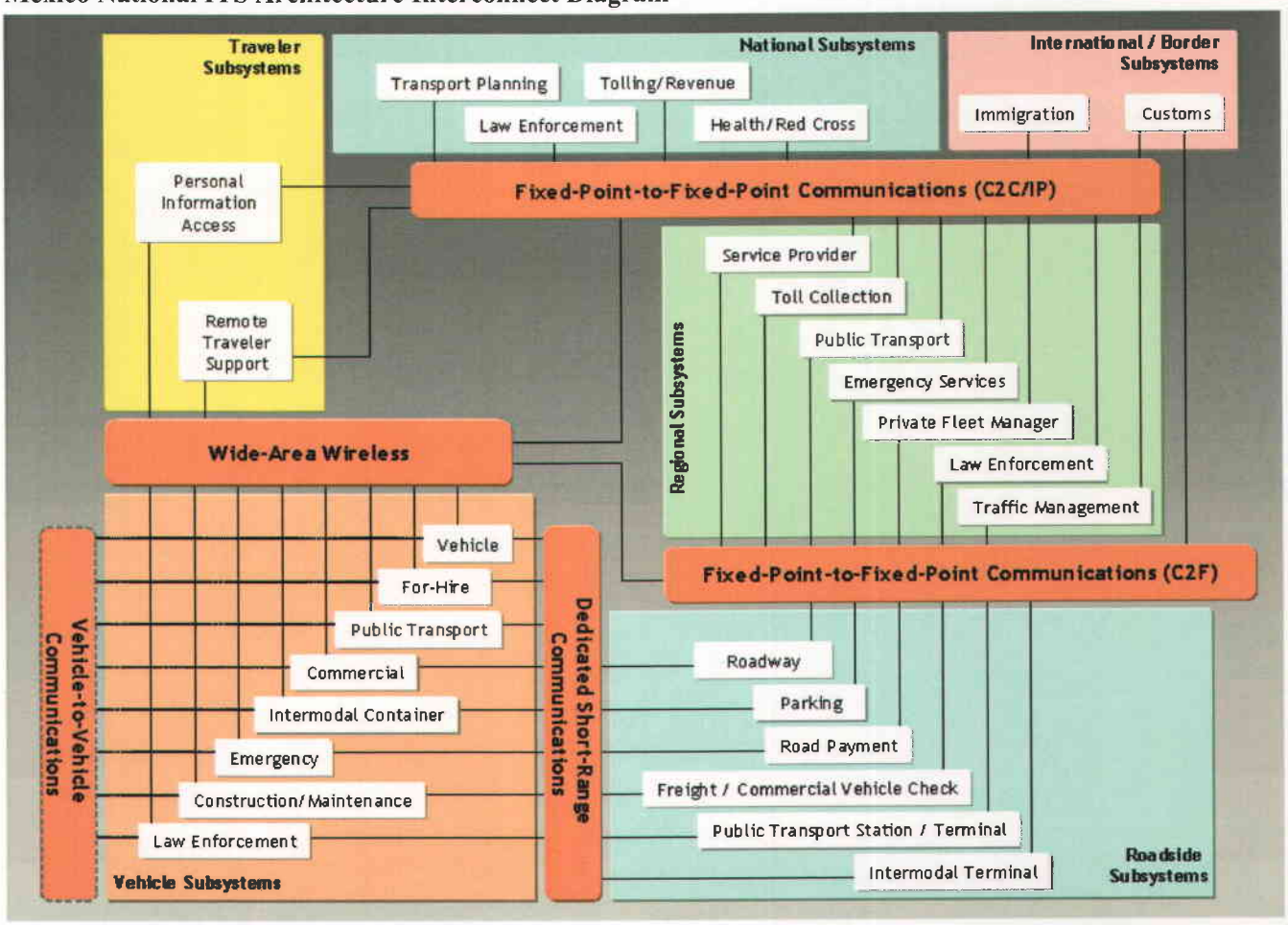
As shown in Exhibit 8.8, the National Coordination Level would be consistent throughout the country, while the State / Regional Coordination Level could be instantiated for every state and region in Mexico. The State / Regional coordination level would bear a close resemblance to the U.S. / Canada architecture framework. For each of the above, coordination with three basic classes of subsystem activities would be needed, including ***Field***, ***Vehicle***, and ***Personal*** classes of activity.

Exhibit 8.10
Interrelationship Between National and State/Regional Architecture Activities



With these fundamental differences noted, all of the efforts previous to this both within and external to this project, the following diagram illustrates the Mexico National ITS Architecture:

Exhibit 8.11
Mexico National ITS Architecture Interconnect Diagram



The Mexico National ITS Architecture differs from the equivalent U.S. and Canada diagrams basically in the specific activities that are defined within each class of subsystem. For example, "For-Hire" vehicles (e.g., taxis, jitneys, rural shared transportation services) are not explicitly shown in the U.S. or Canada architectures, but are relevant here due to the low level of private vehicle ownership in many areas of Mexico. Additionally, and more prominently, the Mexico architecture specific national-level subsystem classes at the top right of the diagram, including national sub-systems (e.g., transportation planning, law enforcement, emergency, national tolling systems) and international / border subsystems (e.g., customs and immigration information at ports of entry). These latter two subsystems would be consistent throughout the country, while individual regional / statewide architectures would be based on other aspects of the architecture interconnect framework presented here, notably the regional subsystems, roadside subsystems, and vehicle subsystems. Traveler subsystems would be expected to be consistent throughout the country (since they are based on commodity products such as computers and mobile phones), but the information and applications might be localized if appropriate.

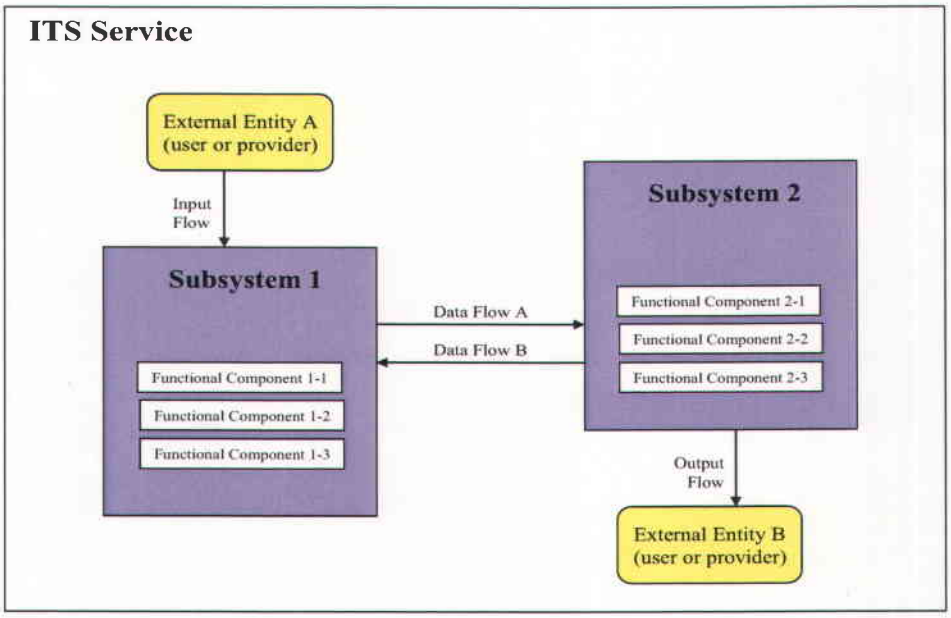
8.8 Detailed Architecture Definition

This section provides a more detailed overview of the Mexico National ITS Architecture Services and specific Functional Components required to support these Services. The Functional Components reside in the specific ITS subsystems that were defined in the previous Section.

8.8.1 Key Elements of the Architecture

The detailed architecture definition associated with the Mexico National ITS Architecture is a high-level definition, since the intent of any system architecture is to assure that the functionality is well-described, without having to limit the system to particular technologies. To this end, Exhibit 8.10 illustrates the relationships between the ITS Service, Subsystems, and Functional Components, such that a high-level "physical architecture" is defined.

Exhibit 8.12
Basis of Detailed Architecture Definition



ITS Service: Provides a functional description of an activity to be carried out by the ITS architecture involving specific actors (providers and users). It is physically described by (a) a definition of the subsystems which represent or are maintained by the various providers, (b) the functional components

needed to implement the service, (c) the data flows to be exchanged between different subsystems in carrying out the service, and (d) the external entities (which could be other subsystems not otherwise directly involved in the service, or either users or providers) which provide input needed to provide the service or receive specific information through the service.

Subsystem: Defined in Section 4 of this document, subsystems house a variety of common transportation activities or functional components, which are united by either their physical location or their provider (e.g., a highway agency, a public transport department, a private vehicle, a personal mobile phone). The subsystem may be defined as being National-level, State/Regional-level, Roadway, Vehicle, or Personal.

Functional Component: Breaks the subsystem into "deployment-sized pieces", which are used to support one or more ITS Services and communicate with other subsystems through generating all or part of the data flows which travel between the various subsystems.

Data Flow: Identifies the information that travels between subsystems in order to provide one or more ITS Services.

Input Flow: Identifies that information that is needed from another subsystem or external user or provider, in order to provide the needed ITS Service.

Output Flow: Identifies the information product (s) that are provided through the ITS Service to another subsystem or external user or provider.

8.8.2 Comparison with the U.S. and Canadian Architectures

The Mexico National ITS Architecture is specifically oriented toward providing a deployment-level tool that can be used in a straightforward fashion by Mexico's transportation stakeholders without more complexity than is absolutely necessary. At the same time, it is important to understand the analogy and the mapping of the various architecture definitions above to those in the U.S. and Canadian National ITS Architectures. Further, the work done under those architectures involving specific logical functions and data definitions is also relevant to the Mexico National ITS Architecture.

- **Mexican ITS Services vs. U.S. / Canada "Market Packages".** The U.S. / Canada Market Package concept was developed specifically to divide the architecture into "slices" which address particular ITS activities, related to one or more specific U.S. / Canada User Service requirements, which in turn serve as detailed functional descriptions of the U.S. / Canada User Services. As a result, the US. / Canada Market Packages are more detailed in nature than the User Service definitions. Similarly, the ITS service definitions in the Mexico National Architecture are also more specific than those provided through the U.S. / Canada User Service definitions. Thus, it was deemed appropriate to physically define the Mexico ITS Services in a similar fashion to the U.S. Market Packages, depending on the nature of the service. To permit the user to obtain additional background information on data or process specifications previously defined in the U.S. and Canada architectures, the ITS Services defined in this section contain specific "mappings" to U.S. or Canada Market Packages. At the same time, if the Mexico ITS Service has no equivalent U.S. or Canada Market Package, then the specific functional component definitions within the service will provide additional information which relates to the U.S. or Canadian ITS Architectures.

- **Mexican ITS Functional Components vs. U.S. / Canada "Equipment Packages".** Each of the Mexico ITS services are divided into Functional Components which are implemented within specific subsystems. The U.S. / Canada nomenclature for this is "Equipment Packages", which identify "deployment-sized pieces" in which subsystems can be broken down. However, the functional components may not necessarily be hardware, they could be software, or could be operational processes or policies, and thus may or may not be specifically defined as "equipment". Where possible, there is a one-to-one relationship between Mexican ITS Functional

Components and U.S. / Canada Equipment Packages; any Mexico ITS Functional Components which do not correspond to a U.S. / Canada Equipment Package are so identified.

- **Mexico ITS Data Flows, Input Flows and Output Flows vs. U.S. / Canada Architecture Flows.** In general, there are one-to-one relationships between similarly-named flows in the Mexico architecture and in the U.S. and Canada architectures except where specifically noted.

8.8.3 ITS Service Diagrams and Descriptions

Appendix A presents in full the ITS Service Diagrams which contain the Subsystems utilized, the Functional Components included with these Subsystems, the Data Flows, Input and Output Flows, and External Entities.

Appendix A also includes a Service Reference Table, in which the following information is presented:

- Service Name
  - Service Description
  - Relevant U.S. and Canadian ITS Market Packages or other references that were used in the development of the ITS Service Diagrams.
  - Functional Components included in the ITS Service

8.8.4 Subsystems and Functional Components Descriptions and Mapping to Services

Appendix B presents a description of ITS Subsystems and Functional Components in tabular form and the ITS Architecture subsystems in which they reside. The table includes the following information in hierarchical fashion:

- Architecture Level / Class (National, International/Border Crossing, State/Regional, Roadway, Vehicle, Personal)
  - Subsystem Name
    - Functional Component Name
      - Functional Component Description
      - Reference to U.S. and Canadian Equipment Packages or other references

CHAPTER NINE
Proposed Systems & Services

In Chapters 2, 3 and 4, specific transportation operational and institutional issues were identified, which in turn served as the basis for selection of ITS services and definition of a National Architecture as presented in subsequent chapters. The purpose of this Chapter is to identify a series of ITS programs and specific projects which would be used to deploy the National ITS Architecture for Mexico. The Chapter also outlines how SCT and other agencies in Mexico can initiate the ITS procurement process.

9.1 OVERVIEW

ITS Programs refer to overall activities intended to implement one or more ITS services throughout Mexico, while *ITS Projects* represent the specific activities needed to implement the ITS Programs.

Cost estimates are developed for Programs and Projects using selected ITS technologies typically used for such deployments (for example, traffic detectors, CCTV, automatic vehicle location systems, traffic management center software) as well as established cost information from similar applications elsewhere in the world. This cost information will be developed in this task and used as input to Chapter 10, which addresses an overall ITS Action Plan.

Programs and projects are then prioritized. This prioritization involves a combination of national needs (e.g., traveler information for all major roads), regional priorities (e.g., specific urban areas and towns), corridor-specific priorities (border crossing activities), or functional priorities (e.g., public transport, urban traffic, trucks, tourists, etc.). Specific "early winner" projects are identified based on an understanding of current activities as well as addressing which initial projects should be deployed which in turn can enable future ITS activities to occur.

9.2 POTENTIAL ITS PROGRAMS AND PROJECTS

The various meetings with Stakeholders and at the regions were very informative as to the needs and issues relative to Mexico. The review of projects in Chapter 5 also provides a view of what has been deployed to date in Mexico, in light of the various "service domains" which have been defined for ITS and have been further refined as ITS services in Chapter 8 of this report, serving as the basis for the National ITS Architecture.

While there may be a number of nationally-oriented ITS efforts (say, traveler information or freight-oriented activities), and other ITS programs may indeed be oriented at the national level, the individual projects will likely be deployed on a more localized basis. It is not the purpose of the National ITS Architecture to define local ITS projects or devices. However, through definition of overall programs and of specific "early start" activities, the groundwork for ITS deployment is laid and local deployment can be facilitated.

ITS projects may have a variety of characteristics. Some are upgrades to existing systems, some are deployments of new technologies, and others represent new application areas identified for Mexico. The programs developed in this report are meant to illustrate the types of projects that could be included. At least one project was identified for each of the services which passed the screening effort presented in Chapter 8.

Collectively, the programs and projects presented in this Chapter are intended to address each of the identified needs for Mexico presented earlier in this Report which can realistically be addressed using ITS. While the early winners and short term projects are expected to accurately represent the short term desires, the program as a whole will be refined with the stakeholders in the coming months and years.

9.2.1 Project Development

Programs are developed based on the proposed ITS Services passing the screening in Chapter 8. This screening takes into consideration goals, objectives, and needs which are addressed, as well as the ability to deploy such services based on the current state-of-the practice.

9.2.1.1 Program Definitions

Programs are considered to be a series of at least three projects which deploy one or more services, which include demonstration, first deployment, and full deployment efforts. The intent is for the program to cover a "life cycle" of ITS projects such that it can deploy a portion of the National ITS Architecture. It is noted that in some cases, the demonstration and first deployment are the same, particularly if the demonstration is highly successful and the system is deemed satisfactory to operate and maintain on a permanent basis. This is dependent on many factors that make each project unique.

Further, recurring maintenance, operations and maintenance activities are not considered to be separate projects or programs, but integrated within the deployment and operation of the physical systems. Maintenance (or lack thereof) may have a significant impact on overall program and project life cycles.

9.2.1.2 Cost Estimates

Cost estimates have been developed for each Program and Project. Estimates are developed within defined assumptions concerning the selected ITS technologies typically used for such deployments. For example, the number and type of traffic detectors, the number and type of CCTV, etc. that would be used in a typical application. Established cost information will be used from similar projects within Mexico if available, or from similar applications elsewhere in the world. Cost information will be compiled for design, deployment, operations and maintenance of all project, programs and systems identified.

Design costs include assumptions on the staff hours necessary to develop similar projects. This includes assumptions on hourly rates for specific classifications (e.g., software developer vs. CAD operator). Design hours are those specific to the ITS component. For example, if ramp meters are installed as part of a larger construction project, the design hours should include creation of all drawings specific to the detectors including additional pavement, but not work related to the creation of the ramp geometry in general.

Annual costs were broken into several categories – staffing, facilities/utilities, and other maintenance and operations (M&O). For the majority of the projects, it is assumed an existing agency (and its associated administrative and executive staff) will assume the responsibility of operating the new project. The staff identified are solely those necessary to provide the functions required for operating and maintaining the new system. The facilities and utilities category identifies new buildings (if necessary) and public utilities, including telecommunications costs. While it is too early in the project cycle to positively identify the means of communications with a high degree of certainty, assumptions are made and appropriate costs identified. Finally, other maintenance and operations costs include maintenance contracts with systems vendors. They also include life cycle costs for equipment, to ensure that the agency plans for improved equipment instead of allowing the equipment to become obsolete. All other miscellaneous expenses that can be readily identified with a project are also included here.

With Design and M&O costs identified, three distinct project phases were generally identified – demonstration, initial deployment, and full deployment. Demonstration projects are those that are focused on demonstrating the success of the technology or project concept, but do not generally tie an agency to a specific vendor or technology. Initial deployments are a longer term commitment where the end product of the project is expected to be a functional operating system. The initial deployment is assumed to include 2 years of operations funding as this is often the responsibility of the contractor until final system acceptance. There are many circumstances where the demonstration project and the initial deployment are the same project. Full deployment includes deployments of a system in all anticipated markets throughout

Mexico. Full deployment is rarely a reality within 20 years. While the United States made a financial commitment in TEA-21 to provide traffic management systems in the 75 largest cities, those deployments 8 years later are far from complete. Therefore, the full deployment cost is included only to demonstrate the high end of a project deployment, not a recommendation for full funding within the 20 year lifespan of the Mexico ITS Architecture.

9.2.2 Program and Project Definitions

For each of the ITS Services established in the last chapter, a Program definition is found below with component projects discussed within. Included in each project is a description of the project and how it could be phased (i.e., demonstration to full deployment). The costs provided are for demonstration and initial deployment only, and are in U.S. Dollars. All detailed cost information is provided in Appendix C.

Services are listed in the boxed headings (white on black), followed by definition of specific projects or programs of projects.

SN.1 Monitoring and Control of Suspicious Vehicles
SN-101a Vehicle hazmat and explosives monitoring (fixed location)

VACUS - Border

Non-intrusive vehicle inspection at a fixed location – This project involves the purchasing of a VACUS or similar system for use at border crossings or port of entry. The VACUS system provides non-intrusive inspection of commercial vehicles (something similar to an X-ray picture) to identify potential explosives, stolen vehicles, people, etc. It is similar to a large x-ray machine sized to inspect commercial vehicles. In a fixed location commercial vehicles are allowed to roll through the system at a low rate of speed. The system requires some additional footprint at the facility, power, monitoring station, etc.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$2,380.000
Initial Deployment	$2,380.000
Potential Procurement	Purchase from Vendor Separate System Integrator
Traffic Management	Possible lane control signs
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Remote Inspection Vehicle Registration
Safety and Security	VACUS

SN-101b Vehicle hazmat and explosives monitoring (mobile location)

VACUS - Mobile

Non-intrusive vehicle inspection in a mobile application – This project involves the purchasing of a VACUS or similar system that is vehicle mounted for portability. They system can be moved from one point to another and used at temporary inspections at any check point. The system provides non-intrusive inspection of commercial vehicles (something similar to an X-ray picture) to identify potential explosives, stolen vehicles, people, etc. In a mobile application, commercial vehicles must come to a stop while the system is moved around the vehicle. The system is self-contained.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$2,060.000
Initial Deployment	$10,300.000
Potential Procurement	Purchase from Vendor Separate System Integrator
Traffic Management	Possible lane control signs
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Remote Inspection Vehicle Registration
Safety and Security	VACUS

SN.3 Coordination of National Assets
SN-301 National data collection and sharing

National Vehicle Registration Database

Nationwide vehicle registration database – Critical to the implementation of many electronic systems is the creation and maintenance of associated databases. Quick and easy access to data is a basic building block of incident response, payment systems, security and inspection. However, creating it is time consuming and expensive. Even modifying databases for sharing of data fields can be expensive. Therefore, this project is a basic building block of many future projects. Initially, several state databases may be consolidated and maintained at the national level. As systems and needs expand, it is expected that additional similar projects will occur in the future.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$260.000
Initial Deployment	$2,674.000

Potential Procurement	System Designer/Manger Separate Developer/Integrator
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	Supports Open Road Tolling
Public Transport	
Commercial Vehicle Systems	Vehicle Registration
Safety and Security	Multi-agency data sharing

National Driver Registration Database

Nationwide driver registration database – Similar to the previous project, several state databases may be consolidated and maintained at the national level. As systems and needs expand, it is expected that additional similar projects will occur in the future.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$260.000
Initial Deployment	$2,674.000
Potential Procurement	System Designer/Manger Separate Developer/Integrator
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	Supports Open Road Tolling
Public Transport	
Commercial Vehicle Systems	Vehicle Registration
Safety and Security	Multi-agency data sharing

SN-302 National multi-agency cooperation

Secure Agency Communications

Secure and private data sharing network – As mentioned above, timely sharing of information between agencies is critical to the successful completion of many tasks. Users of these systems soon realize the benefits, but then understand the dependency on the communications network. Sharing of data is an end-to-end process and the communications link between agencies is the largest physical piece. This project would establish through leased lines or a private network the capability to share data between agencies.

This would likely start as a small scale demonstration in one city, but should eventually encompass nationwide communications between all transportation related agencies.

Development Complexity	High
Integration Complexity	High
Demonstration	$325.000
Initial Deployment	$3,090.000
Potential Procurement	System Designer/Manger Separate Developer/Integrator
Traffic Management	Future System Integration Means
Traveler Information & Communication	Data Sharing Between Agencies
Traffic Detection and Monitoring	
Fares and Toll Systems	Supports financial transactions
Public Transport	
Commercial Vehicle Systems	Vehicle Registration Sharing
Safety and Security	Multi-agency data sharing

SP.1 Public Travel Security
SP-101 Silent Alarm

Public Transit Silent Alarm

Driver initiated silent alarm on public passenger transit vehicles – As public sector projects, the direct responsibility of passengers is only an issue on public passenger transit vehicles. In private cars and commercial vehicles, the public sector will respond to alarms, but it is the responsibility of the owners and private contractors to purchase/design/install the necessary systems. This project would start as a demonstration project in one city and be expanded to other locations as feasible.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$126.000
Initial Deployment	$3,106.000
Potential Procurement	System Designer/Integrator Separate System Vendor
Traffic Management	Data for incident detection Data for incident response
Traveler Information & Communication	
Traffic Detection and Monitoring	

Fares and Toll Systems	
Public Transport	Electronic system for vehicle Robust mobile communications
Commercial Vehicle Systems	
Safety and Security	Coordination with Police

SP-102 9-1-1/Mayday alert for public transport

Public Transit Mayday

Automated Mayday on airbag deployment for public passenger transit vehicles – This project is similar to the above project, only the alarm is automated rather than driver initiated, and it is intended less for security and more for safety. This project would start as a demonstration project in one city and be expanded to other locations as feasible.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$126.000
Initial Deployment	$3,106.000
Potential Procurement	System Designer/Integrator Separate System Vendor
Traffic Management	Data for incident detection Data for incident response
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	Safety and Security Vehicle monitoring system Robust mobile communications
Commercial Vehicle Systems	
Safety and Security	Coordination with police

SP-104 Public transport surveillance

Public Transit Surveillance

Video security on public transport vehicles – This project involves the non-real time use of video in taxis and busses to deter crime. The system would record the passengers and driver on a hidden storage device for downloading at the end of a shift. This would allow law enforcement to have a view of any crimes and provide them with pictures of the offenders. This project would start as a demonstration project in one city and be expanded to other locations as feasible.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$90,600

Initial Deployment	$3,334.000
Potential Procurement	System Designer/Integrator Separate System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Cameras and Video recording System

SP.2 Safety Enhancements for Vulnerable Road Users
SP-202 Systems to monitor specialized vehicles

Public Fleet Mayday

Mayday systems to monitor public maintenance vehicles – The technology is the same regardless of the vehicle, so this initial project can be deployed on many additional vehicles in the future. The system would be relatively off the shelf and would provide emergency notification of vehicle problems. This could be police or fire. This could be Green Angels or maintenance vehicles. The system would send a message as soon as it detects a problem such as airbag deployment or rollover. A single demonstration is recommended first.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$90.600
Initial Deployment	$270.000
Potential Procurement	System Designer/Integrator Separate System Vendor
Traffic Management	Data for incident detection Data for incident response
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	Vehicle electronic monitoring system Robust mobile communications
Commercial Vehicle Systems	
Safety and Security	Coordination with Police

Public Fleet Lane Departure Warning System

Lane change warning system for public maintenance vehicles – This project is to provide driver protection from run off the road accidents. There are currently off the shelf systems for this application that the private sector can purchase for their vehicles. This project is best implemented on vehicles that spend a considerable amount of time driving straight, such as the Green Angels or intercity maintenance crews. The initial demonstration would be on a few vehicles and then expanded as desired and necessary.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$8.000
Initial Deployment	$200.000
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer product now available

Public Fleet Equipment Management

Speed monitoring and limiting systems for public maintenance vehicles – This project is to provide driver protection from excessive speed. There are currently off the shelf systems that the private sector can purchase for their vehicles and many intercity busses use similar systems. This project is best implemented on vehicles that spend a considerable amount of time in mountainous areas. The initial demonstration would be on a few vehicles and then expanded as desired and necessary.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$8.000
Initial Deployment	$200.000
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	

Public Transport	
Commercial Vehicle Systems	Consumer product now available Wireless mobile communications
Safety and Security	

SP.4 Intelligent Junctions and Links
SP-401 Signal display advance warning

Intelligent Intersection

Dynamic signing approaching complex intersections – Use of an "intelligent intersection" is highly dependent on the traffic and geometrics of a particular intersection. When complex intersections with high levels of traffic are identified, a separate study should be executed to examine how ITS could help and then design an appropriate solution. This application is highly dependent on the exact characteristics of the intersection under review, so the initial implementation is in effect the demonstration.

Development Complexity	High
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$320.000
Potential Procurement	System Designer/Integrator Separate System Vendor(s)
Traffic Management	Advanced signal systems Lane control signs
Traveler Information & Communication	Dynamic Message Signs Highway Advisory Radio
Traffic Detection and Monitoring	Roadway Sensors
Fares and Toll Systems	
Public Transport	Bus priority operations
Commercial Vehicle Systems	
Safety and Security	

SE.1 Transport Related Emergency Notification and Personal Security
SE-101 Automated 9-1-1 and Mayday Dispatch

Automated Personal Mayday

Automated Mayday call – Other than the application in public sector vehicles, this is considered a fee based service for the private sector using current off the shelf systems. No costs are identified with this service.

Development Complexity	Low
Integration Complexity	Low
Potential Procurement	System Vendor
Demonstration	$0

Initial Deployment	$0
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer product now available

Manual Personal Mayday

User initiated Mayday call – Other than the application in public sector vehicles, this is considered a fee based service for the private sector using current off the shelf systems. No costs are identified with this service.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer product now available

SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring

Personal Vehicle Recovery Systems

Stolen vehicle recovery system – This is considered a fee based service for the private sector using current off the shelf systems. No costs are identified with this service.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0

Initial Deployment	$0
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer product now avaialable

SE.2 Emergency Vehicle Management
SE-201 Emergency vehicle fleet tracking

AVL for Police/Fire

Automated Vehicle Location for emergency vehicles – In responding to incidents and emergencies, it is critical that the management know where their assets are located so they may better manage them. This project would entail the installation of off the shelf equipment for vehicle location on emergency vehicles. The initial demonstration would be on a few vehicles and then expanded as desired and necessary.

Development Complexity	Low
Integration Complexity	Low
Potential Procurement	System Vendor
Demonstration	$281.000
Initial Deployment	$1.654.000
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer product now available

SE-202 Emergency vehicle – traffic management coordination

Traveler Information for Police/Fire

Real time traffic information in emergency vehicles – In responding to incidents and emergencies, it is critical that the emergency responders know the best route to get to the incident. This project would entail the installation of off the shelf equipment but would be tied to available real time information from

another system. The initial demonstration would be on a few vehicles and then expanded as desired and necessary.

Development Complexity	High
Integration Complexity	High
Demonstration	$272.000
Initial Deployment	$272.000
Potential Procurement	System Designer/Integrator System vendor
Traffic Management	Traffic management center
Traveler Information & Communication	
Traffic Detection and Monitoring	Traffic detectors
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer based AVL system

SE.3 Hazardous Materials & Incident Notification
SE-301 Hazmat vehicle tracking

AVL for Hazmat - System

Real time monitoring of Hazmat vehicles – Use of a generally off-the-shelf system to track commercial vehicles that are transporting hazardous materials. The initial demonstration would be a first phase of a project involving a few vehicles, but the first project is expected to be a nationwide deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$2.560.000
Potential Procurement	System Vendor System designer/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available

Safety and Security	Multi-agency database

SE-302 Automated Hazmat 9-1-1 / Mayday Notification

Automated Hazmat Mayday

Automated Mayday call for hazmat vehicles – Similar to earlier projects, this is considered a fee based service for the private sector using current off the shelf systems. The automated call could occur either with air bad deployment, or upon rollover. While the subject matter may be of interest to the national agencies, the cost to install the system should be borne by those that seek licensing to carry hazardous loads. No costs are identified with this service.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor System designer/integrator
Traffic Management	Private sector management center
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available
Safety and Security	Multi-agency database

Manual Hazmat Mayday

User initiated hazmat mayday call – As explained previously, this is considered a fee based service for the private sector using current off the shelf systems. No costs are identified with this service.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor System designer/integrator
Traffic Management	Private sector management system
Traveler Information & Communication	
Traffic Detection and Monitoring	

Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available
Safety and Security	Multi-agency database

SE-303 Hazmat Preclearance Services

Hazmat Preclearance

Preclearance for Hazmat vehicles at border crossings – This project would be associated with existing projects at the border crossings, including FAST, SENTRI, and CSI. The project would involve identifying areas of action to allow hazmat preclearance as part of these programs or as a separate program if necessary. As it is intended to be part of an existing project, no costs were identified.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System designer/integrator System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	DSRC System for communications
Public Transport	
Commercial Vehicle Systems	Consumer AVL product now available
Safety and Security	Multi-agency database Coordination

SV.2 Automated Vehicle Operation
SV-204 Automated Cruise Control

Intelligent Cruise Control

This is considered a consumer product as it is already available on some commercial cars and trucks. No costs are identified and no public agency project created.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor

Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer product now available

SV.3 Collision Avoidance
SV-301 Longitudinal Collision Avoidance
SV-302 Lateral Collision Avoidance

Intelligent Cruise Control 2
Lane Departure Warning System

Both of these are considered consumer products as they are already available on some commercial cars and trucks. No costs are identified and no public agency projects created.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Consumer product now available

SV.4 Safety Readiness
SV-401 Vehicle Internal Systems Monitoring

Personal Vehicle Management

This is considered a consumer product as it is already available on some commercial cars and trucks. No costs are identified and no public agency project created.

Development Complexity	Low

Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available
Safety and Security	

TC.1 Commercial Vehicle Administrative Processes
TC-101 Automated Credential Filing

Automated Vehicle Credentials

Commercial vehicle automated credential filing – This project must build from the other projects establishing nationwide vehicle and driver databases. The project would involve creating a database and a secure user friendly way to enter information in order to secure all credentials required for use of a commercial vehicle. A demonstration project would test the process in one state, with the initial deployment expanding the use to other states.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$296.000
Initial Deployment	$920.000
Potential Procurement	System designer/integrator System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	DSRC
Public Transport	
Commercial Vehicle Systems	Consumer AVL system now available
Safety and Security	Multi-agency database

TC-102 Automated Commercial Vehicle Administration

E-Carga

This is an early winner project and is discussed later in the document.

One Stop Permit Shopping

One-stop shopping for commercial vehicle permits – This project must build from the other projects establishing nationwide vehicle and driver databases. The project would involve creating a database and a secure user friendly way to enter information in order to secure all permits for a particular trip. A demonstration project would test the process in one state, with the initial deployment expanding the use to other states.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$296.000
Initial Deployment	$920.000
Potential Procurement	System designer/integrator System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	DSRC
Public Transport	
Commercial Vehicle Systems	Consumer product now available
Safety and Security	Multi-agency database

TC-103 Automated Border Crossings

Automated Border Crossing

By-pass at border crossing for selected traffic – Using DSRC technology, commercial vehicles that use the crossing often will be able to by-pass normal inspections and processing. This is similar to several existing projects including FAST and SENTRI. This project is included here because there is a large desire within Mexico to greatly expand this capability. The existing systems will be examined and second and third generation systems designed.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$
Initial Deployment	$1,000.000
Potential Procurement	System designer/integrator System Vendor

Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	DSRC
Public Transport	
Commercial Vehicle Systems	Consumer product now available
Safety and Security	Multi-agency database & coordination

TC.2 Freight Transport Fleet Management
TC-201 Commercial vehicle fleet tracking

Fleet Management

Fleet management – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available
Safety and Security	

TC-202 Commercial vehicle fleet dispatching

Fleet Dispatch

Fleet dispatching – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed.

Development Complexity	Low
Integration Complexity	Low

Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available Includes mobile communications
Safety and Security	Multi-agency database

TC-203 Freight container tracking

Container Tracking

Container management – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed. However, this project relates to many other efforts including intermodal facility management.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System designer/integrator System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available Includes mobile communications
Safety and Security	Multi-agency database

Container Integrity

Container load management – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed. However, this project relates to many other efforts including those involved with CSI in monitoring shifts in loads and load integrity.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System designer/integrator System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available Includes mobile communications
Safety and Security	Multi-agency database

TC.3 Intermodal Information Management
TC-301 Vehicle and container arrival information exchange (users are fleet and intermodal carriers and nodes)

Port Management System

Container data sharing – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed. However, this project relates to many other efforts including intermodal facility management.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System designer/integrator System Vendor
Traffic Management	Potential lane control
Traveler Information & Communication	DMS DSRC with vehicles
Traffic Detection and Monitoring	
Fares and Toll Systems	

Public Transport	
Commercial Vehicle Systems	Consumer product now available Includes mobile communications
Safety and Security	Multi-agency database

Container Management

Container load management – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed. However, this project relates to many other efforts including those involved with CSI in monitoring shifts in loads and load integrity.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System designer/integrator System Vendor
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available Includes mobile communications
Safety and Security	Multi-agency database

TC-302 Customer freight information access (users are customers and shippers)

Container Bulletin Board

Freight information data sharing – This is considered available consumer off the shelf technology that many of the larger companies already use. No project costs have been developed.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System designer/integrator System Vendor
Traffic Management	
Traveler Information & Communication	Web based information sharing

Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer product now available
Safety and Security	

TC.4 Management and Control of intermodal centers
TC-401 Intermodal center facility management

Port Access Control

Automated access control – This project would center on expediting vehicles in and out of a port facility. Similar efforts have already begun in ports such as Vera Cruz. The project would tie in to nationwide databases and use DSRC to ensure security. An initial demonstration would involve either upgrading technical capabilities at an existing intermodal facility, or initiating a new project at an intermodal facility without any current automation. Deployment would consist of full deployment at that facility.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$60.000
Initial Deployment	$458.000
Potential Procurement	System designer/integrator System Vendor
Traffic Management	Lane control and/or signaling
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	DSRC
Public Transport	
Commercial Vehicle Systems	Consumer product now available Includes mobile communications
Safety and Security	

TC-402 Intermodal vehicle and container control

Port Management System 2

Container management within an intermodal facility – This project should build from another effort involving fleet or container management. That is, a new technology should not be used just to manage containers within the facility, but currently deployed technologies should be used to create a local monitoring network. The initial deployment includes the demonstration as once the application is proven, all containers are able to access the system.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$620.000
Potential Procurement	System designer/integrator System developer
Traffic Management	Lane control and/or signaling
Traveler Information & Communication	Direct communications with Shippers HAR to communicate with truckers
Traffic Detection and Monitoring	CCTV and sensors at entry
Fares and Toll Systems	DSRC
Public Transport	
Commercial Vehicle Systems	Driver biometrics AVL to track location within port
Safety and Security	Electronic Seal

Electronic Manifest

Customs automation within an intermodal facility – This project involves the automation of the forms used by Customs. A secure system will be created where the individual carrier only needs an electronic version of the form for use with law enforcement and inspections.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$296.000
Initial Deployment	$616.000
Potential Procurement	System designer/integrator System Vendor
Traffic Management	Lane control and/or signaling
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	DSRC
Public Transport	
Commercial Vehicle Systems	Consumer product now available Includes mobile communications
Safety and Security	

TC.5 Management of special freight
TC-501 Dangerous Goods movement data sharing

Dangerous Goods Cooperation Network

Dangerous Goods Movement System Integration – Dangerous goods refers to high value freight or freight that can cause major problems, but does fall into the hazardous materials category. They may be of particular risk for crime, or potential future hazard, but do would not require specialized clean up and immediate response. This first project is to examine what systems the various law enforcement and other agencies have and identify ways to connect their systems to facilitate information sharing. The demonstration contains the initial design and most interagency coordination, with the initial deployment extending the efforts across more systems and states.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$321.000
Initial Deployment	$3,072.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Vehicle Registration
Safety and Security	Multi-agency data sharing

TC-502 Dangerous Goods movement data registry

Dangerous Goods Database

Nationwide dangerous goods movement database – This project builds from the previous project, where several state databases may be consolidated and maintained at the national level. Appropriate security must be in place. As systems and needs expand, it is expected that additional similar projects will occur in the future.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$232.000
Initial Deployment	$2,096.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	

Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Vehicle Registration
Safety and Security	Multi-agency data sharing

TC-503 Dangerous Goods movement fleet coordination

Dangerous Goods Tracking

Route deviation for dangerous goods vehicles – Use of a generally off-the-shelf system to track commercial vehicles that are transporting dangerous goods. Routes must be input prior to beginning a trip, and the location of the vehicle will be tracked against the route to determine if the vehicle has left the route. Any deviation will be verified and law enforcement notified. The initial demonstration would be a first phase of a project involving a few vehicles, but the first project is expected to be a nationwide deployment.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$2,560.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer AVL systems Satellite communications
Safety and Security	Multi-agency data sharing

Dangerous Goods Driver Registration

Nationwide dangerous goods driver registration database – Beginning with national driver registration databases, a new related database will be created to identify drivers with appropriate training and authority to operate vehicles carrying dangerous goods. The demonstration would be for one particular state, and then as systems and needs expand, it is expected that additional similar projects will occur in the future.

Development Complexity	Low

Integration Complexity	Medium
Demonstration	$231.000
Initial Deployment	$2,066.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Driver Registration
Safety and Security	Multi-agency data sharing

TC-504 Dangerous Goods movement police / safety coordination

Dangerous Goods Incident Management

Automated incident sharing with law enforcement – To some extent, law enforcement is involved in the earlier phases. This project would involve informing police when a vehicle has been involved in an incident so they can be informed of what the freight is before approaching the incident. This project will build from the earlier efforts and will involve automated messaging to the proper authorities.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$48.000
Potential Procurement	System designer/developer/integrator
Traffic Management	Additional responder training
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Dedicated communications links

TC.6 Automated Roadside Safety Inspection
TC-601 Remote access to commercial vehicle safety data

Commercial Vehicle Data Sharing

Automation of vehicle and container records – For the purpose of roadside inspection, the agencies involved need remote access to other databases to confirm the information they are presented with. The demonstration would be for one particular state, and then as systems and needs expand, it is expected that additional similar projects will occur in the future.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$231.000
Initial Deployment	$2,066.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Vehicle Registration
Safety and Security	Multi-agency data sharing

TC-602 Monitoring Vehicle Loads

Paseje Facil

This is an "early winner" project and is discussed later in this document.

TC.7 Commercial Vehicle On-board Safety Monitoring
TC-701 Commercial vehicle internal systems monitoring

Fleet Vehicle Management

Vehicle system monitoring – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor/Integrator

Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	AVL fleet management system
Safety and Security	

TC-702 Commercial vehicle driver alertness monitoring

Fleet Vehicle Driver Alertness Warning System

Driver alertness warning systems – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System Vendor/Integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Consumer available systems
Safety and Security	Consumer available systems

Fleet Vehicle Lane Departure Warning System

Lane departure warning systems – This is considered available consumer off the shelf technology that many of the larger carriers already use. No project costs have been developed.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$0

Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Vehicle Registration
Safety and Security	Multi-agency data sharing

PE.1 Transport Related Electronic Financial Transactions
PE-101 Electronic transit fare payment

National Rail Card

Single transit fare card (rail) – This project involves expanding the existing transit fare card program to include all fixed rail facilities. The demonstration would be for one particular city, and because of the size, it is also the initial deployment.

Development Complexity	Medium
Integration Complexity	High
Demonstration	$0
Initial Deployment	$5,750.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	Existing electronic payment systems
Public Transport	Public transit databases
Commercial Vehicle Systems	
Safety and Security	Multi-agency data sharing

National Bus Card

Single transit fare card (bus) – This project involves creating a transit fare card program to be used on all concessioned bus operations. All concessions would be required to participate. The demonstration would be for one particular city, and because of the size, it is also the initial deployment.

Development Complexity	High

Integration Complexity	High
Demonstration	$0
Initial Deployment	$8,500.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	Existing electronic payment system
Public Transport	Public transit database
Commercial Vehicle Systems	
Safety and Security	Multi-agency data sharing

PE-102 Electronic toll collection

Super IAVE

Super Iave (Single nationwide system) – This project would consist of the effort required to tie various systems together, not to deploy any electronic toll collection systems. It is assumed that all necessary deployments have already happened.

Development Complexity	Medium
Integration Complexity	High
Demonstration	$0
Initial Deployment	$
Potential Procurement	System designer/manager System Developer/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	Existing electronic toll collection system Database coordination
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

PE-103 Electronic parking payment

National Parking Card

Use of IAVE to pay at parking garage – This project would consist of the effort required to tie various systems together, and to deploy an electronic parking collection system. The demonstration will be for one or two facilities in a city. Expansion will depend on the desire of the parking garage owners and CAPUFE.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$71.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	Existing Fare Payment System Database coordination
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

PE.2 Integration of Transport Related Electronic Payment Services
PE-202 Integration of regional multi-modal payment systems

National Transit Card

Nation-wide single payment system – This project would consist of the effort required to tie various systems together (not to deploy any systems) so that the user has only one account to maintain. It is assumed that all necessary deployments have already happened. This does not necessarily guarantee a single technology.

Development Complexity	High
Integration Complexity	High
Demonstration	$0
Initial Deployment	$541.000
Potential Procurement	System designer/manager System Developer/integrator
Traffic Management	
Traveler Information & Communication	Typical Business Database Systems

Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Multi-agency data sharing

GOT.1 Traffic Control
GOT-101 Traffic Monitoring

Roadway Monitoring

Deployment of traffic monitoring sensors – This project consists of deploying sensors on all limited access facilities within a single metropolitan region. This includes communications, but assumes limited or vendor supplied software to monitor the sensors. The demonstration would be on a single roadway with initial deployment covering all of one metropolitan area.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$5,608.000
Initial Deployment	$104,992.000
Potential Procurement	System designer/manager Vendor/System Developer
Traffic Management	
Traveler Information & Communication	Fiber optic or microwave backbone
Traffic Detection and Monitoring	Microwave, video detection, microloops and associated controllers
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Video Surveillance

Deployment of cameras – This project consists of deploying cameras on all limited access facilities within a single metropolitan region. This includes communications, but assumes limited or vendor supplied software to monitor the sensors. The demonstration would be on a single roadway with initial deployment covering all of one metropolitan area.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$5,612.000

Initial Deployment	$105,648.000
Potential Procurement	System designer/manager Vendor/System Integrator
Traffic Management	
Traveler Information & Communication	Fiber optic backbone Gigabit ethernet
Traffic Detection and Monitoring	Digital IP addressable CCTV
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IAVE Travel Times

Monitoring tollroads using toll tags – This project consists of utilizing the information from electronic toll tags and credit cards to provide real time information on those roads with electronic toll collection. This assumes real time communications exists as well as an accessible database. As the work is completely in software and data management, the initial deployment is also the demonstration.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$685.000
Potential Procurement	System designer/manager System Developer/integrator
Traffic Management	
Traveler Information & Communication	Web based distribution Dedicated communications
Traffic Detection and Monitoring	Electronic Toll Collection data
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-102 Surface Street Control

Signal Control

Advanced Signal Control Systems – Many urban areas already have significant signal control systems in place, such as Mexico City, Guadalajara, and Monterrey. This project would expand similar systems to other urban areas. This includes all new equipment and communications, but assumes limited or vendor supplied software to monitor the system.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$270.000
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	Signal system including controllers
Traveler Information & Communication	Dedicated communications to TMC
Traffic Detection and Monitoring	Video detection Loop detectors
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Arterial Lane Control

Lane control along directional routes – This project is for lanes near special even generators where directional use of the roadway can vary considerably. This includes all new equipment and communications, but assumes limited or vendor supplied software to monitor the system.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$1.641.000
Potential Procurement	System designer/integrator
Traffic Management	Lane control signs and controllers
Traveler Information & Communication	Fiber optics or microwave
Traffic Detection and Monitoring	Digital IP CCTV
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Diversion Routing

Incident diversion routing – This project involves examining locations where incidents are frequent and identifying diversion routes. Static and dynamic signing can be used to help route diverted vehicles. As this is on a site by site basis, the demonstration is considered as the initial deployment.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$116.000
Potential Procurement	System designer/integrator
Traffic Management	DMS, Lane control signs, HAR
Traveler Information & Communication	Fiber optic or microwave
Traffic Detection and Monitoring	Digital IP CCTV (Others from previous projects)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-103 Freeway Control

Freeway Lane Control

Lane control – This project is for lanes near special even generators or high incident locations where active lane management can increase safety and decrease congestion. This includes all new equipment and communications, but assumes limited or vendor supplied software to monitor the system.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$1,641.000
Potential Procurement	System designer/manager Vendor/integrator
Traffic Management	Lane control signs and controller
Traveler Information & Communication	Fiber optic or microwave
Traffic Detection and Monitoring	Digital IP CCTV (Others from previous projects)
Fares and Toll Systems	
Public Transport	

Commercial Vehicle Systems	
Safety and Security	

Dynamic Speed Limits

Dynamic speed limits – This project involves the use of dynamic speed signs to change the posted speeds in advance of incidents or congestion. This includes all new equipment and communications, but assumes limited or vendor supplied software to monitor the system. It also assumes sufficient traffic monitoring systems are in place to provide operators with sufficient knowledge to make informed decisions.

Development Complexity	Medium
Integration Complexity	High
Demonstration	$0
Initial Deployment	$1.841.000
Potential Procurement	System designer/manager System Developer/integrator
Traffic Management	Dynamic speed signs and controllers
Traveler Information & Communication	Dedicated fiber or microwave
Traffic Detection and Monitoring	(Others from previous project)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Vehicle Registration
Safety and Security	Multi-agency data sharing

GOT-104 Preferential Treatment for Traffic Control (Signal Priority)

Emergency Vehicle Pre-emption

Emergency vehicle signal pre-emption – This is considered an off the shelf system that can be purchased and installed on a signal system to provide emergency responders with green lights to reduce response times.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$130.000
Potential Procurement	System designer/integrator Vendor
Traffic Management	(Existing Signal system)
Traveler Information & Communication	

Traffic Detection and Monitoring	Available pre-emption system
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-105 Reversible Lane Management

Freeway Reversible Lanes

Reversible lane control (limited access facility) – This project provides automated management of reversible directional lanes on limited access facilities. This includes all new equipment and communications, as well as limited software development to monitor the system.

Development Complexity	High
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$954.000
Potential Procurement	System designer/manager System Developer/integrator
Traffic Management	DMS, Lane control, moveable gates and barriers
Traveler Information & Communication	Dedicated fiber optics or microwave
Traffic Detection and Monitoring	Video, Microwave
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Arterial Reversible Lanes

Reversible control along directional routes – This project is for reversible lanes where directional use of the roadway can vary considerably. This includes all new equipment and communications, but assumes limited or vendor supplied software to monitor the system.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$754.000
Potential Procurement	System designer/manager System Developer/integrator

Traffic Management	DMS, Lane control, moveable gates
Traveler Information & Communication	Dedicated fiber optics or microwave
Traffic Detection and Monitoring	Video, microwave
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-106 Traffic Information Dissemination

DMS Deployment

Deployment and use of DMS for incident and congestion information – This project provides dynamic message signs (DMS). This includes all new equipment and communications, but assumes vendor supplied software to monitor the system. This assumes traffic monitoring through sensors or cameras is in place. The demonstration is a single application while the initial deployment is for a single urban area.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$209.000
Initial Deployment	$4,000.000
Potential Procurement	System designer/integrator Vendor
Traffic Management	DMS overhead or side mounted
Traveler Information & Communication	DMS
Traffic Detection and Monitoring	(Other existing systems)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

HAR Deployment

Deployment and use of HAR for incident and congestion information – This project provides highway advisory radio (HAR). This includes all new equipment and communications, but assumes vendor supplied software to monitor the system. This assumes traffic monitoring through sensors or cameras is in place. The demonstration is a single application while the initial deployment is for a single urban area.

Development Complexity	Low
Integration Complexity	Medium

Demonstration	$34.000
Initial Deployment	$350.000
Potential Procurement	System designer/integrator Vendor
Traffic Management	HAR
Traveler Information & Communication	HAR
Traffic Detection and Monitoring	(Other existing systems)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-107 Coordination of Surface Street and Freeway Control

Ramp Closure Gates

Ramp closure gates for incidents – This project provides ramp closure gates at specific locations that are approaching high incident location areas. The gates would close the ramps during incidents or special events. The demonstration is a single application while the initial deployment is for a single urban area.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$10.000
Initial Deployment	$400.000
Potential Procurement	System designer/integrator
Traffic Management	Gates and barriers
Traveler Information & Communication	
Traffic Detection and Monitoring	(Other existing systems)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Travel Times at Ramps

Travel times at freeway entrance ramps – This project provides DMS with real time information related to the conditions of the limited access facility that a motorist is about to enter. This gives the motorist an opportunity to divert to local roads if appropriate.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$300.000
Potential Procurement	System designer/integrator
Traffic Management	(Other existing systems)
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	(Other existing systems)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Detour Signal Timing

Detour signal timing alternatives – This project provides alternative signal timing along predetermined routes in high incident location areas. The demonstration is a single application while the initial deployment is a program for identifying and updating many alternate routes within a single urban area.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$24.000
Initial Deployment	$480.000
Potential Procurement	System designer/integrator
Traffic Management	Static and dynamic signs
Traveler Information & Communication	Static and dynamic signs
Traffic Detection and Monitoring	(Other existing systems)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-108 Intermodal-Highway Junction Management

Train Approach Active Warning

Train approaching warning – This project provides a warning to motorists that a train is approaching. It is more than a simple actuated flashers design, involving increased warning time and greater warning area. The demonstration is a single application while the initial deployment is for a single urban area.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$104.000
Initial Deployment	$1.040.000
Potential Procurement	System designer/manager System Developer/Integrator
Traffic Management	
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Railroad controller, signal controller
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Multi-agency data sharing

Train Crossing Delay Notification

Dynamic train delay messaging – This project provides an estimated time remaining for a train that is already crossing the roadway. This would be through HAR or DMS broadcasting to those waiting and approaching the crossing. The demonstration is a single application while the initial deployment is for a single urban area.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$164.000
Initial Deployment	$1,640.000
Potential Procurement	System designer/manager System Developer/Integrator
Traffic Management	
Traveler Information & Communication	DMS, HAR,
Traffic Detection and Monitoring	Railroad controller, signal controller
Fares and Toll Systems	
Public Transport	

Commercial Vehicle Systems	
Safety and Security	Multi-agency data sharing

GOT-109 Parking Management

DMS Parking Availability

Parking availability messaging – This is generally an off the shelf product sold as a system to let approaching motorist know what parking is available. The demonstration is a single application while the initial deployment is for a single urban area.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$82.000
Initial Deployment	$820.000
Potential Procurement	System designer/integrator Vendor
Traffic Management	
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Parking counting systems
Fares and Toll Systems	Electronic parking payment systems
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-110 Work Zone Traffic Management

Smart Work Zone 1

Work Zone lane configuration messaging – This project provides a warning to motorists approaching a work zone as to the level of work and expected lane changes. It involves use of portable DMS. The demonstration is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$50.000
Initial Deployment	$50.000
Potential Procurement	System designer/developer/integrator
Traffic Management	
Traveler Information & Communication	DMS, HAR

Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Smart Work Zone 2

Work Zone delay messaging – This project provides a warning to motorists approaching a work zone as to the delay they can expect through the work zone. It involves use of portable DMS and some local traffic monitoring technology. The demonstration is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$50.000
Initial Deployment	$50.000
Potential Procurement	System designer/developer/integrator
Traffic Management	
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Electronic toll tags, license plate readers, radar/microwave
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Work Zone Reversible Lane

Portable barrier wall for reversible lanes in work zone – This project uses a fast moving portable barrier wall system to allow for changing lane configurations daily to meet traffic's needs. This is used in applications where large shifts in directional traffic are anticipated in the work zone and the work zone lane configuration supports this type of application. The demonstration is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	Low
Demonstration	$150.000
Initial Deployment	$150.000
Potential Procurement	System designer/manager System vendor/integrator

Traffic Management	Portable moveable barrier walls Control gates
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Video
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT.2 Demand Management
GOT-201 Variable road pricing

Time of Day Tolling

Off peak toll discounts for commercial vehicles – This project dynamically changes tolls based on time of day and classification to promote off peak usage. The project assumes electronic toll collection is in place and the system requires only minor modifications. The demonstration is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	
Initial Deployment	$0
Potential Procurement	System designer/integrator System Developer
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	Electronic toll collection and controllers
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-202 Access management

Road Pricing

Road pricing in historic districts – This project uses regional electronic toll collection to toll certain vehicles entering historic districts. This would include peak hour commercial vehicles, private vehicles, and possibly taxis. The intent is to limit the vehicle traffic in these environmentally sensitive areas. The project assumes a regional toll road is already using toll tags (existing population of users) and that all

equipment in the historic area would need to be installed under this project. The demonstration is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$2,320.000
Potential Procurement	System designer/manager System Developer/integrator
Traffic Management	Toll gates
Traveler Information & Communication	DMS
Traffic Detection and Monitoring	DSRC, Electronic toll tags
Fares and Toll Systems	Electronic toll collection system
Public Transport	Electronic fare payment system
Commercial Vehicle Systems	Vehicle Registration Electronic pre-clearance
Safety and Security	Multi-agency data sharing

GOT-204 Air Quality-based transport management

Air Quality Road Pricing

Road pricing by air quality – This project uses regional electronic toll collection to toll certain vehicles during periods of poor air quality. The intent is to limit the vehicle traffic in areas that are experiencing air quality issues. The project assumes a regional toll road is already using toll tags (existing population of users) and that all equipment in the area to be protected would need to be installed under this project. The demonstration is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$2,260.000
Potential Procurement	System designer/manager System Developer/integrator
Traffic Management	
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Air pollution sensors
Fares and Toll Systems	Electronic toll collection systems
Public Transport	

Commercial Vehicle Systems	Vehicle Registration Electronic pre-clearance system
Safety and Security	Multi-agency data sharing

Roadside Emissions Testing

Roadside emissions testing – Roadside environmental sensors are installed and incorporated into the existing traffic management system, or used by the vendor supplied software, to provide specific warnings at set thresholds. The project assumes that all field equipment in the area to be tested would need to be installed under this project. The demonstration is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$40.000
Initial Deployment	$40.000
Potential Procurement	System designer/integrator System Developer
Traffic Management	(Other existing system)
Traveler Information & Communication	
Traffic Detection and Monitoring	Air quality/pollution sensors
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT.3 Transport Infrastructure Maintenance Management
GOT-301 Roadway Construction and Maintenance Management

Lane Rental

Lane rental for planned closures – This project applies a fee for contractors to close lanes of traffic for construction or maintenance work. This involves personnel checking and monitoring lane closures and determining through an application the related fee. The demonstration is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$144.000
Initial Deployment	$144.000
Potential Procurement	System designer/manager/developer
Traffic Management	

Traveler Information & Communication	Typical business databases Web site hosting
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-303 Pavement Management

Pavement Management Database

Pavement management asset system – create a database for monitoring the condition of pavement throughout Mexico. The database will be populated and maintained manually. Once created, the database can be shared with other regions at little cost.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$84.000
Potential Procurement	System designer/manager/developer
Traffic Management	Multi-agency data sharing
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-304 Bridge Management

Bridge Management Database

Bridge management asset system – create a database for monitoring the condition of bridges throughout Mexico. The database will be populated and maintained manually. Once created, the database can be shared with other regions at little cost.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0

Initial Deployment	$84.000
Potential Procurement	System designer/manager/developer
Traffic Management	Multi-agency data sharing
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-305 Automated Road Management

Infrastructure Management System

Integration of various asset management systems – Merge the databases for monitoring the condition of all infrastructure throughout Mexico. The database will then be shared with other regions at little cost. This project assumes the other asset management systems are already in place and mature.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$144.000
Potential Procurement	System designer/manager/developer
Traffic Management	Multi-agency data sharing
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-306 Work Zone Safety Management

Freeway Lane Closure Information System

Media information sharing – Provide real time data on work zones to the media so they may distribute to the general public. This can be accomplished by fax, email, phone calls, the internet, etc. This project assumes the other work zone management systems are already in place and mature.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$168.000
Potential Procurement	System designer/manager/developer
Traffic Management	
Traveler Information & Communication	Web site hosting General business database
Traffic Detection and Monitoring	Multi-agency data sharing
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-307 Utility and infrastructure Management

Communications Management Database

Communications asset management – Create a database or system to monitor the location, type, condition, etc. of all publicly owned communications used by ITS.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$65.000
Potential Procurement	System designer/manager/developer
Traffic Management	Multi-agency data sharing
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

ITS Management Database

ITS asset management – Create a database or system to monitor the location, type, condition, etc. of all ITS field equipment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$65.000
Potential Procurement	System designer/manager/developer
Traffic Management	Multi-agency data sharing
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT.4 Transport Related Incident and Event Management
GOT-401 Incident On-Site Motorist Assistance

Urban Green Angels

Urban Green Angels – Expand the Green Angel program to the urban limited access facilities. The demonstration would be over a portion of an urban region while the initial deployment represents the full scale deployment of equipment in a single urban area.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$1,750.000
Initial Deployment	$31,600.000
Potential Procurement	System designer/manager Vendors
Traffic Management	Portable DMS Fleet management systems
Traveler Information & Communication	Multi-agency coordination
Traffic Detection and Monitoring	(Provide input to other systems)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Incident management vehicles Driver training, policy quidance

Motorist Aid Training

Increased Motorist Aid Training – Develop a program for providing increased training for all emergency responders in motorist aid. This should be focused on the motorist but include all agencies responsible. The demonstration would be a single class while the initial deployment represents the full scale training program in all states and regions.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$7.000
Initial Deployment	$217.000
Potential Procurement	Vendor Developer/vendor
Traffic Management	Training classes
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-402 Incident On-Site Traffic Management

Portable DMS for Incident Management

Portable DMS to manage traffic at an incident – Purchase a portable DMS (probably truck mounted) for deployment and larger incidents. Provide training on when and how to use the DMS. Demonstration is a single unit. Initial deployment is dependent on the relative success of the initial unit.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$25.000
Initial Deployment	$250.000
Potential Procurement	Vendor
Traffic Management	Portable DMS
Traveler Information & Communication	Portable DMS
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	

Commercial Vehicle Systems	
Safety and Security	

Incident Management Training

Increased Incident Management Training – Develop a program for providing increased training for all emergency responders in Incident Management. This should include all phases of incident management and all agencies responsible. The demonstration would be a single class while the initial deployment represents the full scale training program in all states and regions.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$7.000
Initial Deployment	$217.000
Potential Procurement	Vendor, Developer
Traffic Management	Training classes
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Training classes

Incident Command Vehicle

Incident command vehicle – Purchase an incident command vehicle for use at large scale incidents. Provide training on when and how to use the command vehicle. Demonstration is the same as initial deployment.

Development Complexity	Medium
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$330.000
Potential Procurement	System designer/vendor
Traffic Management	Custom command vehicle
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	

Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Custom command vehicle

GOT-403 Incident and Event Coordination

Integrated Dispatch System

Integration of response agency dispatch computers –Timely sharing of information between agencies is critical to the successful management of an incident. Integration would include the ability to share comments and information on incidents. This project is dependent on the agencies having operational dispatch systems. The demonstration is to test critical aspects while the initial deployment represents a single regional effort.

Development Complexity	Medium
Integration Complexity	High
Demonstration	$268.000
Initial Deployment	$514.000
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	Multi-agency data sharing
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Multi-agency data sharing

Incident Coordination Training

Increased Incident Coordination Training – Develop a program for providing increased training for all emergency responders and associated agencies in Interagency Coordination. This focus here should be on the value of sharing of information and possibly the incident command structure. The demonstration would be a single class while the initial deployment represents the full scale training program in all states and regions.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$7.000
Initial Deployment	$217.000

Potential Procurement	Vendor, Developer
Traffic Management	Training class
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

GOT-404 Hazardous Materials Monitoring and Management

Hazmat Response System 1

Real time Hazmat information sharing – This is an extension of the Real time monitoring of Hazmat vehicles in SE-301 (Hazmat vehicle tracking). Information is shared from the agency tracking systems with emergency responders. This can begin by simply having a single phone number to call, but should eventually involve integration of dispatch systems to allow real time sharing of data. The initial demonstration is institutional, the initial deployment represents an automated connection in one location.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$10.000
Initial Deployment	$192.000
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	Multi-agency data sharing
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	Vehicle database
Safety and Security	Multi-agency data sharing

GI.2 Disaster Response Management
GI-201 Disaster Response Planning for Transport Network

Disaster Response Coordinated Planning

Response plan sharing – This is a institutional project involving coordination of existing response plans and examination of areas of concern or further development. This project will likely be done internally between the responsible agencies.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	Multi-agency cooperation
Traffic Management	Multi-agency cooperation
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	Multi-agency cooperation

GI.3 Coordination with Emergency Agencies
GI-301 Disaster Response Coordination

Disaster Response Secure Communications

Emergency communications system – There are commercially available off the shelf communication systems that can be quickly deployed in disaster areas and used by all agencies responsible for portions of the disaster. The system needs to be purchased as a whole since only partial communications during a disaster is of little help.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$1,108.000
Potential Procurement	System designer/manager Vendor
Traffic Management	
Traveler Information & Communication	Secure wireless communications
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

MA.1 Weather Monitoring
MA-101 Road Weather Information Monitoring

Weather Station Deployment

Road and weather monitoring stations – These are commercially available off the shelf systems. Road agencies need to monitor such conditions as flooding, high winds, and fog. The demonstration is a single station – the initial deployment is for a single region. It is assumed the vendor supplied software is used.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$40.000
Initial Deployment	$200.000
Potential Procurement	System vendor/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	Commercial weather station
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Fog Warning System

Road and weather warning system – These are commercially available off the shelf systems. This involves using the information from the stations to provide warnings for drivers through HAR or DMS. For example, warning of fog entering a mountainous area or flooding approaching a valley. This project assumes no monitoring is in place, so it contains both the monitoring equipment and the traveler information equipment as a single unit. The demonstration is a single system. As these are more site specific, the demonstration is the initial deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$90.000
Initial Deployment	$90.000
Potential Procurement	System vendor/integrator
Traffic Management	
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Fog sensors

Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

MA.2 Environmental Conditions Monitoring
MA-201 Water Level /Tidal Monitoring and Prediction

Water Level Monitoring System

Water level monitoring system – These are commercially available off the shelf systems. The system will monitor a specific body of water (river or gulf) for indications of flooding . The system uses vendor supplied software to give warnings of potential flooding. The demonstration is a single system. As these are more site specific, the demonstration is the initial deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$90.000
Initial Deployment	$90.000
Potential Procurement	System vendor/integrator
Traffic Management	
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Water level sensors
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

MA-203 Pollution Monitoring

Air Quality Integration with Management Systems

Air quality integrated with traffic management – This project installs air quality measuring devices and integrates them with available traffic management centers. The project assumes that the traffic management center is operational. The demonstration is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0

Initial Deployment	$72.000
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	(Other existing system)
Traveler Information & Communication	DMS, HAR
Traffic Detection and Monitoring	Air quality sensors
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

TP.1 Public Transport Management
TP-101 Public Transport Vehicle Internal Systems Monitoring

Fleet Equipment Management for Public Passenger Transit Vehicles

Internal systems monitoring – This is considered a consumer product as it is already available on some cars and trucks. It is assumed that concessions would be responsible for this equipment so no costs are identified.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System vendor/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	Internal system monitoring systems
Commercial Vehicle Systems	
Safety and Security	

TP-102 Public Transport Vehicle Fleet Tracking

Fleet Management for Public Passenger Transit Vehicles

Fleet management – This is considered available consumer off the shelf technology. It is assumed that concessions would be responsible for this equipment so no costs are identified.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$0
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	Commercial AVL systems and central software
Commercial Vehicle Systems	
Safety and Security	

TP.2 Demand Responsive and Shared Public Transport
TP-201 Paratransit Fleet Dispatch

Automated Paratransit Requests

Automated receipt of requests – This project would provide a means for users to request paratransit service without having to talk to an operator. The demonstration is for one region and is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$888.000
Potential Procurement	System designer/developer
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	General database and communications systems
Commercial Vehicle Systems	
Safety and Security	

CAD for Paratransit

Automated dispatch of nearest vehicle – This project would provide a means for a concession to dispatch paratransit service efficiently by finding the closest available vehicle. This demonstration is for a limited area within one region. The initial deployment would be throughout one region.

Development Complexity	Low
Integration Complexity	Medium
Demonstration	$137.000
Initial Deployment	$5.912.000
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	Commercial AVL system
Commercial Vehicle Systems	
Safety and Security	

TP-202 Dynamic Ridesharing

Dynamic Paratransit Assignment

Dynamic routing of paratransit vehicles – This project would be an enhancement to the automated dispatch by allowing en-route route changes to accommodate new requests for service. This demonstration assumes the automated dispatch is already operational. The demonstration is for one region and is considered the initial deployment.

Development Complexity	High
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$384.000
Potential Procurement	System designer/developer/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	General business database (Other existing systems)

Commercial Vehicle Systems	
Safety and Security	

IV.1 Pre-trip Information
IV-101 Pre-Trip Information – Traffic and Roadway

Info Viaje

This is an "early winner" project and is discussed later in this Chapter.

Major Roadway Travel Times

Real time congestion information – This project would provide internet access to all available real time congestion information. The project assumes the traffic monitoring capability already exists. The demonstration is for one region and is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$810.000
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	(Other existing system)
Traveler Information & Communication	DMS, HAR, web site
Traffic Detection and Monitoring	(Other existing system)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IV-102 Pre-Trip Information – Public Transport (bus and rail)

Schedule Adherence Information

Real time schedule adherence information – This project would provide internet access to all available real time information concerning public transit systems. The project assumes this information is already available from transit fleet management systems. The demonstration is for one region and is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	High
Demonstration	$0

Initial Deployment	$192.000
Potential Procurement	System designer/developer
Traffic Management	(Other existing systems)
Traveler Information & Communication	Web site Multi-agency data sharing
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

Static Schedule Information

Static public transit information – This project would provide internet access to all available static public transit information. Much of this information is currently available for each system. This project will provide access to all of the available information. The initial deployment is effectively the full deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$100.000
Potential Procurement	System designer
Traffic Management	
Traveler Information & Communication	Web site
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IV.2 On-trip Information
IV-201 On-Trip Information – Roadside

DMS Incident Messaging

DMS with real time incident messaging – This project provides a warning to motorists of incidents downstream from them. It assumes DMS have already been deployed and a TMC is operational. This project focuses solely on the work to integrate the sources of information. The demonstration is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$120.000
Potential Procurement	System designer/developer/Integrator
Traffic Management	(Other existing system)
Traveler Information & Communication	DMS
Traffic Detection and Monitoring	(Other existing system)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

HAR Incident Messaging

HAR with real time congestion messaging – This project provides information to motorists of congestion downstream from them. It assumes HAR have already been deployed and a TMC is operational. This project focuses solely on the work to integrate the sources of information and to provide an automated message generation system. The demonstration is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$228.000
Potential Procurement	System designer/developer/integrator
Traffic Management	(Other existing system)
Traveler Information & Communication	HAR
Traffic Detection and Monitoring	(Other existing system)

Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IV-203 On-Trip Information – Public transport vehicle

Next Stop DMS

Next stop on electronic banner – This system uses static route information tied to sensors on the bus to provide visual display information on the next scheduled stop. Numerous low end systems have been deployed. A small demonstration with limited vehicles is possible, with the initial deployment covering an entire metropolitan area.

Development Complexity	Medium
Integration Complexity	Low
Demonstration	$70.000
Initial Deployment	$1,050.000
Potential Procurement	System vendor/integrator
Traffic Management	
Traveler Information & Communication	In-vehicle DMS
Traffic Detection and Monitoring	(existing AVL)
Fares and Toll Systems	
Public Transport	(existing AVL)
Commercial Vehicle Systems	
Safety and Security	

IV-205 On-Trip Information through mobile devices

Incidents to Mobile Phone
Travel Times to Mobile Phone

Real time traffic information to a personal mobile device – This is currently available to consumers in selected markets. Real time information in Mexico is dependent on either the speed at which public systems are deployed, or the willingness of the private sector to invest their own data gathering measures. It is assumed that consumers would be responsible for purchasing this service so no costs are identified.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0

Initial Deployment	$0
Potential Procurement	Commercial product
Traffic Management	(Other existing system)
Traveler Information & Communication	(Other existing data sharing)
Traffic Detection and Monitoring	(Other existing system)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IV.3 Travel Services Information
IV-301 Travel Services Information – In-vehicle

Traveler Services In-Vehicle

Local consumer based service information – This is currently available to consumers. It is assumed that consumers would be responsible for purchasing this service so no costs are identified.

Development Complexity	Medium
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	Commercial product
Traffic Management	(Other existing system)
Traveler Information & Communication	(Other existing data sharing)
Traffic Detection and Monitoring	(Other existing system)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IV-302 Travel Services Information – Personal interactive

Traveler Services to Mobile Phones

Local consumer based service information – This is currently available to consumers. It is assumed that consumers would be responsible for purchasing this service so no costs are identified.

Development Complexity	Medium

Integration Complexity	Low
Demonstration	$0
Initial Deployment	$0
Potential Procurement	Commercial product
Traffic Management	(Other existing system)
Traveler Information & Communication	(Other existing data sharing)
Traffic Detection and Monitoring	(Other existing system)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IV-303 Travel Services Information – Dedicated location

Local HAR

Low power HAR with local service information – This project provides information to motorists local services (e.g., restaurants at approaching rest area). As this is site specific, the demonstration is considered the initial deployment.

Development Complexity	Low
Integration Complexity	Low
Demonstration	$0
Initial Deployment	$35,000
Potential Procurement	System Vendor
Traffic Management	(Other existing system)
Traveler Information & Communication	HAR, Web site
Traffic Detection and Monitoring	(Other existing system)
Fares and Toll Systems	
Public Transport	
Commercial Vehicle Systems	
Safety and Security	

IV.6 Trip Planning Support
IV-602 current utilisation levels from public transport information systems

Automated Ridership Integration

Automated passenger counting systems – This project would provide automated passenger counting systems and the archival of this information. The information could then be used for planning purposes. This demonstration assumes all equipment must be purchased, installed, and a central system created to store the information. The demonstration is for one region and is considered the initial deployment.

Development Complexity	Medium
Integration Complexity	Medium
Demonstration	$0
Initial Deployment	$30,572,000
Potential Procurement	System designer/manager System vendor/integrator
Traffic Management	
Traveler Information & Communication	
Traffic Detection and Monitoring	
Fares and Toll Systems	
Public Transport	Existing Passenger counting system Associated database
Commercial Vehicle Systems	
Safety and Security	

9.2.3 Prioritization of Projects

The National ITS Architecture has continually been described as a tool for aiding in the development of an ITS Program. This section provides the initial program for Mexico. This is meant as a starting point for the agencies within Mexico. The program should be reviewed and modified on a continuing basis. New projects will be added; lower priority projects will be deleted. The sequencing of the projects will change as will the level of deployment.

For this initial program, projects have been prioritized into three main categories, and two additional categories. The three main categories are short, medium and long-term. The definition of each category is 2-7 years, 8-13 years, and 14-20 years. This provides opportunity for one of the other categories – Early Winners. The early winner projects are described in the following section.

Input was taken from all previous tasks and in particular from the ranking table shown in Chapter 8. Included in each table is the initial estimate of the timing for each identified project. As with the costs, projects have been broken down into Demonstration, Initial Deployment, and Full Deployment.

Within the timing is some indication of whether a project is national, regional, or local. However, it should be noted that the ultimate goal of ITS is that ALL systems are eventually integrated.

9.2.4 Early Winner Projects

Specific "early winner" projects have been identified based on an understanding of current activities as well as the necessity of deploying certain ITS projects to enable future ITS projects to be deployed. These

projects were initially identified in Task 4, were subsequently expanded, discussed with the stakeholders, and reviewed with executives within SCT. The projects are intended to represent efforts that are relatively easy to implement, have an expected high benefit to cost ratio, and can demonstrate success quickly.

After all input was received, the early winner projects were reduced to three specific initial efforts – E-Carga, Paseje Facil, and Infoviaje. Below is a brief synopsis of early winner project.

9.2.4.1 E-Carga

One major problem to the motor carrier industry is that while there are standard forms and laws across the country, each customs office in each city interprets those rules and forms differently. The intent of this project is to provide an automated way of completing and exchanging customs and manifest information. The purpose is to speed the processing of trucks at ports, and to provide some time savings at inspections. This system will attempt to remove any variability of interpretation of laws and possibly provide a level of compatibility with certain US systems. This has the potential for significant reductions in delays reducing transportation costs and increasing the competitiveness of Mexican industry.

9.2.4.2 Info Viaje

Many inter-city travelers are not properly informed about conditions pertaining to the roadway availability ahead of them. Consequently, it is common for travelers to drive tens (if not hundreds) of kilometers along a road only to find access to the next city blocked due to traffic incidents, weather, rockslides, etc. Due to the structure of the road network in Mexico, often the only alternative is to go back to the previous city to take an alternate route. If properly informed, the travelers could have taken the alternate route at the previous decision point that would have prevented the wasted portion of the trip. For commercial goods, this often translates into savings of a day or more in delivery time. This will make the Mexican transportation industry more competitive with other nations. The system can also be used in urban areas where real time alternate routes are available to motorists. By reducing delays, the system will also reduce secondary accidents.

9.2.4.3 Pesaje Facil

Most nations build large commercial vehicle weigh and inspection facilities for enforcement of overweight rules and laws. These facilities are expensive and as a fixed facility, they catch very few violators (those that violate know the locations and bypass them).

There are numerous inspections of commercial vehicles across Mexico. Many of them are focused on safety. Currently, there are no (?) weigh stations anywhere in Mexico. Overweight vehicles account for much of the damage to the roadway system. So, other than stopping and checking all vehicles (which is wasteful for those legal carriers), a system of targeting the gross violators would be helpful. This system would deploy hidden sensors across multiple highways that would provide indications of vehicles that are grossly violating weight restrictions. The police could then remove these violators from the traffic stream without causing legal carriers to be delayed. The result is an efficient use of resources. Also, by targeting gross violators, the agencies can remove those vehicles that cause the most damage to the roadways. This results in much improved pavement life for all vehicles to enjoy. This also allows for more efficient travel for legal carriers that then provides decreased travel times and increased efficiencies making Mexican industry more competitive with others.

9.3 Future Systems Procurement

Over the coming years, it is anticipated that Mexico will deploy more and more ITS technologies by utilizing this National architecture. The projects listed above are just the beginning.

As an aid, this section reviews some of the current vendors in a variety of categories and provides some review comments. The intent of this section is not to recommend specific vendors – only to provide some

insight into the current industry and some of it's members. It should be noted that as technology changes quickly, so do the list of vendors.

Over the coming years, it is anticipated that Mexico will deploy more and more ITS technologies by utilizing this National architecture. The projects listed above are just the beginning.

9.3.1 List of Vendors

The vendor industry changes year by year with companies entering and leaving the business. Still, the majority of the industry is represented by companies that have been in the business of technology or traffic for many years.

Appendix D contains a list of the more common and visible companies, their contact information, and the sector within the industry that they serve. The sectors served include DMS, Signals, CCTV, etc. No endorsement is meant by this listing, only that these vendors are common to the ITS industry. **Those firms that are U.S.-based are noted in the list.**

9.3.2 ITS Procurement Processes

There are several different ways to procure ITS services or products. Products are often chosen by low-bid. This is acceptable so long as the products meet industry or regional standards, or are compatible with existing operational systems. Since compatibility is a much greater issue with technology than more traditional transportation issues (e.g., pavement, drainage), it is useful to prequalify firms and only allow procurement from those firms that have demonstrated compatibility with existing systems or regional standards.

Many more recent ITS procurements involve design-build activities which incorporate design, construction and testing activities under one contractor, with client oversight activities provided to provide reassurance that the correct system is chosen and is operating properly.

The following section explains many of the options and attributes of procurement

9.3.2.1 General Issues

Acquiring Intelligent Transportation Systems equipment and services by governmental transportation agencies is typically accomplished using three procurement processes: Request for information (RFI), Request of Qualifications (RFQ), and Request for Proposal (RFP). An RFI is typically used to obtain information from the manufacturer about the different physical configuration, operational characteristics and performance parameters of ITS equipment they manufacture. This information is then used by the agency staff to evaluate the ability of the equipment to meet their operational needs. An RFQ is typically used for the procurement of engineering planning and design projects. Firms prepare and submit a document that presents their expertise, similar project experience, and available staffing to accomplish the work required by the client. This information is used by the procuring agency to evaluate and select the most qualified firm to perform needed services. An RFP is typically used in procuring design and design/build services. Firms prepare and submit a document that presents their understanding and approach to the project, similar project experience, staff expertise and financial capabilities to carry out and complete the project. This information is used by the procuring agency to select and negotiate a contract with the most qualified firm.

These three procurement processes have shared and unique elements that must be developed by the procuring agency. Once competed the agency can then use a number of different informational outlets (newspaper, trade journals, internet posting, etc.) to solicit responses from interested companies.

Presented below are generic descriptions for each process that can be used to procure ITS equipment and services.

9.3.2.2 Request for Information

A Request for Information (RFI) is not a contractual commitment. It is simply providing an opportunity for vendors and suppliers to inform the public agency of services and equipment that are available to them. The RFI is often followed by an official procurement. The basic format for an RFI is comprised of the following elements.

General Information. Under this heading the following information is included:

- Document Type;
- Solicitation Number;
- Posted Date;
- Response Date;
- Current Archive Date; and
- Classification Code.

Contracting Office Address. Under this heading the address of the contract office is identified.

Point of Contact. Under this heading the name, address, telephone and e-mail address of the person responsible for managing the RFI process is listed.

Description. Information presented under this heading includes:

- Name of the agency responsible for project being procured;
- Name of the project;
- Action being taken (i.e. RFI);
- Summary of the project; and
- Purpose of the project.

Objective. Under this heading a detail description is presented of what the project is to accomplish and how success is to be measured. Typically a project will have multiple objectives.

Background. Under this heading previous work relative to the project is presented. This provides the respondents to the RFI a better understanding of the circumstances and actions that have occurred, giving rise to the project. Additionally any pertinent technical data or operational information is presented that is associated with or may affect the project.

RFI Respondent Requirements. Under this heading the category of respondents (i.e. private industry, universities, etc.) anticipated are identified by the procuring agency. Additionally the procuring agency should describe in detail the type of information it is requesting and how the respondent should document and present such information.

How to Respond. Under this heading the contracting agency instructs the respondent what medium to use when forwarding their response (i.e. e-mail, mailing address, etc.)

9.3.2.3 Request for Qualifications

A Request for Qualifications (RFQ) also is not a contractual commitment. It is an opportunity for vendors, suppliers, and consulting firms to demonstrate to the public agency their qualifications in specific areas. The RFQ is typically redone every few years to ensure that the vendors remain qualified. Usually the prequalification process is used to limit the number of vendors that may potentially respond to a Request for Proposals. The basic format for an RFQ is comprised of the following elements.

General Information. Under this heading the following information is included:

- The Procuring Agency;
- Document Type;
- Solicitation Number;

- Posted Date; and
- Response Date

Contracting Office Address. Under this heading the address of the contract office is identified.

Point of Contact. Under this heading the name, address, telephone and e-mail address of the person responsible for managing the RFI process is listed.

Description. Information presented under this heading includes:

- Name of the agency responsible for project being procured;
- Name of the project;
- Summary of the project; and
- Purpose of the project.

Objective. Under this heading a detail description is presented of what the project is to accomplish and how success is to be measured. Typically a project will have multiple objectives.

Scope of Services: Under this heading the procuring agency identifies what services are being procured. The Scope of Services document usually includes:

- Project description;
- Services to be delivered;
- Client furnished information;
- Project management and reporting requirements;
- Schedule;
- Documentation and report requirements; and
- Project quality assurance procedures.

Development of the Scope of Services is a very critical element of the RFQ process. The better defined the scope of the project, the high the quality of responses received, and greatly likelihood the contracting agency will a product that fulfills their needs.

Respondent Requirements: Under this heading the format of the response document is described including: page length, specific forms, and number of copies. Additionally the procuring agency describes the concerns (i.e. criteria) associated with the selection process. This includes but is not limited to:

- Professional qualifications;
- Relevant firm experience for similar work;
- Experience of the project manager;
- Past successfully experience;
- Knowledge of locality of the project; and
- The firm's quality assurance/quality control program.

How to Respond. Under this heading the contracting agency instructs the respondent what medium to use when forwarding their response (i.e. e-mail, mailing address, etc.)

9.3.2.4 Request for Proposals

A Request for Proposal (RFP) is intended to lead to a contractual commitment. It seeks specific answers to specific questions that comprise a defined project. The basic format for an RFP is comprised of the following elements.

General Information. Under this heading the following information is included:

- The Procuring Agency;
- Document Type;

- Solicitation Number;
- Posted Date;
- Response Date;

Contracting Office Address. Under this heading the address of the contract office is identified.

Point of Contact. Under this heading the name, address, telephone and e-mail address of the person responsible for managing the RFI process is listed.

Description. Information presented under this heading includes:

- Name of the agency responsible for project being procured;
- Name of the project;
- Summary of the project; and
- Purpose of the project.

Objective. Under this heading a detail description is presented of what the project is to accomplish and how success is to be measured. Typically a project will have multiple objectives.

Scope of Services: Under this heading the procuring agency identifies what services are being procured. The Scope of Services document usually includes:

- Project description;
- Services being requested;
- Deliverable items (i.e. technical reports, plans, drawings, etc.)
- Client furnished information;
- Project management and reporting requirements;
- Schedule;
- Documentation and report requirements; and,
- Project quality assurance procedures;

Development of the Scope of Services is a very critical element of the RFQ process. The better defined the scope of the project, the high the quality of responses received, and greatly likelihood the contracting agency will a product that fulfills their needs.

Respondent Requirements: Under this heading the format of the response document is described including: page length, specific forms, and number of copies. Additionally the procuring agency describes the selection criteria and scoring techniques that will be used to evaluate and select the most qualified firm. Selection criteria may include but is not limited to:

- Professional qualifications;
- Relevant firm experience for similar work;
- Experience of the project manager;
- Past successfully experience;
- Knowledge of locality of the project; and
- The firm's quality assurance/quality control program.

How to Respond. Under this heading the contracting agency instructs the respondent what medium to use when forwarding their response (i.e. e-mail, mailing address, etc.)

CHAPTER TEN
Action Plan

10.1 OVERVIEW

In Chapters 2, 3 and 4, specific transportation operational and institutional issues were identified, which in turn served as the basis for selection of ITS services and definition of a National Architecture as presented in subsequent chapters. The purpose of this Chapter is to identify an action plan. This includes a Concept of Operations, a business plan, and an implementation plan. The Concept of Operations is the final step defining the ITS Architecture. The business and implementation plans tie together the financing and initial deployment plan. All are focused on what SCT and others need to do in the short term to help initiate ITS projects in Mexico.

The intent of this Chapter is to outline the next steps for Mexico in pursuing ITS projects. The elements discussed above include discussions of legal actions for agreements, further developing and maintaining regional architectures, and discussing financing possibilities.

10.2 CONCEPT OF OPERATIONS PLAN

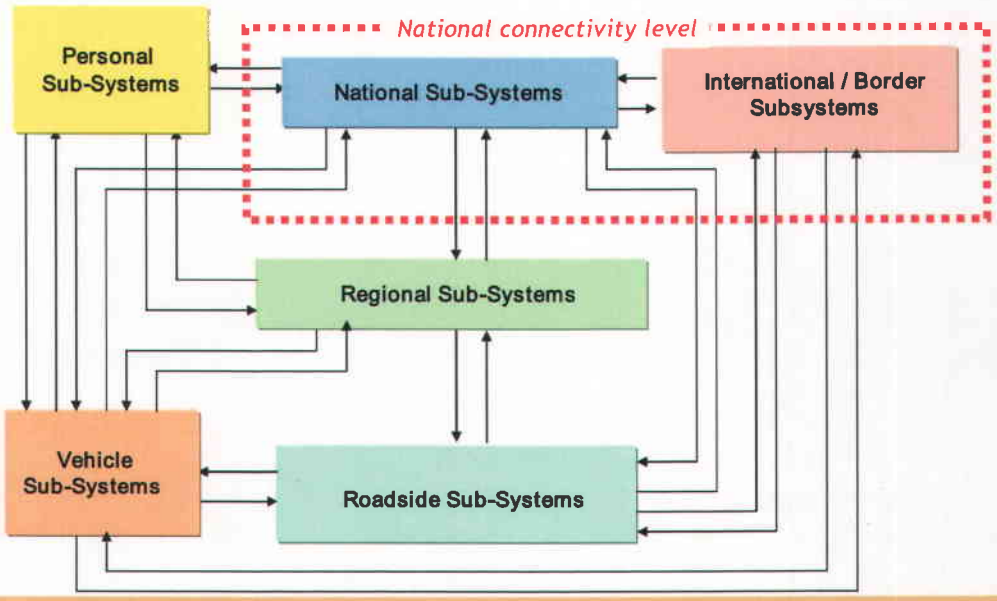
Following the Systems Engineering process, a Concept of Operations Plan is necessary to ensure that the various stakeholders know their roles and responsibilities within the identified project. For a national effort such as this project, that plan by necessity needs to be fairly high level. The following section provides the plan highlights.

For all responses, responsibility is defined as being the champion or lead that ensures that function is completed and/or provided. In many cases, that function may be done by a third party and costs may be shared in other ways.

10.2.1 National Level

The National ITS Architecture created for Mexico is unique in that it encompasses both national and regional components. This makes it easier to understand the relationships between the various levels of authority. It is also flexible in that it can easily migrate from this hierarchical approach to one that is more peer-to-peer over the long term.

Exhibit 10.1
National Level Connections



At the national level, there are responsibilities to all main sub-systems. The federal agencies own or manage all intercity routes, international border crossings and ports. They also interface with the regional and local systems where they match to federal facilities. Thus, individuals and local systems also interact with the federal systems. The federal operations responsibilities include the following:

Operations – the national level is responsible for operating and maintaining all intercity transportation. This includes highway and rail and the operations are either direct, or through a concession managed by SCT. All roadside equipment is included with the physical travel way. Additionally, the national level includes operations of all port and border crossing facilities. This is also done either directly by one of several agencies (SCT, Customs, Immigration) or by concession (e.g., many of the maritime port operations).

Interfaces/integration – the national level is responsible for providing interfaces (electronic or otherwise) or integrating electronic systems with all foreign agencies, including those from the U.S. and trading partners in Central and South America, Asia, and Europe. The national level is also responsible for providing connectivity between regional and state systems internal to Mexico. Additionally, the national level interfaces with the public and business entities related to the operations of those facilities and systems they operate.

Memorandums of Understanding – the national level is responsible for ensuring the appropriate agreements are executed in order to provide the services identified under the ITS Architecture. This includes all international agreements. It also includes regional agreements where national systems are involved. The exception is when regions are dealing directly with each other without a need to interface with national systems.

ITS Infrastructure – the national level is responsible for providing the appropriate communications between systems in order to provide the services identified under the ITS Architecture. This includes the following international communications:

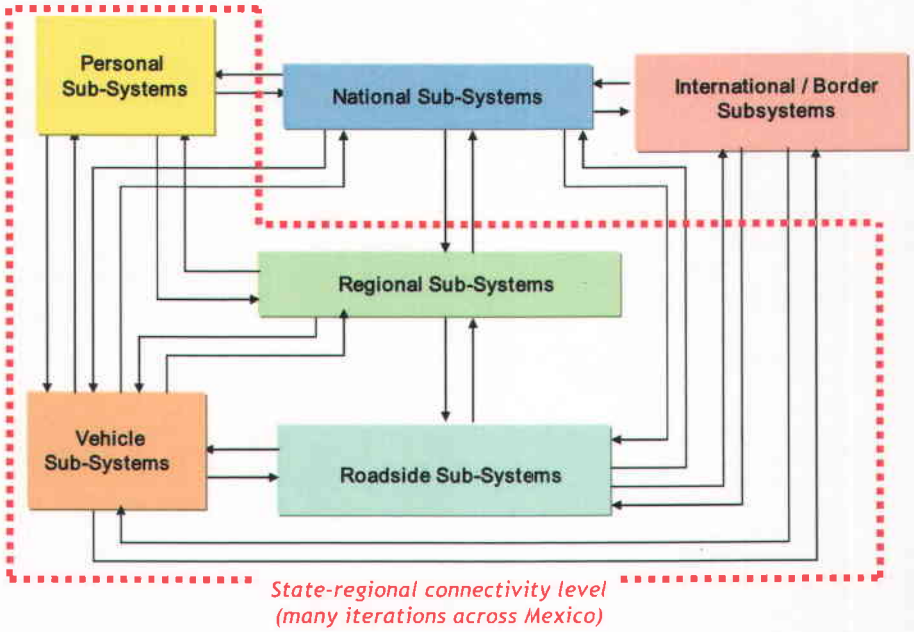
- Shared local communications with the U.S.
- National communications from border facilities to all necessary national resources
- All communications within a port
- Shared communications with shippers and countries using ports
- Shared communications with local shippers and carriers using the ports
- National communications from port facilities to all necessary national resources

Internal to Mexico, the national level is responsible for shared communications between national and local systems as well as connections with the public and media for nationally operated systems. Each operation is also directly responsible for communications with all field devices.

10.2.2 Regional Level

Much of traffic operations takes place at the regional level. All signal timing, all public passenger transit, signing, pavement markings, etc. are all addressed at the state or municipal level. This is also accomplished without significant standardization from the federal level. Therefore, many of the regions use a variety of systems and standards, but they all have a common level of responsibility.

Exhibit 10.2
Regional Level Connections



Operations – the regional level is responsible for operating and maintaining all state and local routes including both highway and rail. This can either be directly by the public agency or under concession. This also includes all public passenger transit systems.

Interfaces/integration – the regional level is responsible for providing interfaces (electronic or otherwise) or integrating electronic systems with national systems and between local entities within a region. Additionally, the regional level interfaces with the public and business entities related to the operations of those facilities and systems they operate.

Memorandums of Understanding – the regional level is responsible for ensuring the appropriate agreements are executed in order to provide the services identified under the ITS Architecture. This includes agreements with local operating agencies, industry, the media, and the public.

ITS Infrastructure – the regional level is responsible for providing the appropriate communications between systems in order to provide the services identified under the ITS Architecture. This may include shared communications with the national level or other systems and all communications required to interface with field devices.

10.3 Project Sequencing and Integration Strategy

As discussed in chapter 9, the initial program is meant as a starting point for Mexico. Individual projects will move forward at different paces than the plan indicates, new projects will be added, and some current projects will be removed.

However, in determining the sequencing of projects, the stakeholders need to use the Systems Engineering process and the ITS Architecture process to ensure that projects are developed in a logical and well designed manner. What is more important here is not the sequencing as applied to the initial plan, but the process used to determine this sequencing. It is this process that must be followed in the future.

The sequencing process can be summarized as follows:

1. Determine dependencies
2. Examine institutional issues
3. Determine partnerships
4. Decision maker buy in
5. Maintenance and operations

10.3.1 Project Dependencies

The first step is to determine the project dependencies. This starts with the service diagrams identified for a project. General descriptions of systems and terminators are already identified. The stakeholders have to examine existing and planned systems that fit the general descriptions and determine their status. For example, a national hazardous material tracking system may not be possible without the national database of hazmat drivers and containers. By identifying these dependencies, the user can identify which projects must be before others in the sequencing.

10.3.2 Institutional

Once the systems have been identified, the institutional issues must also be identified. It is often said that the technology issues are easy to solve, the institutional problems take much longer. This is generally true all over the world.

Examples of institutional issues include items such as a need for a signed agreement, or the priorities of the current leadership. It should be noted that the institutional issues will exist regardless of the leadership – it is always a matter of the value and level of the issues. Depending on the needs and focus of the institution, projects will be accelerated or delayed in the sequencing. For instance, many electronic toll collection projects require the existence of a national vehicle license database. However, the agency responsible for the database may have more pressing concerns with other higher value systems. The delays in accomplishing this project stem from very legitimate concerns within an agency to ensure they are making the most of their resources.

The best strategy is to encourage the spirit of cooperation and partnership, and recognize that the struggle to establish relationships and cooperation is a long-term effort that must be accomplished at many levels. This is best accomplished with a strong federal lead. For National projects, or those requiring coordination across multiple regions, either a single federal champion or multiple regional champions are necessary to move the project forward. This allows standards to be better implemented and promotes integration of projects.

As most of the operations of facilities are accomplished at the state level, there is also a need for champions at the state level. At this level, the coordination is more directed to operations. The champions need to ensure the projects accomplish their more basic goals. This includes meeting the goals of the host agency, and trying to meet the needs of other agencies that the individual projects must coordinate.

In all cases, a spirit of cooperation is important. It should be recognized that this is not always possible. It is usually easier at the operations level, but sometimes agencies have competing goals, whether intrinsic to their mission statement or temporary with current leadership or specific environments. It is important that in the attempt to establish cooperation and agreements, agencies be willing to stay focused on the long term. It may be necessary to wait for better conditions in which to negotiate an agreement. Agencies should try to avoid actions in the short term that may hurt longer term agreements.

10.3.3 Partnerships

Partnerships are really a subset of the institutional issues. As the various systems are identified, potential partnership opportunities become apparent. In general, partnership agreements with the private sector are much different than the inter-governmental agreements previously discussed. The private sector operates

on a different timeframe, and sees no need to keep long-term relationships unless beneficial to them. Again, they operate within their own legitimate operations concerns, so if an agreement begins to cost them significantly more, they may end the partnership.

Partnerships have the ability to bring additional resources to a project or region, but the cost is the need to move in a more timely manner. The availability of a partnership opportunity may change the location of a project within the sequencing process.

10.3.4 Decision-maker Buy-in

This is also a sub set of institutional issues. Public agencies often have regular turnover in the leadership. With new administrations come new priorities. Again, as the focus changes, the projects must be revisited and adjusted as necessary.

This is one of the single most important non-technical issues. It should be embraced as appropriate in order to advance those projects that become more favorable, as long as this is within the constraints imposed by other items,

10.3.5 Funding

Funding is discussed in more detail in one of the following sections. As users examine projects, they should be looking for opportunities to seek additional funding from other sources. Again, many funding opportunities come with schedule constraints. The sequencing needs to be adjusted to fully realize these benefits.

10.3.6 Integration strategy

As the dependencies are identified, an integration strategy should be developed. This is moving a little closer to the design of the system rather than its planning. From the service diagrams, data flows and standards are identified. Communication with the other project managers will determine the exact interpretation of the standards that were used for legacy systems, or will be used for future systems.

The following table lists the projects identified in the initial program. Additionally, descriptions of those types of projects that must occur prior to the subject project are provided, and descriptions of projects that will build from the subject project. As the projects will change, only descriptions are used.

Table 10.1
Relationships Between Projects

Predecessors	Service	Project/Program	Name	Future Dependencies
	SN-101 Vehicle hazmat and explosives monitoring	VACUS system for remote inspection of vehicles. Used at border crossings.	VACUS - border	Automated border crossings,
	SN-301 National data collection and sharing	Nationwide vehicle registration database (both commercial and private autos)	Vehicle Registration database	All security and payment related tracking systems
	SN-301 National data collection and sharing	Nationwide driver registration database	Driver Registration database	All security and payment related tracking systems
Several agencies must have systems they wish to connect, whether ITS or not	SN-302 National multi-agency cooperation	Establishing a secure and automated network for sharing and privacy	Secure agency coms	All future national systems
	SP-102 9-1-1/Mayday alert for public transport	Automated messaging to emergency responders if airbags are deployed	Public Transit Mayday	Future incident management and emergency response systems
	SP-104 Public transport surveillance	Cameras on vehicles recording information (no real time) - drivers download video when completing shift	Public Transit Surveillance	Future security initiatives
Fleet management for public sector vehicles	SP-202 Systems to monitor public sector fleet vehicles	Mayday systems	Public Fleet Mayday	Future incident management and emergency response systems
	SP-202 Systems to monitor public sector fleet vehicles	Lane change warning systems	Public Fleet Lane Departure System	
Fleet management for public sector vehicles	SP-202 Systems to monitor public sector fleet vehicles	Vehicle-based variable speed alerting and limiting systems	Public Fleet Equipment Management	

Predecessors	Service	Project/Program	Name	Future Dependencies
System surveillance on the transportation network	SE-202 Emergency vehicle – traffic management coordination	Real time travel information in emergency vehicles for better route selection - provided to central system and radioed to vehicles	Traffic Information for Police/Fire	
	SE-301 Hazmat vehicle tracking	AVL for Hazmat vehicles with national real time monitoring of hazmat vehicles and loads	AVL for Hazmat - System	All future Hazmat systems
AVL and fleet management for Hazmat	SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Driver initiated mayday notification	Manual Hazmat Mayday	Future incident management and emergency response systems
AVL and fleet management for Hazmat	SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated notification when airbags have deployed	Automated Hazmat Mayday	Future incident management and emergency response systems
AVL and fleet management for Hazmat	SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated notification when vehicle has detected a rollover	Automated Rollover Hazmat Mayday	Future incident management and emergency response systems
Hazmat database and secure communications	SE-303 Hazmat preclearance services	Preclear for hazmat vehicles at border crossings.	Hazmat Preclearance	automated border crossings,
National vehicle and driver databases	TC-101 Automated Credential Filing	Create a system for automated processing of Commercial vehicle	Automated Vehicle Credentials	All freight security and automated processing projects
National vehicle and driver databases	TC-102 Automated Commercial Vehicle Administration	One-stop shopping for all Commercial Vehicle	One Stop Permit Shopping	All freight security and automated processing projects
National vehicle and driver databases	TC-102 Automated Commercial Vehicle Administration	Automated Customs processing	Automated Customs	
National vehicle and driver databases	TC-103 Automated Border Crossings	Bypass at border crossings using toll tag technology	Automated Border Crossing	
National vehicle and driver databases	TC-203 Freight container tracking	Use of AVL to track container location	Container Tracking	All freight security and automated processing projects
	TC-203 Freight container tracking	Alerts for cargo shifting/spilling	Container Integrity	All freight security and automated processing projects

Predecessors	Service	Project/Program	Name	Future Dependencies
National vehicle and driver databases	TC-301 Vehicle and container arrival information exchange	Automated information exchange between shippers and carriers	Port Management System	Freight efficiency projects
National vehicle and driver databases	TC-301 Vehicle and container arrival information exchange	Improved coordination with various modes of transport available to a shipper.	Container Management	Freight efficiency projects
Port management system	TC-302 Customer freight information access (users are customers and shippers)	Customer access to location information in real time.	Container Bulletin Board	Future improvements in customer service
Port management system	TC-401 Intermodal center facility management	Automated access control	Port Access Control	All freight security and automated processing projects
Port management system	TC-402 Intermodal vehicle and container control	AVL to track containers within a facility	Port Management System 2	All freight security and automated processing projects
Dangerous goods database	TC-503 Dangerous Goods movement fleet coordination	Detection and verification of route deviation	Dangerous Goods Tracking	All dangerous goods security and automated processing
Dangerous goods database	TC-504 Dangerous Goods movement police / safety coordination	Automated sharing of goods information with local law enforcement when there is an incident (enhancement to TC-503)	Dangerous Goods Incident Management	Future incident management and emergency response systems
National vehicle and driver databases	TC-601 Remote access to commercial vehicle safety data	Automation of vehicle and container records	Commercial Vehicle Data Sharing	All freight security and automated processing projects
National vehicle and driver databases	TC-601 Remote access to commercial vehicle safety data	Automate sharing of records with local law enforcement (assuming TC-601 is in place)	Commercial Vehicle Data Sharing	All freight security and automated processing projects
National financial database or system	PE-101 Electronic transit fare payment	Use of smart cards for all public transit payments (fixed rail)	National Rail Card	
National financial database or system	PE-101 Electronic transit fare payment	Use of smart cards for all public transit payments (Bus)	National Bus Card	

Predecessors	Service	Project/Program	Name	Future Dependencies
National financial database or system and national vehicle and driver database	PE-102 Electronic toll collection	Use of a single standard throughout all of Mexico	Super IAVE	
National financial database or system	PE-103 Electronic parking payment	Use of toll tags to pay for parking	National Parking Card	
National financial database or system	PE-202 Integration of regional multi-modal payment systems	Allow smart cards to be used on all modes of public transit.	National Transit Card	
	GOT-101 Traffic Monitoring	Deployment of sensors along routes	Roadway Monitoring	All future systems that depend on real time traffic information
	GOT-101 Traffic Monitoring	Deployment of cameras at strategic locations	Video Surveillance	All future incident management and security systems
	GOT-101 Traffic Monitoring	Monitoring of ETC users travel times for non-enforcement purposes	IAVE Travel Times	All future systems that depend on real time traffic information
Roadway monitoring and surveillance	GOT-103 Freeway Control	Deployment of lane control systems	Freeway Lane Control	
Roadway monitoring and surveillance	GOT-103 Freeway Control	Dynamic speed limits	Dynamic Speed Limit	
Roadway monitoring and surveillance	GOT-106 Traffic Information Dissemination	Deployment and use of DMS for incident and congestion information	DMS deployment	
Roadway monitoring and surveillance	GOT-106 Traffic Information Dissemination	Deployment and use of HAR for incident and congestion information	HAR deployment	
Roadway monitoring and surveillance	GOT-107 Coordination of Surface Street and Freeway Control	Dynamic travel time or congestion information approaching freeway entrances	Travel Times at Ramps	
Air quality monitoring systems	GOT-204 Air Quality-based transport management	Restricted access to areas based on air quality and access granted by electronic tag	Air Quality Road Pricing	

Predecessors	Service	Project/Program	Name	Future Dependencies
	GOT-306 Work Zone Safety Management	Provide information on maintenance and lane closure activities to the media	Freeway Lane Closure Information System	All advanced traveler information systems
	GOT-401 Incident On-Site Motorist Assistance	Green Angels Service patrols in urban areas	Urban Green Angels	Future incident management and emergency response systems
	GOT-401 Incident On-Site Motorist Assistance	Increased training for local police and other staff in motorist aid	Motorist Aid Training	Future incident management and emergency response systems
	GOT-402 Incident On-Site Traffic Management	Increased training for local police in incident management	Incident Management Training	Future incident management and emergency response systems
	GOT-402 Incident On-Site Traffic Management	Incident command vehicle	Incident Command Vehicel	Future incident management and emergency response systems
Existing CAD systems	GOT-403 Incident and Event Coordination	Integration of response agency dispatch computers	Integrated CAD systems	Future incident management and emergency response systems
Air quality monitoring systems and traffic management centers	MA-203 Pollution Monitoring	Monitoring of air quality integrated with traffic management centers	Air Quality Integration with Management Centers	
	TP-201 Paratransit Fleet Dispatch	Automated dispatch of nearest vehicle	CAD for Paratransit	Dynamic Paratransit Assignment
AVL and CAD for Paratransit vehicles	TP-2-202 Dynamic Ridesharing	Dynamic routing of paratransit to allow for en-route changes to add riders	Dynamic Paratransit Assignment	
Roadway monitoring and surveillance	IV-101 Pre-Trip Information – Traffic and Roadway	Real time congestion information on major roads by internet, TV, media	Major Roadway Incident Information	
AVL for public passenger transit	IV-102 Pre-Trip Information – Public Transport (bus and rail)	Schedule adherence information by internet, TV, media	Schedule Adherence Information	
Roadway monitoring and surveillance	IV-201 On-Trip Information – Roadside	DMS with real time incident messages	DMS Incident Messaging	

Predecessors	Service	Project/Program	Name	Future Dependencies
Roadway monitoring and surveillance	IV-201 On-Trip Information – Roadside	HAR with real time congestion information	HAR Congestion Information	
AVL for public passenger transit	IV-203 On-Trip Information – Public transport vehicle	Scrolling electronic banner on bus with stop/location information	Next Stop DMS	
Roadway monitoring and surveillance	IV-205 On-Trip Information through mobile devices	Messages sent to pagers with real time incident information on chosen route	Incidents to Mobile Phones	
Roadway monitoring and surveillance	IV-205 On-Trip Information through mobile devices	Ability to download real time congestion maps over mobile phone	Travel Times to Mobile Phones	
Roadway monitoring and surveillance	IV-303 Travel Services Information – Dedicated location	Broadcast information for service areas on low power HAR	Local HAR	
AVL for public passenger transit	IV 601 - Public Transit Fleet Data for Planning Purposes	Provide automated rider counting systems linked to a central database	Automated Ridership Integration	

10.4 Identify Agreements

The structure of the Mexican government is generally centralized. Most policies and agendas are established at the national level. However, it is the state and local entities that are responsible for all operations of systems. This issue was discussed in detail in chapter 3. Still, agreements are necessary either between agencies or between agencies and other stakeholders.

When is an agreement required? As required for agencies to perform operations of an ITS project(s) in the architecture, including funding channels, ITS project interoperability, and use of standards. Generally, an agreement is needed between entities involved in information exchange. This can be determined through the identification of connections between systems in an ITS architecture, which represents cooperation between stakeholders. However, an agreement may not be necessary for every single connection between systems in the architecture, or funding channel, etc. One agreement or master agreement, or possibly an extension to an existing agreement, may accomplish what is necessary to support many or possibly even all connections between agencies in an architecture.

A list of required agreements can be compiled based upon the connections in the architecture and other needs, i.e. funding, cooperation in operations. Then existing agreements between the agencies identified in the list of required agreements should be gathered that support sharing of information, funding, or specific ITS projects. A review of each agreement can then be made to determine whether the existing agreement can be amended or modified to include additional new requirements for cooperation identified in the architecture. If current agreements are not sufficient to meet the needs, at least until more specific operational agreements can be made in the future, then new agreements will be required. Since new agreements can take considerable time, a handshake agreement or a Memorandum of Understanding may suffice to move the ITS process along in the interim. These are discussed further under the ITS Business Plan section.

The number, level of formality, and structure of agreements must be determined by the agencies involved. There are several types of agreements that can be considered for ITS projects:

- Handshake agreements can serve as early agreements between one or more partners if they are agreeable; however, are not recommended for long-term operations or ones involving large financial commitments.
- Non-binding Memorandum of Understanding (MOU) may be considered for certain situations too, including:
  - An initial agreement used to provide minimal detail (not technology prescriptive) and demonstrate a general consensus amongst regional or project partners when developing ITS plans and architectures. As formal agreements can take considerable time, an MOU may help progress a project or architecture development.
  - Used to expand a more detailed agreement like an Interagency agreement which may be broad in scope but contains all the standard contract clauses required by the specific agencies.
  - Serve as a mean to modify a much broader Master Funding Agreement, allowing the master agreement to cover various ITS projects throughout a region, and the MOUs to specify the scopes of the projects.
- Interagency Agreements are between public agencies (e.g. highway agencies, transit agencies, states, counties, cities) for operations, services or funding, and document responsibilities, functions and liability.
- Intergovernmental Agreements are between governmental agencies (e.g. universities and SCT or states, planning authorities and states).
- Operational Agreements are between any agency involved in funding, operating, right-of-way of another public or private agency that identifies respective responsibilities for all activities associated with shared systems being operated and/or maintained.
- Funding Agreements document the funding arrangements for ITS projects including, at a minimum, standard funding clauses, detailed scopes, services to be performed, detailed project budgets, etc.
- Master Agreements are standard contracts for an agency which serve as a master agreement for how all business is to be done. These can be found in the legal departments of many public agencies. These allow agencies that do business with the same agencies over and over to have one *Master Agreement* that uses smaller agreements (e.g. MOUs, Scope of Work and Budget Modifications, Funding Agreements, Project Agreements) to modify or expand the boundaries of the larger agreement to include more specific verbiage.

There are existing agreements throughout Mexico. Several ITS agreements exist with the U.S. and the border states. Agreements also exist at the local level between a variety of public and private entities. A prime example is the multi-agency cooperative agreement in Monterrey for the operation of the traffic signal system. There exists an agreement between the agencies for sharing the costs, as well as an agreement with the concession to operate the system. Other agreements exist for demonstration projects such as the CVOIS effort in the Tijuana area.

10.5 Regional Architectures

The National Architecture is the definitive framework that will guide deployment of ITS in Mexico for the next 20 years or more. This will help assure consistency and inter-operability between deployments in various regions through the use of mutual standards. It is a very complete framework of ITS services. However, it is independent of any specific system design or region in Mexico, and many ITS projects will

be implemented in regional or local deployments. Since most transportation projects are deployed regionally or locally, a regional ITS architecture can serve as an effective tool to support the planning and project development process. This will help foster regional integration, leading to successful and cost efficient ITS deployments.

A regional or local architecture is recommended anytime there is a need or ITS project to exchange information between two or more systems within a region. A regional ITS architecture is a specific regional framework for ensuring institutional agreement and technical integration for the implementation of ITS in a particular region. Every region has unique needs, and a regional ITS architecture can help use the ITS information to better manage and operate their transportation systems. The regional architecture should involve all potential stakeholders in the overall ITS program. This will involve a diverse array that may not normally participate in the tradition transportation planning process, in the overall ITS program.

To assure cost effective ITS deployments, the SCT should require a regional ITS architecture be developed prior to the implementation of an ITS project in a region that is to be at least partially funded by the SCT. Furthermore, the deployment should be preceded by a project architecture that conforms to the regional and national architectures before receiving approval by the SCT. The development of these architectures are not minor efforts, therefore, realistic timeframes for their development should be built into the ITS program schedules.

The regional architecture should use the national architecture as a resource and the basis for creating the regional architecture for national consistency and inter-operability purposes, as many ITS applications may occur on a national perspective, and a significant savings in time and money can be realized.

The regional ITS architecture should fit within the broader context of the regional transportation planning and project development process. If a proposed ITS project is not situated in a location that falls within a regional planning authority, a project ITS architecture should be developed so that follows similar guidelines as a regional architecture, and conforms to the national architecture.

The recommended guidelines to follow in the regional ITS architecture development process are almost the same as with the national ITS Architecture. Much of this work has already been accomplished for the regions under this project. The following clarifies the individual steps:

1. Architecture Initiation
   - 1.1 Identify Needs of Architecture – Why does the region want to deploy ITS?
   - 1.2 Define Region – the boundaries for regional deployments
   - 1.3 Identify Stakeholders – all institutions and people involved should be represented, along with "ITS Champions" to take leadership roles (include SCT representative)
2. Gathering Information
   - 2.1 Inventory existing and planned systems – identifies the current scenario
   - 2.2 Determine the needs and services desired – based on gaps in the current scenario
   - 2.3 Develop an operational concept – roles of stakeholders to operate the ITS
   - 2.4 Define functional requirements – how shall the ITS deployment operate
3. Define System Interfaces
   - 3.1 Start with the National ITS Architecture and Services
   - 3.2 Identify system interconnects – what systems are required to share information
   - 3.3 Define information flows – what specific information must be transmitted on each interconnect
4. ITS Implementation Plan
   - 4.1 Define project sequencing – based on funding limitations, priorities and project dependencies
   - 4.2 Develop list of needed agency agreements – as needed for required operations
   - 4.3 Identify ITS standards – as needed to assure consistency and inter-operability
5. Use the Regional Architecture for project deployments and operations
6. Maintain the Regional Architecture

In Chapter 2, 7 regions were defined. In Chapter 4, the inventories and initial ITS assessment were provided for each region. The Chorizo diagram created for Mexico includes the regions in the architecture. Appendix E shows versions of each diagram for each of the seven regions, with the particular elements for that region highlighted. Each diagram represents a starting point from which more detailed regional architectures can be built. The following table of services is matched to each region. The X indicates that such a service may be possible within the region. A timeframe matching the short term is illustrated. The long-term goals of most regions are nearly identical, with almost all services within the Architecture desired within twenty years. The regional Architecture should use these services as a starting point.

Table 10.2
Services by Region

Corridor	Central region to Nogales and Mexicali	Guadalajara to Pacific ports	Central region to Chihuahua	Central region to Monterey	Central region to Yucatan penninsula	Central region to Chiapas	Central region
Service \ Región	1	2	3	4	5	6	7
SN-101a Vehicle hazmat and explosives monitoring at the border	X		X	X			
SN-101B Vehicle hazmat and explosives monitoring mobile application		X			X	X	
SN-301 National Data Collection and Sharing	X	X	X	X	X	X	X
SN-302 National Multi-agency Cooperation	X	X	X	X	X	X	X
SP-101 Silent Alarm	X	X	X	X	X	X	X
SP-102 Mayday Alert for Public Transport		X					X
SP-104 Public Transport Surveillance		X					X
SP-202 Systems to Monitor Public Sector Fleet Vehicles		X					X
SP-401 Intelligent Intersection							X
SE-101 Automated Mayday Dispatch					X		
SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring	X	X	X	X	X	X	X
SE-201 Emergency Vehicle Fleet Tracking							X
SE-202 Emergency Vehicle - Traffic Management Coordination							X
SE-301 Hazmat Vehicle Tracking	X	X	X	X	X	X	X
SE-302 Automated Hazmat Mayday							
SE-303 Hazmat Preclearance							
SV-204 Automated Cruise Control							
SV-301 Longitudinal Collision Avoidance							
SV-302 Lateral Collision Avoidance							
SV-401 Vehicle Internal Systems Monitoring							
TC-101 Automated Credential Filing	X		X	X			X
TC-102 Automated Commercial Vehicle Administration	X		X	X			X
TC-103 Automated Border Crossing	X		X	X		X	
TC-201 Commercial Vehicle Fleet Tracking	X	X	X	X	X	X	X
TC-202 Commercial Vehicle Fleet Dispatching	X	X	X	X	X	X	X
TC-203 Freight Container Tracking	X	X	X	X	X	X	X

Corridor	Central region to Nogales and Mexicali	Guadalajara to Pacific ports	Central region to Chihuahua	Central region to Monterey	Central region to Yucatan penninsula	Central region to Chiapas	Central region
TC-301 Vehicle and Container Arrival Information Exchange	X	X			X	X	
TC-302 Customer Freight Information Access	X	X			X	X	
TC-401 Intermodal Center Facility Management	X	X			X	X	
TC-402 Intermodal Vehicle and Container Control	X	X	X	X	X	X	X
TC-501 Special Goods Movement Data Sharing							X
TC-502 Special Goods Movement Data Registry							X
TC-503 Special Goods Movement Fleet							X
TC-504 Special Goods Movement Police/Safety Coordination							X
TC-601 Remote Access to Commercial Vehicle Safety Data							
TC-602 Monitoring Vehicle Loads	X		X	X			
TC-701 Commercial Vehicle Internal Systems Monitoring							
TC-702 Commercial Vehicle Driver Alertness Monitoring							
PE-101a Electronic Transit Fare Payment (Light Rail)		X					X
PE-101b Electronic Transit Fare Payment (bus concessions)		X					X
PE-102 Electronic Toll Collection	X	X	X	X	X	X	X
PE-103 Electronic Parking Payment							
PE-202 Integration of Regional Multi-modal Payment Systems							
GOT-101 Traffic Monitoring		X					X
GOT-102 Surface Street Control		X	X	X			X
GOT-103 Freeway Control		X					X
GOT-104 Preferential Treatment for Traffic Control	X	X	X	X	X	X	X
GOT-105 Reversible Lane Management							
GOT-106 Traffic Information Dissemination	X	X	X	X	X	X	X
GOT-107 Coordination of Surface Street and Freeway Control							
GOT-108 Intermodal Highway Junction Management							X
GOT-109 Parking Management							
GOT-110 Work Zone Traffic Management	X	X	X	X	X	X	X
GOT-201 Variable Road Pricing							
GOT-202 Access Management							
GOT-204 Air Quality Based Transport Management							
GOT-301 Roadway Construction and Maintenance Management							
GOT-303 Pavement Management	X	X	X	X	X	X	X

Corridor	Central region to Nogales and Mexicali	Guadalajara to Pacific ports	Central region to Chihuahua	Central region to Monterey	Central region to Yucatan penninsula	Central region to Chiapas	Central region
GOT-304 Bridge Management	X	X	X	X	X	X	X
GOT-305 Automated Road Management							
GOT-306 Work Zone Safety Management	X	X	X	X	X	X	X
GOT-307 Utility and Infrastructure Management							
GOT-401 Incident On-Site Motorist Assist	X	X	X	X	X	X	X
GOT-402 Incident On-Site Traffic Management	X	X	X	X	X	X	X
GOT-403 Incident and Event Coordination	X	X	X	X	X	X	X
GOT-404 Hazardous Materials Monitoring and Management							
GI-201 Disaster Response Planning for Transport Network	X	X		X	X	X	X
GI-301 Disaster Response Coordination	X	X		X	X	X	X
MA-101 Road Weather Information Monitoring							
MA-201 Water Level / Tidal Monitoring and Prediction							
MA-203 Pollution Monitoring		X		X			X
TP-101 Public Transport Vehicle Internal Systems Monitoring							
TP-102 Public Transport Vehicle Fleet Tracking							X
TP-201 Paratransit Fleet Dispatch							
TP-202 Dynamic Ridesharing							
IV-101 Pre-Trip Information - Traffic and Roadway	X	X	X	X	X	X	X
IV-102 Pre-Trip Information - Public Transport	X	X	X	X	X	X	X
IV-201 On-Trip Information - Roadside	X	X	X	X	X	X	X
IV-203 On-Trip Information - Public Transport Vehicle							
IV-302 Travel Services Information - Personal Interactive							
IV-303 Travel Services Information - Dedicated Location	X		X	X			X
IV-602 Current Utilization Levels from Public Transport Information Systems							

10.6 ITS Business Plan

Much of the ITS Business Plan has already been discussed in Chapters 5 and 9. This process is more of a formalization of steps than a new plan. Various agencies throughout Mexico have already been successfully implementing ITS for many years, so much of what is discussed here is already known to them. The basic elements of the plan are as follows:

- Procurement Guides
- Legal Actions necessary to execute ITS Projects
- Agreements Required/Standard Agreements

- ITS Project elements (Design, Deployment, and Operations)
- Testing / System Acceptance / Independent Verification &Validation (IV&V)
- Updating Mexico ITS Architectures
- Financial Impacts/Considerations (Section Five)
- Training

The business plan represents a general approach intended to provide the greatest likelihood of success. Numerous individual elements, including current financing, executive goals, interagency relationships, and many others, will require adjustments in the actual plan, but the basic elements should remain intact.

10.6.1 Procurement Guide

Chapter 9 identified the basic elements for procurement. There are several steps that may be summarized from Chapter 9 to provide a guide or approach.

- Find quality firms
- Write good Requests for Proposals (RFPs)
- Ensure Systems Engineering is included
- Choose the right form of contract

Chapter 9 identified numerous vendors within the ITS community. It also discussed the value of a Request for Qualifications (RFQ). The RFQ process allows the contracting agency to secure a list of firms or vendors that have the necessary skills for a project before advertising the project. Responders are asked to provide proof of qualifications in similar efforts. The procuring agency can do an RFQ prior to each project, or once every few years. In either case, as long as the agency restricts procurement to those firms pre-approved, they can have confidence in the outcome of the project.

Again, Chapter 9 explained the RFP process and the elements that make a good RFP. While there are many elements that have to be included, the key elements are the goal, the scope of services, and the requirements. The intent of each is to ensure the responders understand what services you require, and to provide the best possible answers. It is desirable to have the responses in a common format so the procuring agency can properly compare all responders.

The Systems Engineering approach has been discussed throughout this entire project. It is key for ITS projects as it documents decision making from the earliest stages. Again, all ITS projects are required to use this process in the United States and other countries.

There are several different forms of contracts. The basic elements relate to payment and deliverable. A well defined scope of services with payment tied to specific documented accomplishments is key. The intent is to ensure that both parties completely understand what is to be delivered and then work together. This is true whether the project is publicly or privately financed. Smaller tasks are easier to track than larger tasks, so reviews at deliverables can be beneficial to both sides. The importance of the contract is that it defines the relationship for the duration of the project.

For programs rather than projects, the Systems Engineering approach is still valid, but an on-call or task order contract may be more appropriate. The agency hires a qualified firm and then negotiates smaller scopes and prices for individual tasks. On the larger projects, it may be of value to have either a project manager or system manager hired separately from the primary contract. The second contract is for additional technical staff to provide oversight on the more complex issues. For software projects, it is extremely critical that the agency allow for considerable time with the project manager and developer. The agency project manager should be with the developer a minimum of 10% of the time (weekly, not overall contract). That means the agency needs to make their staff available, and be willing to pay for the contractors staff to be available. This increased management time is the single greatest factor in software success. Finally, on complex projects the agency should consider Independent Verification and Validation

(IV&V). This is a separate contract for a firm to come in and ensure that the developer is meeting all of the requirements from the Systems Engineering process.

While many ITS projects have considerably more overhead and management than typical civil projects, their complexity usually requires and justifies the expense. As has been shown in Task 8 and earlier in this report, ITS projects build upon each other and integrate with other projects. Extra time spent up front on good design and implementation yield significant savings over the long term.

10.6.2 Legal Action

In Chapter 3, the legal issues were reviewed. At that time, it was determined that there were no legal obstacles for the future procurement and deployment of ITS in Mexico. As of the time of this report, this remains true.

It is always best to involve legal departments early on in the planning process. Many agencies have not deployed ITS projects yet, and these projects often do not fit nicely within the common parameters of typical roadway construction. As a partner, the legal offices may be able to guide the developers around specific agency related issues or local regulations. The intent is not to change or break laws, but to accomplish the tasks within the limits of existing laws whenever possible.

The only exception is in some operational issues. For instance, some jurisdictions make an agency liable for damage to a vehicle they tow off a roadway, even if it is blocking a major lane on a high volume facility. These issues become identified as agencies operate systems. When appropriate, the agencies should work with their legal departments to seek changes in laws that help the operators better serve and protect the general public.

Concerning software, intellectual property rights are a large issue. For single applications and "black box" systems, this is not an issue. For example, an agency does not need the rights to see and modify software operating a camera. However, for those management center or database projects where an agency is expecting to evolve the system, full rights of the public agency are critical. An agency should not be afraid to go to a second or third vendor if the first selected vendor will not give them the real ability to modify and enhance portions of the software.

10.6.3 Interagency Agreements

Agreements were discussed in detail in Section 3 under the concept of operations. Each project will need to identify what stakeholders will have a real responsibility for each project, and work out the appropriate agreement. Real responsibility is defined as providing information or a service on a regular basis. This would include items such as sending lane closure information daily, or providing real time traffic congestion. This does not necessarily include attending meetings and supporting the project publicly.

10.6.4 Project Elements

During the project cost development phase, each project identified in the program had several initial cost estimates developed. These costs addressed such issues as developer time for both senior and junior level staff, monthly utility costs, increased staffing costs, equipment costs including life-cycling, as well as additional issues. Projects were then assembled as demonstrations, initial deployments, and full scale deployments. Demonstrations are small projects focused on a specific area and test of technology or institutional issues. The initial deployment is a full deployment in one location that is completely funded for 2 years (all staffing and utilities included). In many cases, the initial deployment and the demonstration are the same project. A full deployment includes all aspects of a deployment in all locations across all of Mexico. In many respects, the full deployment cost is unrealistic in that no nation has completed deployed a single technology in every possible location. Rather, it represents an extremely high level value that illustrates what a full scale deployment could cost.

Again, these costs are specific to the individual projects. If the Systems Engineering approach is applied correctly in a more detailed design process, the project elements will be properly defined. As a project is developed, there will likely be changes that are required. Again, through the Systems Engineering process, the agency and the vendor can determine what requirements must still be met, and what requirements can be waived in lieu of additional or different services. It is important that the agency be willing to work with the vendor to address new challenges, but not allow the vendor to fail in meeting the requirements of the project.

10.6.5 Testing / System Acceptance

The ITS testing stage overlaps the implementation stage. It involves three levels of testing:

- *unit testing*, i.e., the testing of individual pieces of the system, as soon as any pieces are available from the contractor or supplier.
- *string or integration testing*, which ensures that individual pieces work together as intended and which tests interfaces at the lowest level within the system.
- *system testing*, which involves a full end-to-end test of the complete system and comes in two major "flavors." The first is the final integration test by the system developer (whether that's the agency or a hired contractor).

System acceptance follows testing. This is where the end user(s) of the system make sure that the system does what it is supposed to do. During this stage, you test the completed system prior to putting it into production use. Users and operators should participate in the system acceptance process. During this stage, in preparation for the system acceptance process, you must train the users and operators of the system so they understand how to use it to do their jobs. Independent resources who were not involved in the system deployment and integration stages are highly recommended to perform verification and validation for the client agency.

10.6.6 Training

ITS involves applying information technologies and many other non-traditional skill sets to the transportation industry. Traditionally, highway agencies have focused on roadway planning, design, construction and maintenance. However, building and maintaining roadway capacity alone is not meeting the transportation needs in a satisfactory manner.

Transportation agencies need to create a transportation workforce of the future by building state-of-the-art ITS knowledge and skills. An ITS curriculum should be developed for Mexico with the following evolutionary levels of training:

- Awareness of ITS (i.e. National Architecture, Overview of various ITS Applications)
- Implementing and Managing ITS (i.e. Developing Regional Architectures, Systems Engineering, Managing ITS projects, Procurement and Software Acquisition of ITS, System Configuration Management, Standards)
- Specialized ITS (i.e. Telecommunications, Operations and Incident Management, Simulation Modeling, Specialized Applications)

Training needs should be based on the ITS projects to be implemented by an agency and the life cycle stage of a project, along with the resource capabilities of a particular agency. Each agency must assess its own individual needs, as they will be different throughout the country. The training assessment will help identify the gaps in their resources, and lead to selection of an appropriate training curriculum.

10.7 ITS Implementation Plan

The Mexico ITS Action Plan has three main components that make up the plan. The first is the process, the second is the projects themselves, and the third is the financing. Together these components illustrate

a path for Mexico to properly program, design, and build ITS projects in a logical and cost effective manner.

This project has generated a wealth of information about Mexico, and has developed the Mexico ITS Architecture. The process used for developing the initial ITS Architecture is more complex than the process to either develop regional ITS Architectures or to maintain the Architecture. Still, the larger national effort illustrates the basic steps. These steps are also very similar to the initial steps of the Systems Engineering process. They can be summarized as follows:

Step	ITS Architectures	ITS Projects
1. Inventory	Build and maintain a national database of systems and projects including contact information for owners or operators	Detail list of field elements including model numbers, and other systems with which to integrate including center to center standards utilized
2. Gather Stakeholders	Identify and maintain a list of the major national stakeholders which will include the major regional stakeholders	Identify the operations level staff for systems with which the project will integrate and any executive level staff necessary for agreements
3. Vision / Goals / Objectives	Identify and maintain the vision, goals, and objectives including any necessary modifications	Determine the scope of the project, including goals and objectives
4. Requirements	Identify and maintain the high level requirements for the ITS Architecture	Use the Systems Engineering process to develop the detailed system requirements. This includes matching the ITS Project requirements to the appropriate ITS Architecture
5. Design	Not applicable	Use the Systems Engineering process to develop the detailed design for the system
6. Build	Not applicable	Procure qualified vendors and ensure they meet the requirements of the system.
7. Maintain	Review the ITS Architecture on a recurring basis making changes at all applicable levels	Maintain and operate system. Use knowledge to help create requirements for next generation of the system.

This table illustrates the main tasks required to implement the process portion of the Implementation Plan. Agencies should recognize the two phase commitment. First, at the planning level, to commit to maintaining a current ITS Architecture (whether regional or national). The ITS Architectures will be used by the ITS Project developers in step 4. By maintaining accurate system identifications and standards, the ITS design team can properly develop the requirements to best guarantee interoperability.

10.7.1 ITS Projects

In Chapter 9, the initial program was proposed. This program was intended as a starting point for Mexico. The projects contained within the program addressed every service that was identified as part of the Mexico ITS Architecture. Individual agencies to implement these projects were not identified. However, the program did identify general timeframes for when various projects may be most likely to begin.

Earlier in this report, the individual cost elements were discussed. It is important to identify reasonable costs for the projects in order to help refine the plan. Costs were identified to an appropriate level of detail without a specific detailed scope of work. As individual projects are identified for implementation, the participating agencies should reexamine the costs and determine more accurate levels of funding necessary.

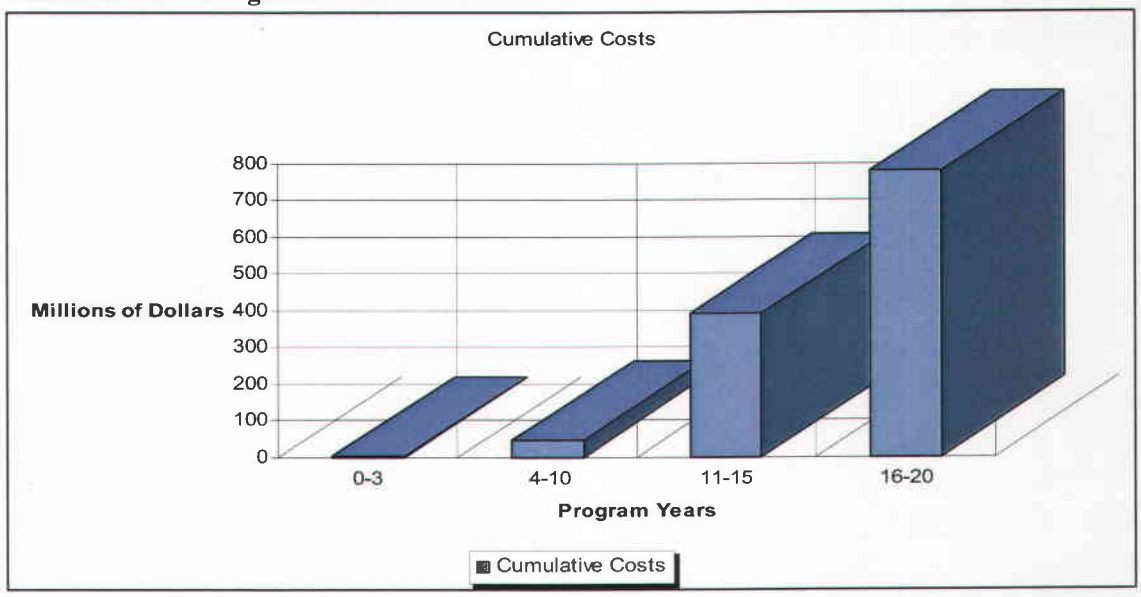
Using the initial program and the project cost elements, an initial estimate of funding has been created. The program identified four categories for projects – early winner/early start, short term, medium term, and long term. In Chapter 9, they were identified as follows: early winner 0-2 years, short term 3-7, medium term 8-13, and long term 14-20. For this document, those years have been modified to create more logical break points. The new program assumes that the early winner and short term projects are addressed in the first ten years, medium in the next five, and long in the last five years. The general description of the categories are as follows:

- Early Winner/Early Start
  - One of the three chosen Early Winner Projects
  - Locations where legacy systems already exist and are being modified
  - Locations where other demonstration projects are ongoing
  - Between programming and project execution, a minimum of 3 years
- Short Term
  - High value projects
  - High priority from the stakeholders
  - While many could be considered Early Starts, they should wait for deployment until the Early Winner projects are operational so the agencies can gain experience with ITS projects
  - While after the early winner early start projects, they should go from 4-10 years
- Medium Term
  - High value projects with a low stakeholder priority
  - Lower value projects with a high stakeholder priority
  - Projects that require predecessor efforts be completed first
  - These are the projects that will be addressed after many of the initial efforts are long complete, 11-15 years
- Long Term
  - Projects that should be included in the architecture process, but have little support or little real value for the foreseeable future
  - 16-20 years

Each project had its various appropriate components assigned to one of these categories. That is, some projects are projected to achieve full deployment within 20 years, while others will only be starting the demonstration phase. The combination of the program and the project costs generates an initial cost structure for the next 20 years. A simple summing of high level costs results in the following summary:

- Early Winners / Early Starts - $2.2 Million
- Short Term - $40.9 Million
- Medium Term - $346.3 Million
- Long Term - $390.9 Million
- Total 20 year deployment - $780.4 Million

Exhibit 10.3
Cumulative ITS Program Costs



There are some severe limitations of this simple analysis. For one, it assumes an entire program is completed. Most likely, deployments will continue in various areas well beyond the 20 year horizon assumed here. Therefore, the costs are not distributed as they should. Second, this assumes that every single project will be implemented. When the stakeholders review and refine this program, they will cut some projects and add others. Assumptions on spending beyond the first few deployments is more speculative.

The real value of the initial program is in the Early Winners/Early Starts and the short term list. These are the projects that have been identified to have good potential for success or to be of high value to the transportation community. There cumulative total over ten years is $43.1 million dollars, for an annual program of about $4M dollars. It should be noted that $17M dollars of the initial list of projects is from three individual projects – National Rail Card, Roadway Monitoring, and Video Surveillance. A less aggressive application of these three projects would result in a ten year program of approximately $30M dollars, or $3M per year.

The following list contains the ITS Services and the individual projects that have been associated with early starts or short term commencement. For most of these, the efforts within the first 10 years will be generally demonstration projects with a few initial deployments.

Table 10.3
Services and Initial Projects

Service	Short Term Projects
SN-101 Vehicle hazmat and explosives monitoring	VACUS - Border
SN-101 Vehicle hazmat and explosives monitoring	VACUS - Mobile
SN-301 National data collection and sharing	Vehicle Registration database
SN-301 National data collection and sharing	Driver Registration database
SP-101 Silent alarm	Public Transit Silent Alarm
SP-104 Public transport surveillance	Public Transit Surveillance
SE-301 Hazmat vehicle tracking	AVL for Hazmat - System
TC-101 Automated Credential Filing	Automated Vehicle Credentials
TC-102 Automated Commercial Vehicle Administration	Automated Customs
TC-103 Automated Border Crossings	Automated Border Crossing

Service	Short Term Projects
TC-401 Intermodal center facility management	Port Access Control
TC-402 Intermodal vehicle and container control	Port Management System 2
TC-601 Remote access to commercial vehicle safety data	Commercial Vehicle Data Sharing
TC-602 Monitoring Vehicle Loads	Virtual Weigh Station
PE-101 Electronic transit fare payment	National Rail Card
GOT-101 Traffic Monitoring	Roadway Monitoring
GOT-101 Traffic Monitoring	Video Surveillance
GOT-101 Traffic Monitoring	IAVE Travel Times
GOT-102 Surface Street Control	Signal Control
GOT-102 Surface Street Control	Arterial Lane Control
GOT-102 Surface Street Control	Diversion Routing
GOT-103 Freeway Control	Freeway Lane Control
GOT-104 Preferential Treatment for Traffic Control (Signal Priority)	Emergency Vehicle Pre-emption
GOT-106 Traffic Information Dissemination	HAR deployment
GOT-107 Coordination of Surface Street and Freeway Control	Ramp Closure Gates
GOT-110 Work Zone Traffic Management	Smart Work Zone 1
GOT-301 Roadway Construction and Maintenance Management	Lane Rental
GOT-303 Pavement Management	Pavement Management Database
GOT-304 Bridge Management	Bridge Management Database
GOT-306 Work Zone Safety Management	Freeway Lane Closure Information System
GOT-401 Incident On-Site Motorist Assistance	Urban Green Angels
GOT-401 Incident On-Site Motorist Assistance	Motorist Aid Training
GOT-402 Incident On-Site Traffic Management	PDMS for Incident Management
GOT-402 Incident On-Site Traffic Management	Incident Management Training
MA-101 Road Weather Information Monitoring	Weather Station Deployment
IV-101 Pre-Trip Information – Traffic and Roadway	Major Roadway Incident Information
IV-102 Pre-Trip Information – Public Transport (bus and rail)	Static Schedule Information
IV-303 Travel Services Information – Dedicated location	Local HAR

10.7.2 Funding

A preliminary financial plan was developed in Chapter 5. That chapter also identified the significant benefits that could be realized with early winner projects. The plan also recognized significant funding gaps. There are some innovative projects like the CVOIS demonstration project in Tijuana (as part of Mexico's trade corridor program) where the private sector is paying for the project. Still, there remains a need to prioritize ITS projects against the numerous other demands within Mexico.

Privately Funded Short Term

Many of the projects identified in the program were shown as having no cost. The program identifies those costs associated with direct public sector financing, as opposed to those that should be the responsibility of the consumer or the private sector. The following projects were identified as solely privately financed projects.

Table 10.4
Services and Privately Financed Projects

Service	Project
SP-102 9-1-1/Mayday alert for public transport	Public Transit Mayday
SE-101 Automated 9-1-1 and Mayday Dispatch	Automated Personal Mayday
SE-101 Automated 9-1-1 and Mayday Dispatch	Manual Personal Mayday
SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring	Personal Vehicle Recovery
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Manual Hazmat Mayday
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated Hazmat Mayday
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated Rollover Hazmat Mayday
SE-303 Hazmat preclearance services	Hazmat Preclearance
SV-204 Automated Cruise Control	Intelligent Cruise Control
SV-301 Longitudinal Collision Avoidance	Intelligent Cruise Control 2
SV-302 Lateral Collision Avoidance	Lane Departure Warning System
SV-401 Vehicle Internal Systems Monitoring	Personal Vehicle Management
TC-202 Commercial vehicle fleet dispatching	Fleet Dispatch
TC-203 Freight container tracking	Container Tracking
TC-203 Freight container tracking	Container Integrity
TC-301 Vehicle and container arrival information exchange	Port Management System
TC-301 Vehicle and container arrival information exchange	Container Management
TC-302 Customer freight information access (users are customers and shippers)	Container Bulletin Board
TC-701 Commercial vehicle internal systems monitoring	Fleet Vehicle Management
TC-701 Commercial vehicle internal systems monitoring	Driver Alertness Warning System
TC-701 Commercial vehicle internal systems monitoring	Lane Departure Warning System
PE-102 Electronic toll collection	Super Llave
GOT-110 Work Zone Traffic Management	Smart Work Zone 2
GOT-201 Variable road pricing	Time of Day Tolling
GI-201 Disaster Response Planning for Transport Network	Disaster Response Coordinated Planning
TP-101 Public Transport Vehicle Internal Systems Monitoring	Fleet Management for Public Passenger Vehicles
TP-102 Public Transport Vehicle Fleet Tracking	AVL for Public Passenger Vehicles
IV-205 On-Trip Information through mobile devices	Incidents to Mobile Phones
IV-205 On-Trip Information through mobile devices	Travel Times to Mobile Phones
IV-302 Travel Services Information – Personal interactive	Traveler Information to Mobile Phones

Some of these projects are directly consumer products (e.g., intelligent cruise control). The systems are either self contained or rely on the private sector to provide the supporting services. Others are viewed as the responsibility of the private sector. For example, the public sector is not responsible for paying for a carrier to have the ability to track his fleet of trucks. The carrier should determine that himself. If it is cost effective to monitor his fleet, he will. However, in some of these cases, it may become an unfunded mandate imposed upon the concessions or an industry in support of a common good.

Outside Funding Sources

Trade corridors and similar efforts are excellent opportunities to find additional ways of funding projects. Many of the border projects can be financed through international projects. Funding from the USTDA or other US or multilateral agencies is possible on all projects involving the border crossings. These sometimes extend to efforts a considerable distance from the border. The Container Security Initiative is an example. While not currently financially supported by the US in Mexico, the project involves security

of containers from their source within Mexico to the US border. The CVOIS project in Tijuana is funded by the shippers, not the US government, but there may be some potential for these types of projects. Other international development agencies or UN sponsored efforts should be sought as much as possible.

Those projects involving the shipper and carrier industry can also be financed entirely through higher transportation charges. It should be noted that increasing the charges placed upon the carrier reduces Mexico's competitiveness slightly. Any funding of these efforts must involve the support of the highest levels of the public and private sector as its impact could be felt throughout the economy.

Finally, user fees are another means of paying for many projects. This can be extended beyond the current toll road system to include special districts or modes of transportation. As with any toll financed operation, it is important that the project be modeled and studied before any funding decisions are made to ensure that the costs are recoverable from the users.

The remainder of the project funding will have to come from public financing. The total of $43M dollars assumes either complete financing by the public sector or complete financing by the consumer/private sector. The more that is privately financed, and the more that is sought from international aid efforts, the less the burden on the public sector. It has already been recognized that this figure is significant and will require decision makers to chose between many worthy uses of public funds.

Maintenance and Operations

In the detailed cost assessments, estimates of annual operating expenses were created. These included facilities, utilities, preventative maintenance, and life-cycling of equipment. Also included were additional staffing necessary to operate the new projects. This made the assumption that staff were not available to accomplish those support tasks with the projects. For some of these projects, those costs are significant.

For the Early Winner and Short Term projects, the annual costs were summed. A simple summary revealed total annual operations of almost $47M dollars. A quick review reveals that three projects (Traffic Monitoring Roadway, Traffic Monitoring Video Surveillance, and Urban Green Angels) account for $37M of that total. Outside of these three projects, the annual operating costs are approximately $10M dollars. Staffing alone accounts for $22M dollars additional annually, with $14M of that staffing solely from the Urban Green Angels project.

Most of the initial projects are demonstrations. As demonstrations, the staff support is either through the contractor or a small portion of an existing public sector staff member's time. As each project is developed, a more thorough analysis of the annual expenses related to the project should be considered and included in the program decision making process.

Mexico National ITS Architecture

Task 10 Report—Appendices

Submitted by Wilbur Smith Associates

ENGINEERS PLANNERS ECONOMISTS
WilburSmith ASSOCIATES

www.wilbursmith.com

Appendix Summary

In the course of reviewing the final deliverables with the Mexican National ITS Architecture, it became apparent that there were some issues that required some additional explanation. This appendix contains a series of white papers that address these issues. None of these whitepapers change the intent or the meaning of the text in the final deliverable, but they do provide additional explanation and clarification. The following is a list of the whitepapers and the chapters of the final document to which they are relevant:

- ITS Architecture Development Overview – Chapters 3, 5, and 8
- Legal and Institutional Issues – Chapter 4
- Regional ITS Architecture Development – Chapters 5, 8, and 10
- Funding Table Summary – Chapter 6
- Pesaje Facil Economic Review – Chapters 6 and 10
- Air Quality Quantities – Chapter 7
- ITS Technology Assessment – Chapter 9
- ITS Project Development Explanation – Chapters 9 and 10
- Immediate Action Plan – Chapter 10

These documents should be considered within the context of the entire ITS Architecture.

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
SN.1 Monitoring and control of suspicious vehicles	***SN-101. Vehicle hazmat and explosives monitoring***	**None**	This service includes the monitoring and control of vehicles for potential threats using sensors, surveillance equipment, barriers and safeguard systems to preclude an incident, control the vehicle during and after an incident or mitigate impact of an incident. Threats can result from terrorist attacks or other criminal activity. Legal vehicles carrying hazardous materials should be considered "suspicious vehicles", because they could be easily high-jacked by criminal elements and used for illegal activities. Vehicles may be monitored by a variety of sensors in either a fixed or mobile application. Data from such sensors and surveillance equipment will be processed immediately. The data enables operators to detect and verify threats. Detected threats or advisories received from other agencies result in an increased level of system preparedness. In response to threats, barrier and safeguard systems may be activated by	

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			Emergency Management Subsystems to deter an incident, control access to an area or mitigate the impact of an incident. Barrier systems include gates, barriers and other automated and remotely controlled systems that manage vehicle location. Safeguard systems include blast shields, exhaust systems and other automated and remotely controlled systems that mitigate impact of an incident.	
	SN-102. Vehicle disablement		***(TBD)***	
SN.2 Utility or pipeline monitoring	***SN-201. Pipeline and utility HAZMAT / explosives monitoring***	***EM05(US) - Transportation Infrastructure Protection***	This service includes the monitoring of utility or pipeline infrastructure for potential threats using sensors, surveillance equipment, barriers and safeguard systems to preclude an incident, control access during and after an incident or mitigate impact of an incident. Threats can result from acts of nature (e.g., hurricanes, earthquakes), terrorist attacks or other incidents causing damage to the infrastructure (e.g., stray barge hitting a bridge support). Infrastructure may be monitored with acoustic, environmental threat (such as nuclear, and explosives), infrastructure condition and integrity,	- Center Secure Area Sensor Management - Center Secure Area Surveillance - Field Barrier System Control - Field Safeguard System Control - Field Secure Area Sensor Monitoring - Field Secure Area

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			motion and object sensors and video and audio surveillance equipment. Data from such sensors and surveillance equipment may be processed in the field or sent to a center for processing. The data enables operators at the center to detect and verify threats. When a threat is detected, agencies are notified. Detected threats or advisories received from other agencies result in an increased level of system preparedness. In response to threats, barrier and safeguard systems may be activated by Emergency Management Subsystems to deter an incident, control access to an area or mitigate the impact of an incident. Barrier systems include gates, barriers and other automated and remotely controlled systems that manage entry to the utility or pipeline infrastructure. Safeguard systems include blast shields, exhaust systems and other automated and remotely controlled systems that mitigate impact of an incident.	Surveillance - Barrier System Management - Safeguard System Management - TMC Incident Dispatch Coordination/Communication
	SN-202. Emergency notification to key agencies	***EM07(US) - Early Warning System,***	This service monitors and detects potential, looming, and actual disasters including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents,	- Center Secure Area Sensor Management - Center Secure Area Surveillance

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			nuclear power plant accidents, and acts of terrorism including nuclear, and radiological weapons attacks). The service monitors alerting and advisory systems, ITS sensors and surveillance systems, field reports, and emergency call-taking systems to identify emergencies and notifies all responding agencies of detected emergencies.	- Emergency Early Warning System - Emergency Environmental Monitoring - MCM Incident Management - Field Secure Area Sensor Monitoring - Field Secure Area Surveillance - TMC Incident Detection
SN.3 Coordination of National Assets	***SN-301 National data collection and sharing***	***AD2(US) – ITS Data Warehouse***	This service provides a central vehicle and cargo data warehouse and communications for data collection and sharing between both public and private users.	-
	SN-302 National multi-agency cooperation	***AD2(US) – ITS Data Warehouse***	This service provides a secure central vehicle and cargo data warehouse and communications for data collection and sharing amongst public agencies.	-
SP.1 Public travel security	***SP-101. Silent alarm***	***CVO12(US) - CV Driver Security Authentication***	This service provides drives the ability to silently notify Emergency Management when a potential vehicle hijacking or theft and potential hazardous situation occurs. If an unauthorized driver has been	- On-board Driver Authentication - Emergency Commercial Vehicle Response

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		, AVSS02 (US) - Driver Safety Monitoring	reported, Emergency Management can activate commands to safely disable the vehicle.	- Manage CV Driver Identification - Driver Safety Monitoring
(also see Public Transport Management)	***SP-102. Mayday alert for public transport***	***APTS5(US) - Transit Security, APTS5(CAN) - Public Travel Security***	This service provides for the physical security of transit passengers and transit vehicle operators. Transit user or transit vehicle operator activated alarms are provided on-board. Public areas (e.g., transit stops, park and ride lots, stations) are also monitored with similar surveillance and sensor equipment and provided with transit user activated alarms. On-board alarms, activated by transit users or transit vehicle operators are transmitted to both the Emergency Management Subsystem and the Transit Management Subsystem, indicating two possible approaches to implementing this service. Transit user activated alarms in public secure areas are transmitted to the Emergency Management Subsystem. In addition the service supports remote transit vehicle disabling by the Transit Management	- Center Secure Area Alarm Support - Center Secure Area Sensor Management - Emergency Response Management - Traveler Secure Area Sensor Monitoring - Field Secure Area Sensor Monitoring - Transit Center Security - On-board Transit Security

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			Subsystem and transit vehicle operator authentication.	
	SP-103. Intrusion detection	***APTS5(US) - Transit Security, APTS5(CAN) - Public Travel Security***	This service provides surveillance and sensor monitoring equipment on-board transit vehicles. On-board equipment is deployed to perform surveillance and sensor monitoring in order to warn of potentially hazardous situations. The surveillance equipment includes video (e.g., CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g., metal detectors).	- Center Secure Area Alarm Support - Center Secure Area Sensor Management - Center Secure Area Surveillance - Emergency Response Management - On-board Transit Security
	SP-104. Public transport surveillance	***APTS5(US) - Transit Security, APTS5(CAN) - Public Travel Security***	This service provides surveillance and sensor monitoring equipment on-board transit vehicles. In addition this service provides surveillance and sensor monitoring of non-public areas of transit facilities (e.g., transit yards) and transit infrastructure such as bridges, tunnels, and transit railways or bus rapid transit (BRT) guideways. The surveillance equipment includes video and/or audio systems. The sensor equipment includes threat sensors and object detection sensors as described	- Center Secure Area Alarm Support - Center Secure Area Sensor Management - Center Secure Area Surveillance - Emergency Response Management - Field Secure Area Sensor

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			above as well as, intrusion or motion detection sensors and infrastructure integrity monitoring (e.g., rail track continuity checking or bridge structural integrity monitoring).	Monitoring - Field Secure Area Surveillance
SP.2 Safety enhancements for vulnerable road users	***SP-201. Non-motorized vehicle and pedestrian monitoring systems***	***ATMS30(CAN) - Automated Non-Vehicular Road User Protection,***	This service supports more advanced systems of sensing and warning for pedestrians, bicyclists and other vehicles that operate on the main vehicle roadways, or on pathways which intersect the main vehicle roadways. Specifically, advanced imaging sensors are anticipated to provide improved sensing and recognition capabilities, which would allow automated warning or active protection systems for this class of users.	- Roadway Subsystem - Traffic Management Subsystem
	SP-202. Systems to monitor specialized vehicles	***ATMS24(CAN) - Maintenance Fleet Management, MC01(US) - Maintenance and Construction Vehicle and Equipment***	This service supports automated management of fleets of maintenance, construction, or special service vehicles. These types of vehicles include snowplows and sand/salt trucks. This service includes the infrastructure-based systems that monitor vehicle location, vehicle status, and the output of sensors (such as environmental or road surface sensors) which are mounted on the vehicles. Also included are the systems within the maintenance vehicles that create this information	- MCM Vehicle Tracking - MCV Vehicle Location Tracking - Vehicle Location Determination

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		Tracking	and send it to the control centre or control system. The infrastructure systems perform vehicle dispatch, routing, and asset management.	
SP.3 Safety enhancements for disabled road users	***SP-301. Intersection monitoring of specialized conveyences (e.g. wheelchairs, carts)***	***ATMS30(CAN) - Automated Non-Vehicular Road User Protection***	This service supports more advanced systems of sensing and warning for pedestrians, bicyclists and other vehicles that operate on the main vehicle roadways, or on pathways which intersect the main vehicle roadways. Specifically, advanced imaging sensors are anticipated to provide improved sensing and recognition capabilities, which would allow automated warning or active protection systems for this class of users.	- Roadway Subsystem - Traffic Management Subsystem
	SP-302. Driver warnings for specialized conveyances	***ATMS29(CAN) - Mixed Use Warning Systems***	This service supports the near term sensing and warning systems used to interact with pedestrians, bicyclists, and other vehicles that operate on the main vehicle roadways, or on pathways which intersect the main vehicle roadways.	- Roadway Subsystem - Traffic Management Subsystem
SP.4 Intelligent junctions and Links	***SP-401. Intelligent intersection***	***ATMS03(CAN) - Surface Street Control***	This service provides general advisory and traffic control information to the driver while en-route. This package also covers the equipment and interfaces that provide traffic information from the assigned traffic signal.	- Roadway Subsystem - Traffic Management Subsystem
	SP-402.	***AVSS03(CAN)***	This service allows for longitudinal and lateral	- Vehicle Subsystem

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	Oncoming vehicle advance warning (for non-signalized junction)	***- Longitudinal Warning Systems AVSS03(CAN) - Lateral Warning Systems***	warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of, to the sides of, and behind the vehicle to present warnings to the driver about potential hazards.	
	SP-403. In-vehicle signage and warning systems	***ATIS9(CAN) - In-Vehicle Signing***	This service supports distribution of traffic and travel advisory information to drivers through in-vehicle devices. It includes short-range communications between roadside equipment and the vehicle and wireline connections to the Traffic Management Subsystem for co-ordination and control.	- Roadway Subsystem - Traffic Management Subsystem
SE.1 Transport related emergency notification and personal security	***SE-101. Automated 9-1-1 and mayday dispatch***	***EM3(US) - Personal Security and MAYDAY Support EM3(CAN) - Personal Security and MAYDAY Support***	This service allows the user (driver or non-driver) to initiate a request for emergency assistance and enables the Emergency Management Subsystem to locate the user and determine the appropriate response. The Emergency Management Subsystem may be operated by the public sector or by a private sector provider. The request from the traveler needing assistance may be manually initiated or automated and linked to vehicle sensors. The data is sent to the Emergency Management subsystem	- Center Secure Area Alarm Support - Center Secure Area Surveillance - Mayday Support - Personal Location Determination - Personal Mayday I/F - Remote Traveler Security

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			using wide area wireless communications with voice as an option. Providing user location implies either a location technology within the user device or location determination within the communications infrastructure.	- Traveler Secure Area Surveillance - Vehicle Location Determination - Vehicle Mayday I/F
	SE-102. Automated vehicle intrusion and stolen vehicle monitoring	***CVO12(US) - CV Driver Security Authentication***	This service provides the ability for Fleet and Freight Management to detect when an unauthorized commercial vehicle driver attempts to drive their vehicle based on stored driver identity information. If an unauthorized driver has been detected, Fleet and Freight Management can activate commands to safely disable the commercial vehicle. Alarms can also be sent to emergency management to inform them of a potential commercial vehicle hijacking or theft and potential hazardous situation. In addition, Emergency Management can request Fleet and Freight Management to disable a specific vehicle in their fleet.	- On-board Driver Authentication - Emergency Commercial Vehicle Response - Manage CV Driver Identification
SE.2 Emergency vehicle management	***SE-201. Emergency vehicle fleet tracking***	***APTS1(US) - Transit Vehicle Tracking, EM02(US) -***	This service monitors current emergency vehicle location using an Automated Vehicle Location System. The location data may be used to determine route guidance information. Vehicle	- TMC Incident Dispatch Coordination/ Communication - On-board Vehicle

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		Emergency Routing, EM2(CAN) - Emergency Vehicle Routing, ATMS24(CAN) - Maintenance Fleet Management	position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Emergency Management Subsystem is used for relaying vehicle position and control measures.	Monitoring - Vehicle Location Determination - On-board Trip Monitoring
	SE-202. Emergency vehicle – traffic management coordination	***EM02(US) - Emergency Routing, EM2(CAN) - Emergency Vehicle Routing***	This service supports automated vehicle location and dynamic routing of emergency vehicles. Traffic information, road conditions, and suggested routing information are provided to enhance emergency vehicle routing. Special priority or other specific emergency traffic control strategies can be coordinated to improve the safety and time-efficiency of responding vehicle travel on the selected route(s). The Emergency Management Subsystem provides the routing for the emergency fleet based on real-time conditions and has the option of requesting a route from the Traffic Management subsystem. The Emergency Vehicle may also be equipped with dedicated short range	- Emergency Routing - On-board EV En Route Support - Roadway Signal Priority - TMC Incident Dispatch Coordination / Communication - TMC Signal Control - Vehicle Location Determination

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			communications for local signal preemption. The service provides for information exchange between care facilities and both the Emergency Management Subsystem and emergency vehicles.	
SE.3 Hazardous materials & incident notification	***SE-301. Hazmat vehicle tracking***	***CVO10(US) - HAZMAT Management, CVO10(CAN) - Hazardous Material Planning and Incident Response***	This service integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem.	- On-Board Cargo Monitoring - Mayday Support - Fleet HAZMAT Management - Vehicle Location Determination
	SE-302. Automated HAZMAT 9-1-1 / Mayday Notification	***CVO10(US) - HAZMAT Management, CVO10(CAN) - Hazardous Material Planning and Incident Response***	The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.	- On-Board Cargo Monitoring - Emergency Commercial Vehicle Response - Mayday Support - Fleet HAZMAT Management - Vehicle Location Determination - Vehicle Mayday I/F

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	SE-303. Hazmat preclearance services	***CVO03(US) - Electronic Clearance, CVO03(CAN) - Electronic Clearance***	This service provides for automated pre-clearance for HAZMAT cargo at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem over wireline to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This package allows a compliant driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated short-range communications to the roadside. The roadside check facility may be equipped with AVI, weighing sensors, transponder read/write devices, computer workstation processing hardware, software, and databases.	- CV Information Exchange - CV Safety Administration - Citation and Accident Electronic Recording - Roadside Electronic Screening - On-board CV Electronic Data
SV.1 Transport-related vision enhancement	***SV-101. In-vehicle driver vision management***	***AVSS07(US) - Driver Visibility Improvement, AVSS07(CAN) - Sensor-Based Driving Safety Enhancement***	This service will enhance driver visibility using an enhanced vision system. On-board display hardware is needed	- Driver Visibility Improvement System
SV.2 Automated	***SV-201. Automated***	***AVSS11(US) - Automated***	This service enables "hands-off" operation of the vehicle on the automated portion of the highway	- Roadway Systems for

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
vehicle operation	***highway operation***	***Highway System, AVSS11(CAN) - Automated Highway System***	system. Implementation requires lateral lane holding, vehicle speed and steering control, and Automated Highway System check-in and checkout. This service currently supports a balance in intelligence allocation between infrastructure and the vehicle pending selection of a single operational concept by the AHS consortium.	AHS - TMC for AHS - Vehicle Systems for AHS
	SV-202. Automated low-speed manoeuvring	***AVSS09(US) - Advanced Vehicle Lateral Control, AVSS09(CAN) Lateral Collision Avoidance***	This service 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.	- Vehicle Lateral Control
	SV-203. Precision docking for public transport vehicles			
	SV-204. Automated	***AVSS08(US) - Advanced***	This service automates the speed and headway control functions on board the vehicle. It utilizes	- Vehicle Longitudinal Control

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	cruise control	***Vehicle Longitudinal Control, AVSS08(CAN) Longitudinal Collision Avoidance***	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.	
SV.3 Collision avoidance	***SV-301. Longitudinal collision avoidance***	***AVSS03(US) - Longitudinal Safety Warning, AVSS03(CAN) - Longitudinal Warning Systems***	This service allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.	- Vehicle Longitudinal Warning System
	SV-302. Lateral Collision Avoidance	***AVSS04(US) - Lateral Safety Warning, AVSS04(CAN) - Lateral Warning Systems***	This service allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.	- Vehicle Lateral Warning System
	SV-303.			-

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	Intersection Collision Avoidance			
SV.4 Safety readiness	***SV-401. Vehicle internal systems monitoring***	***AVSS01(US) - Vehicle Safety Monitoring, AVSS01(CAN) - Vehicle Safety Monitoring***	This service will diagnose critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition, performance, on-board safety data, and display information.	- Vehicle Safety Monitoring System
	SV-402. Vehicle external conditions monitoring	***MC03(US) - Road Weather Data Collection, ATMS20(CAN) - Roadway Environmental Sensing***	This service collects current road and weather conditions using data collected 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 Service to process the information and make decisions on operations.	- On-Board EV Environmental Monitoring - MCM Environmental Information Collection - MCV Environmental Monitoring - TMC Environmental Monitoring - TMC Probe Information Collection - On-Board Environmental Monitoring - Smart Probe

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
SV.5 Pre-crash restraint deployment	***SV-501. Pre-crash restraint deployment***	***AVSS06(US) - Pre-Crash Restraint Deployment, AVSS06(CAN) - Pre-Crash Restraint Deployment***	This service provides in-vehicle sensors to monitor the vehicle's local environment, determine collision probability and deploy a pre-crash safety system. It will include on-board sensors to measure lateral and longitudinal gaps and together with weather and roadway conditions will determine lateral and longitudinal collision probability. It will have the mechanism to deploy a pre-crash safety system.	- Vehicle Pre-Crash Safety Systems
TC.1 Commercial vehicle administrative processes	***TC-101. Automated credential filing***	***CVO04(US) - CV Administrative Processes, CVO04(CAN) - Commercial Vehicle Administrative Processes***	This service provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in the electronic clearance program provided by a separate service which allows commercial vehicles to be screened at mainline speeds at roadside check facilities. Through this enrollment process, current profile databases are maintained in the Commercial Vehicle Administration subsystem and snapshots of this database are made available to the roadside check facilities at the roadside to support the electronic clearance process. Commercial Vehicle Administration subsystems	- Credentials and Taxes Administration - CV Information Exchange - Fleet Administration - Fleet Credentials and Taxes Management and Reporting

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			can share credential information with other Commercial Vehicle Administration subsystems, so that it is possible for any Commercial Vehicle Administration subsystem to have access to all credentials, credential fees, credentials status and safety status information. In addition, it is possible for one Commercial Vehicle Administration subsystem to collect HAZMAT route restrictions information from other Commercial Vehicle Administration subsystems and then act as a clearinghouse for this route restrictions information for Information Service Providers, Map Update Providers, and Fleet and Freight Management subsystems.	
	TC-102. Automated commercial vehicle administration			-
	TC-103. Automated border crossings	***CVO05(US) - International Border Electronic Clearance,***	This service provides for automated clearance at international border crossings. This package augments the electronic clearance package by allowing interface with customs related functions.	- CV Information Exchange - CV Safety Administration - International CV Administration

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		CVO05(CAN) - International Border Crossing Clearance		- International Border Crossing - Roadside Electronic Screening - On-board CV Electronic Data - Freight Administration and Management
TC.2 Freight transport fleet management	***TC-201. Commercial vehicle fleet tracking***	***APTS1(US) - Transit Vehicle Tracking, EM02(US) - Emergency Routing, EM2(CAN) - Emergency Vehicle Routing, ATMS24(CAN) - Maintenance Fleet Management***	This service monitors current commercial vehicle's location using an Automated Vehicle Location System. The location data may be used to determine route guidance information. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Fleet and Freight Management Subsystem is used for relaying vehicle position and control measures.	- TMC Incident Dispatch Coordination/ Communication - On-board Vehicle Monitoring - Vehicle Location Determination - On-board Trip Monitoring
	TC-202.	***CVO01(US) -***	This service provides the capabilities to manage a	- On-board Trip Monitoring

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	Commercial vehicle fleet dispatching	***Fleet Administration, CVO01(CAN) - Fleet Administration***	fleet of commercial vehicles. The Fleet and Freight Management subsystem provides the route for a commercial vehicle by either utilizing an in-house routing software package or an Information Service Provider. Routes generated by either approach are constrained by hazardous materials and other restrictions (such as height or weight). Any such restricted areas are determined by the Commercial Vehicle Administration. A route would be electronically sent to the Commercial Vehicle with any appropriate dispatch instructions. The location of the Commercial Vehicle can be monitored by the Fleet and Freight Management subsystem and routing changes can be made depending on current road network conditions. Once a route has been assigned, changes must be coordinated between the Fleet and Freight Management subsystem and the Commercial Vehicle. Commercial Vehicle Drivers would be alerted to any changes in route from the planned route and given an opportunity to justify a rerouting. Any unauthorized or unexpected route changes by the Commercial Vehicle will register a route deviation alert with the Fleet and Freight Management subsystem. The Fleet and Freight	- Fleet Administration - Vehicle Location Determination

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			Management subsystem can also notify local public safety agencies of the route deviation when appropriate (e.g., if there is safety sensitive HAZMAT being carried), by sending an alarm to the Emergency Management subsystem.	
	TC-203. Freight container tracking	***CVO11(CAN) - Freight In-Transit Monitoring, CVO13(US) - Freight Assignment Tracking***	This service covers the ability to track and monitor intermodal containers and intermodal freight shipments. This includes determining the location of a container while it is on a railway car and, if appropriate, monitoring measured parameters of the container contents (temperature, shock and vibration, etc.). This information is provided to freight customers, fleet managers, and logistics service providers. In general, a truck will pick up a container from a customer, a container freight station, or an intermodal terminal, and then deliver the container to the appropriate one of these for intermodal mode change or final delivery. This service supports the monitoring of the container during this pickup-transport-drop-off period.	- On-board Cargo Monitoring - On-board Trip Monitoring - Commercial Vehicle and Freight Security - Fleet Administration - Freight Administration and Management
TC.3 Intermodal information management	***TC-301. Vehicle and container arrival***	***CVO12(CAN) - Freight Terminal Management,***	This service provides an interface to Customs, and acknowledges container pickup and drop-off. Other capabilities include the ability to track container locations within the facility and to manage any	- On-board Cargo Monitoring - Fleet Administration

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	information exchange		other required assets, like truck chassis. This service may be deployed in conjunction with Weigh-in-Motion and Roadside CVO Safety to provide truck weight and safety assessments for vehicles prior to departing the facility.	- Freight Administration and Management
	TC-302. Customer freight information access			-
TC.4 Management and control of intermodal centres	***TC-401. Intermodal centre facility management***	***CVO12(CAN) - Freight Terminal Management***	This service supports the operation of the roadway aspects of an intermodal center facility. The "center facility" may represent the transfer point between roadway and one or more other modes of container transport (rail, air or water), and may be an actual port facility or a private intermodal transfer facility. The key capabilities include the ability to identify and control vehicle traffic entering and departing the facility, guide vehicles to loading and unloading points, maintain site security and monitor container integrity, provide an interface to Customs as appropriate, and acknowledge container pickup and drop-off. Other capabilities include the ability to track container locations within the facility and to	- On-board Cargo Monitoring - Fleet Administration - Freight Administration and Management - Commercial Vehicle and Freight Security - On-board Trip Monitoring - On-board Driver Authentication

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			manage any other required assets, like truck chassis. This service may be deployed in conjunction with Weigh-in-Motion and Roadside CVO Safety to provide truck weight and safety assessments for vehicles prior to departing the facility.	
(related to Traffic Management)	***TC-402. Intermodal vehicle and container control***	***CVO11(CAN) - Freight In-Transit Monitoring***	This service covers the ability to track and monitor intermodal containers. This includes determining the location of a container while it is on a railway car and, if appropriate, monitoring measured parameters of the container contents (temperature, shock and vibration, etc.). This service supports the monitoring of the container during this pickup-transport-drop-off period.	- On-board Cargo Monitoring - On-board Trip Monitoring - Commercial Vehicle and Freight Security - Fleet Administration - Freight Administration and Management
TC.5 Management of dangerous freight	***TC-501. Dangerous goods movement data sharing***		This service provides an interface to Customs, and Traffic Management Subsystems to acknowledge container pickup and drop-off.	- Commercial Vehicle Subsystem - Fleet and Freight Management - Commercial Vehicle - Information Service Provider
	TC-502. Dangerous	***CVO02(US) – Freight***	This service creates a registry, tracks the movement of dangerous goods and monitors its condition.	- On-board Cargo Monitoring

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	goods movement data registry	***Administration, CVO02(CAN) - Freight Administration***	This registry is made available to local and state transportation and emergency officials to provide them information related to the transport of dangerous goods on their roadways in the event of an incident involving a vehicle transporting dangerous goods. Interconnections are provided to intermodal freight shippers and intermodal freight depots for tracking of dangerous goods from source to destination. In addition to the usual dangerous goods monitoring required to insure dangerous goods shipments gets from origin to destination, the Fleet and Freight Management subsystem monitors shipments to make sure no tampering or breach of security occurs to the cargo on commercial vehicles. Any such tampering will be reported to the Fleet and Freight Management subsystem. The commercial vehicle driver is also alerted of any tampering or breach of cargo security. Freight managers may decide to take further action on the alerts and/or provide responses that explain that the alerts are false alarms. If no explanation is received, the Fleet and Freight Management subsystem may notify the Emergency Management subsystem.	- On-board CV Safety and Security - On-board Trip Monitoring - Commercial Vehicle and Freight Security - Fleet Administration - Freight Administration and Management - Fleet HAZMAT Management - Emergency Commercial Vehicle Response - Emergency Management Subsystem
(related to	***TC-503.***	***CVO11(CAN) -***	This service keeps track of vehicle location,	- On-board Trip Monitoring

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
Traffic Management)	***Dangerous goods movement fleet coordination***	***Freight In-Transit Monitoring, CVO01(CAN) - Fleet Administration, CVO01(US) - Fleet Administration***	itineraries, and dangerous goods cargo at the Fleet and Freight Management Subsystems and coordinates with freight customers, fleet managers, and logistics service providers. This service supports the coordination of the shipment during the pickup-transport-drop-off periods be.	- Fleet Administration - Vehicle Location Determination - Fleet Administration - Freight Administration and Management - Fleet HAZMAT Management
	TC-504. Dangerous goods movement police / safety coordination	***CVO01(US) – Fleet Administration, CVO01(CAN) - Fleet Administration, ATIS6(US) - Integrated Transportation Management / Route Guidance***	This service supports coordination between Emergency Management Subsystem and the Fleet and Freight Management Subsystem supporting commercial vehicles transporting dangerous goods. Vehicle location, expected vehicle routing, and nature of dangerous goods cargo are provide by the Fleet and Freight Management Subsystem while the Emergency Management Subsystem provides incident information.	- Fleet Administration - Vehicle Location Determination - Fleet Administration - Freight Administration and Management - Fleet HAZMAT Management - Emergency Management Subsystem
TC.6 Automated roadside safety	***TC-601. Remote access to commercial***	***CVO07(US) - Roadside CVO Safety,***	This market pack provides for automated roadside retrieval of commercial vehicle safety data from a central database. The basic option, directly	- CV Information Exchange - CV Safety Administration

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
inspection	***vehicle safety data***	***CVO07(CAN) - Roadside CVO Safety***	supported by this service, facilitates safety inspection of vehicles that have been pulled in, perhaps as a result of the automated screening process provided by the Electronic Clearance Service. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-Board CVO Safety service, utilize additional vehicle safety monitoring and reporting capabilities in the commercial vehicle to augment the roadside safety check. Age	- Citation and Accident Electronic Recording - Roadside Electronic Screening - Roadside Safety and Security Inspection - On-board CV Electronic Data - Fleet Administration
	TC-602 Monitor Vehicle Loads			-
TC.7 Commercial vehicle on-board safety	***TC-701. Commercial vehicle internal systems***	***CVO08(US) - On-board CVO and Freight Safety &***	This service provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety Service and includes roadside support for reading on-board	- Citation and Accident Electronic Recording - Roadside Safety and

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
monitoring	***monitoring***	***Security, CVO08(CAN) - On-Board Safety Monitoring***	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 service allows for the Fleet and Freight Management subsystem to have access to the on-board safety data. In addition to safety data, this service provides a means for monitoring the security of the Commercial Vehicle along with the cargo, containers, trailers, and other equipment that are being hauled. Commercial Vehicle on-board tamper and breach sensors provide an indication of any security irregularities and the sensor data is provided to the Fleet and Freight Management subsystem along with particular notification of any breach alerts. Commercial Vehicle Drivers may be aware of the sensor readings and can provide an explanation back to the Fleet and Freight Management subsystem via the Commercial Vehicle. Commercial vehicle and freight security breaches are also sent to the commercial vehicle check.	Security Inspection - On-board Cargo Monitoring - On-board CV Safety and Security - Commercial Vehicle and Freight Security - Fleet Maintenance Management
	TC-702. Commercial vehicle driver	***AVSS02(US) - Driver Safety Monitoring,***	This service will determine the driver's condition, and warn the driver of potential dangers. On-board sensors will determine the driver's condition,	- Driver Safety Monitoring System

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	alertness monitoring	*AVSS02(CAN) - Driver Safety Monitoring*	performance, on-board safety data, and display information.	
PE.1 Transport-related electronic financial transactions	***PE-101. Electronic transit fare payment***	***APTS4(US) - Transit Passenger and Fare Management, APTS4(CAN) - Passenger and Fare Management***	This service manages passenger loading and fare payments on-board transit 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 operator and central operations to determine vehicle loads, and readers located either in the infrastructure or on-board the transit vehicle allow electronic fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem.	- Remote Transit Fare Management - Transit Center Fare and Load Management - On-board Transit Fare and Load Management
	PE-102. Electronic toll collection	***ATMS10(US) - Electronic Toll Collection, ATMS10(CAN) - Electronic Toll Collection***	This service provides toll operators with the ability to collect tolls electronically and detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Dedicated short range communication between the roadway equipment and the vehicle is required as well as fixed-point to fixed-point interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Vehicle	- Fleet Administration - Infrastructure Provided Trip Planning - ISP Traveler Data Collection - Toll Administration - Toll Plaza Toll Collection - Vehicle Toll/Parking Interface

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			tags of toll violators are read and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional, and ultimately national interoperability for these services. The toll tags and roadside readers that these systems utilize can also be used to collect road use statistics for highway authorities. This data can be collected as a natural by-product of the toll collection process or collected by separate readers that are dedicated to probe data collection.	
(related to Traffic Management)	***PE-103. Electronic parking payment***	***ATMS16(US) - Parking Facility Management, ATMS16(CAN) - Electronic Parking Payment and Parking Facility***	This service provides enhanced monitoring and management of parking facilities. It assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This service collects current parking status, shares this data with Information Service Providers and Traffic Management, and collects parking fees using the same in-vehicle equipment utilized for electronic toll collection or contact or proximity traveler cards	- Parking Electronic Payment - Parking Management - Vehicle Toll/Parking Interface

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		Management	used for electronic payment.	
	PE-104. Electronic services payment (e.g., traveller information, reservations)	***ATIS7(CAN) - Traveller Services Payment and Reservation, ATIS7(US) - Yellow Pages and Reservation***	This service enhances the Interactive Traveler Information package by making infrastructure provided business directory and reservation services available to the user. The same basic user equipment is included. This service provides multiple ways for accessing information either while en-route in a vehicle using wide-area wireless communications or pre-trip via wireline connections.	- Infrastructure Provided Yellow Pages & Reservation - ISP Traveler Data Collection - Personal Interactive Information Reception - Remote Interactive Information Reception - Interactive Vehicle Reception
	PE-105. Electronic distance-based road user fee payment services	***ATMS10(US) - Electronic Toll Collection, ATMS10(CAN) - Electronic Toll Collection***	This service provides toll operators with the ability to collect tolls electronically based on the distance traveled on the facility as well as detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Dedicated short range communication between the roadway equipment and the vehicle is required as well as fixed-point to fixed-point interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Vehicle	- Fleet Administration - Infrastructure Provided Trip Planning - ISP Traveler Data Collection - Toll Administration - Toll Plaza Toll Collection - Vehicle Toll/Parking Interface

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			tags of toll violators are read and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional, and ultimately national interoperability for these services. The toll tags and roadside readers this system utilizes can also be used to collect road use statistics for highway authorities. This data can be collected as a natural by-product of the toll collection process or collected by separate readers that are dedicated to probe data collection.	
PE.2 Integration of transport related electronic payment services	***PE-201. Integration of multi-jurisdictional electronic payment systems***	***ATMS10(US) - Electronic Toll Collection, ATMS10(CAN) - Electronic Toll Collection***	This service provides standards, inter-agency coordination, and financial clearinghouse capabilities enable regional, and ultimately national interoperability for these services. Electronic Toll Collection and Electronic distance-based road user fee payment services provide the toll collection equipment required for this service	- Fleet Administration - Infrastructure Provided Trip Planning - ISP Traveler Data Collection - Toll Administration - Toll Plaza Toll Collection - Vehicle Toll/Parking Interface
	PE-202. Integration of	***APTS4(US) - Transit***	This service provides standards, inter-agency coordination, and financial clearinghouse	- Fleet Administration - Remote Transit Fare

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	regional multi-modal payment systems	***Passenger and Fare Management, APTS4(CAN) - Passenger and Fare Management***	capabilities enable regional, and ultimately national interoperability for multimodal services.	Management - Transit Center Fare and Load Management - On-board Transit Fare and Load Management
GOT.1 Traffic control	***GOT-101. Traffic monitoring***	***ATMS01(CAN) - Traffic Network Flow Monitoring***	This service includes traffic detectors, road condition sensors, environmental sensors, other surveillance equipment, the supporting field equipment, and wireline communications to transmit the collected data back to the centre which uses the data (traffic management, maintenance management, or archive data management). The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this service enables the operators of the centers to monitor traffic environmental and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The	- Roadway Basic Surveillance - Roadway Equipment Coordination - Roadway Signal Controls - Collect Traffic Surveillance - Traffic Maintenance

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.	
	GOT-102. Surface street control	***ATMS03(US) - Surface Street Control, ATMS03(CAN) - Surface Street Control***	This service provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this service ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. This service is generally an intra-jurisdictional package that does not rely on real-time communications between separate control systems to achieve area-wide traffic signal coordination. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would be represented by this package. This service is consistent with typical urban traffic signal control systems.	- Roadway Basic Surveillance - Roadway Equipment Coordination - Roadway Signal Controls - Collect Traffic Surveillance - TMC Signal Control - Traffic Maintenance
	GOT-103. Freeway	***ATMS04(US) - Freeway***	This service provides central monitoring and control, communications, and field equipment that	- Roadway Basic

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	control	***Control, ATMS04(CAN) - Freeway Control***	support freeway management. It supports a range of freeway management control strategies including ramp metering, interchange metering, mainline lane controls, mainline metering, and other strategies including variable speed controls. This package incorporates the instrumentation included in the Network Surveillance Service to support freeway monitoring and adaptive strategies as an option. This service also includes the capability to utilize surveillance information for detection of incidents. Typically, the processing would be performed at a traffic management center; however, developments might allow for point detection with roadway equipment. For example, a CCTV might include the capability to detect an incident based upon image changes. Additionally, this service allows general advisory and traffic control information to be provided to the driver while en route.	Surveillance - Roadway Equipment Coordination - Roadway Freeway Control - Roadway Traffic Information Dissemination - Collect Traffic Surveillance - TMC Freeway Management - TMC Traffic Information Dissemination - Traffic Maintenance
	GOT-104. Preferential treatment for traffic control (signal	***EM2(CAN) - Emergency Vehicle Routing, EM02(US) -***	This service supports co-ordination with the Traffic Management Subsystem for special priority on the selected route(s). The Emergency Vehicle would also optionally be equipped with dedicated short-range communications for local signal pre-emption	- Emergency Routing - On-board EV En Route Support - Roadway Signal Priority

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	priority)	***Emergency Vehicle Routing***		- TMC Incident Dispatch Coordination/Communication - TMC Signal Control - Vehicle Location Determination
	GOT-105. Reversible lane management	***ATMS18(US) - Reversible Lane Management, ATMS17(CAN) - Reversible Lane Management***	This service provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this service includes sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This service also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.	- Roadway Equipment Coordination - Roadway Reversible Lanes - TMC Reversible Lane Management
	GOT-106. Traffic information dissemination	***ATMS06(US) - Traffic Information Dissemination,***	This service provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic	- Roadway Equipment Coordination - Roadway Traffic Information Dissemination

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		ATMS06(CAN) - Traffic Information Dissemination	and road conditions, closure and detour information, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. Careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), Transit Management, Emergency Management, and Information Service Providers. A link to the Maintenance and Construction Management subsystem allows real time information on road/bridge closures due to maintenance and construction activities to be disseminated.	- TMC Traffic Information Dissemination
	GOT-107. Coordination of surface street and	***ATMS07(US) - Regional Traffic Control,***	This service advances the Surface Street Control and Freeway Control Services by adding the communications links and integrated control strategies that enable integrated interjurisdictional	- TMC Freeway Management - TMC Regional Traffic

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	freeway control	***ATMS07(CAN) - Regional Traffic Control***	traffic control. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Services and adds hardware, software, and fixed-point to fixed-point communications capabilities to implement traffic management strategies that are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of control between traffic management centers.	Control - TMC Signal Control
	GOT-108. Intermodal-highway junction management	***ATMS13(US) - Standard Railroad Grade Crossing, ATMS13(CAN) - Basic At-Grade Crossing Control***	This service manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate more advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Both passive (e.g., the crossbuck sign) and active warning systems (e.g., flashing lights and gates) are supported. (Note that passive systems exercise only the single interface between the roadway subsystem and the driver in the architecture definition.) These traditional HRI warning systems may also be augmented with other	- Standard Rail Crossing - HRI Traffic Management

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			standard traffic management devices. The warning systems are activated on notification by interfaced wayside equipment of an approaching train. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported to both highway and railroad officials through wayside interfaces and interfaces to the traffic management subsystem.	
	GOT-109. Parking management	***ATMS16(US) - Parking Facility Management, ATMS16(CAN) - Electronic Parking Payment and Parking Facility Management***	This service provides enhanced monitoring and management of parking facilities. It assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This service collects current parking status, shares this data with Information Service Providers and Traffic Management, and collects parking fees using the same in-vehicle equipment utilized for electronic toll collection or contact or proximity traveler cards used for electronic payment.	- Parking Electronic Payment - Parking Management - Vehicle Toll/Parking Interface
	GOT-110. Work zone	***MC08(US) - Work Zone***	This service manages work zones, controlling traffic in areas of the roadway where maintenance,	- MCM Work Zone

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	traffic management	***Management, ATMS25(CAN) - Smart Work Zones***	construction, and utility work activities are underway. Traffic conditions are monitored using CCTV cameras and controlled using dynamic message signs (DMS), Highway Advisory Radio (HAR), gates and barriers. Work zone information is coordinated with other groups (e.g., ISP, traffic management, other maintenance and construction centers). Work zone speeds and delays are provided to the motorist prior to the work zones. This service provides control of field equipment in all maintenance and construction areas, including fixed, portable, and truck-mounted devices supporting both stationary and mobile work zones.	Management - MCV Barrier System Control - MCV Work Zone Support - Roadway Work Zone Traffic Control - TMC Work Zone Traffic Management
GOT.2 Demand management	***GOT-201. Variable road pricing (related to Toll Collection)***	***ATMS9(US) – Traffic Forecast and Demand Management ATMS10(US & CAN) – Electronic Toll Collection***	This service manages demand management using variable road pricing as a tool. This service is an interface of the US Services ATMS 9 and ATMS 10 to charge the road users based on the demand. The ATMS9 provides the demand forecasting using historical as well as real time data to process the toll prices based on demands and ATMS 10 provides the infrastructure to implement such demand management strategies.	- TMC Toll/Parking Coordination - TMC Traffic Network Performance Evaluation - Toll Administration - Toll Plaza Toll Collection
	GOT-202.			

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	Access management			
	GOT-203. High-occupancy lane management	***ATMS05(US & CAN) – HOV Lane Management***	This service manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.	- Roadway HOV Control - TMC HOV Lane Management - Roadway Equipment Coordination
	GOT-204. Air quality-based transport management			-
GOT.3 Transport infrastructure maintenance management	***GOT-301. Roadway construction and maintenance management***		This service 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	- MCM Roadway Maintenance and Construction - MCM Maintenance Decision Support - Roadway Field Device Monitoring - Roadway Infrastructure

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			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.	Monitoring - MCV Infrastructure Monitoring - MCV Roadway Maintenance and Construction
	GOT-302. Winter maintenance	***MC06(US) – Winter Maintenance***	This service supports winter road maintenance including snow plow operations, roadway treatments (e.g., salt spraying and other anti-icing material applications), and other snow and ice control activities at high altitudes where snow is a frequent occurrence. This package monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response, and track and manage response operations.	- MCM Maintenance Decision Support - MCM Winter Maintenance Management - MCV Winter Maintenance
	GOT-303. Pavement management	***N/A***	This service supports in pavement sensors to monitor pavement conditions and parameters like temperature to better predict and manage the pavement treatments.	- Roadway Environmental Monitoring - MCM Maintenance Decision Support

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	GOT-304 Bridge Management			-
	GOT-305. Automated road management	***MC05 (US) - Roadway Automated Treatment***	This service automatically treats a roadway section based on environmental or atmospheric conditions. Treatments include fog dispersion, anti-icing chemicals, etc. The service includes the environmental sensors that detect adverse conditions, the automated treatment system itself, and driver information systems (e.g., dynamic message signs) that warn drivers when the treatment system is activated.	- Roadway Automated Treatment - MCM Automated Treatment Systems Control - Roadway Equipment Coordination
	GOT-306. Work zone safety management	***MC09 (US) – Work Zone Safety Monitoring***	This service includes systems that improve work crew safety and reduce collisions between the motoring public and maintenance and construction vehicles. This service 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 service supports both stationary and mobile work zones. The intrusion	- MCM Work zone safety Management - MCV Vehicle Safety Monitoring - Roadway Work zone Safety - Roadway Equipment Coordination

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			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).	
	GOT-307. Utility and infrastructure Management			-
GOT.4 Transport-related incident management	***GOT-401. Incident on-site motorist assistance***	***EM04 (US) – Roadway Service Patrols***	This service supports roadway service patrol, police, and emergency response vehicles that monitor roads and aid motorists, offering rapid response to minor incidents (flat tire, accidents, out of gas) to minimize disruption to the traffic stream. If problems are detected such vehicles will provide assistance to the motorist (e.g., push a vehicle to the shoulder or median). The service supports monitoring and communications with service vehicles to supports resource dispatch to identified incident locations. Incident information collected by the service vehicles is shared with traffic, maintenance and construction, and traveler information systems.	- Service Patrol Management - Onboard EV En route Support - Onboard EV Incident Management Communication

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	GOT-402. Incident on-site traffic assistance	***ATMS08 (US) – Traffic Incident Management System***	This service supports traveller support at the incident site including emergency first response. This also includes notifying other drivers about the incident, incident status, and detour or alternative route guidance. This is achieved through presentation of information to affected travelers using the Traffic Information Dissemination service and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information services.	- Emergency Response Management - MCM Incident Management - Roadway Equipment Coordination - TMC Incident Dispatch Coordination/Communication.
	GOT-403. Incident and Event Coordination	***ATMS08 (US) – Traffic Incident Management System***	This service manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The service includes incident detection capabilities through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as rail operations and event promoters. Information from these diverse sources is collected and correlated by this service to detect and verify incidents and implement an appropriate response. This service supports traffic operations personnel in developing an appropriate	- Emergency Response Management - Incident Command - TMC Incident Dispatch Coordination/Communication. - MCM Incident Management

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			response in coordination with emergency management, maintenance and construction management, and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications or resource coordination between center subsystems. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.	
	GOT-404. Hazardous materials monitoring and management	***CVO10 (US) – HAZMAT Management*** ***CVO10 (CAN) – Hazardous Material Planning and Incident Response***	This service integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter	- Fleet HAZMAT Management - Vehicle Location Determination. - May day support - Emergency Commercial Vehicle Support

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.	
	GOT-405 Incident Monitoring and Confirmation			-
	GOT-406 Incident Response and Clearance			-
GI.1 Disaster data management	***GI-101. Disaster and emergency data collection***	***EM07 (US) - Early Warning System***	This service collects emergency data via monitoring and detecting potential, looming, and actual disasters including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and acts of terrorism including nuclear, chemical, biological, and radiological weapons attacks).	- Field Secure Area Sensor Management - Field Secure Area Surveillance. - Emergency Early Warning System - Emergency Environmental Monitoring
	GI-102.	***EM08 (US) –***	This service develops disaster and emergency data	- Emergency Response

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	Disaster and emergency data sharing	***Disaster Response and Recovery***	sharing. This includes developing agency agreements to share the emergency data collected via several sources. The service also includes developing communications protocol/capabilities for such kind of data sharing between various emergency response and other transportation agencies.	Management
GI.2 Disaster response management	***GI-201. Disaster response planning for transport network***	***EM08 (US) – Disaster Response and Recovery***	This service enhances the ability of the surface transportation system to respond to and recover from disasters. The service supports coordination of emergency response plans, including general plans developed before a disaster as well as specific tactical plans with short time horizon that are developed as part of a disaster response.	- Emergency Response Management - Incident Command.
	GI-202. Disaster response implementation	***EM08 (US) – Disaster Response and Recovery***	This service supports actual disaster response implementation and defines roles of all the emergency response as well as other transportation agencies involved. The service identifies the key points of integration between transportation systems and the public safety, emergency management, and other allied organizations that form the overall disaster response. In this service, the Emergency Management subsystem represents	- Emergency Response Management - Incident Command - MCM Incident Management - TMC Incident Coordination/Communications

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			the federal, regional, state, and local Emergency Operations Centers and the Incident Commands that are established to respond to the disaster. The interface between the Emergency Management Subsystem and the other center subsystems provides situation awareness and resource coordination among transportation and other allied response agencies. In its role, traffic management implements special traffic control strategies and detours and restrictions to effectively manage traffic in and around the disaster. Maintenance and construction provides damage assessment of road network facilities and manages service restoration. Transit management provides a similar assessment of status for transit facilities and modifies transit operations to meet the special demands of the disaster. As immediate public safety concerns are addressed and disaster response transitions into recovery, this service supports transition back to normal transportation system operation, recovering resources, managing on-going transportation facility repair, supporting data collection and revised plan coordination, and other recovery activities.	- Transit Centre Security.

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
GI.3 Coordination with emergency agencies	***GI-301. Disaster response coordination***	***EM08 (US) – Disaster Response and Recovery***	The service supports coordination of emergency response plans, including general plans developed before a disaster response. In addition, this service tracks and coordinates the transportation resources - the transportation professionals, equipment, and materials - that constitute a portion of the disaster response.	- Emergency Response Management - MCM Incident Management - TMC Incident Coordination/Communications
MA.1 Weather monitoring	***MA-101. Road weather information monitoring***	***MC03 (US) – Road Weather Data Collection***	This service collects and monitors 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 Road Weather Prediction Service to process the information and make decisions on operations.	- Roadway Environmental Monitoring - Roadway Probe Beacon - TMC Environmental Monitoring
	MA-102. Road weather prediction	***MC04 (US) – Road Weather Information***	This service processes the environmental information. This service uses the environmental data to detect/predict environmental hazards such	- Emergency Environmental Monitoring - TMC Environmental

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		Processing and Distribution	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, and aid operators in scheduling work activity.	Monitoring
MA.2 Environmental conditions monitoring	***MA-201. Water level /Tidal monitoring and prediction***	***EM07 (US) Early Warning System***	This service monitors water level and tidal conditions to detect/predict floods, abnormal water level patterns, etc. to issue early warnings about floods. The service includes monitoring equipment and communication/coordination to issue warnings.	- Emergency Environmental Monitoring - Emergency Early Warning System
	MA-202. Seismic monitoring	***EM07 (US) Early Warning System***	This service monitors seismic activities to detect/predict earthquakes to issue early warnings and prepare earthquake response management. The service includes monitoring equipment and communication/coordination to issue warnings.	- Emergency Environmental Monitoring - Emergency Early Warning System
	MA-203. Pollution monitoring	***AMTS11 (US & CAN) – Emissions Monitoring***	This service 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	- Emissions Data Management - Roadway Emissions Monitoring

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		and Management	management subsystem for processing. Both area wide air quality monitoring and point emissions monitoring are supported by this service. For area wide monitoring, this service 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 service measures tail pipe emissions and identifies vehicles that exceed emissions standards. Summary emissions information or warnings can also be displayed to drivers. The gathered information can be used to implement environmentally sensitive TDM programs, policies, and regulations.	- Roadway Equipment Coordination
TP.1 Public transport management	***TP-101. Public transport vehicle internal systems monitoring***	***APTS6 (US & CAN) – Transit Maintenance*** ***APTS5 (US) – Transit Security*** ***APTS5 (CAN) – Public Travel***	This service supports transit system monitoring for maintenance and security purposes. This service 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. This service also provides for the physical security of	- Transit Centre Security - Onboard Transit Security - Transit Garage Maintenance - Onboard Transit Maintenance

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		Security	transit passengers and transit vehicle operators. On-board equipment is deployed to perform surveillance and sensor monitoring in order to warn of potentially hazardous situations. The surveillance equipment includes video (e.g., CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g., metal detectors). Transit user or transit vehicle operator activated alarms are provided on-board.	
	TP-102. Public transport Vehicle fleet tracking	***APTS1 (US & CAN) – Transit Vehicle Tracking***	This service monitors current transit vehicle location using an Automated Vehicle Location System. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. Fixed route transit systems may	- Transit Centre Vehicle Tracking - Onboard Transit Trip Monitoring - Vehicle Location Determination

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the Information Service Provider.	
	TP-103. Public transport Scheduling services	***APTS2 (US & CAN) – Transit Fixed Route Operations***	This service performs vehicle routing and scheduling. This service determines current schedule performance using AVL data and provides information displays at the Transit Management Subsystem. Static and real time transit data is exchanged with Information Service Providers where it is integrated with that from other transportation modes (e.g. rail, ferry, air) to provide the public with integrated and personalized dynamic schedules.	- Transit Centre Fixed-route Operations - Transit Vehicle Operating Scheduling - Onboard Fixed Route Schedule Management
	TP-104. Public transport Service dispatch	***APTS2 (US & CAN) – Transit Fixed Route Operations***	This service supports dispatch services for the transit fixed-route operations. This package includes automatic operator assignment and system monitoring for fixed-route and flexible-route transit services. This package also includes transit management/dispatch centre communications and tracking capabilities. Two way communications	- Transit Vehicle Operating Scheduling - Transit Centre Vehicle Tracking

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			with the transit vehicle is supported for the dispatch coordination.	
	TP-105. Public transport Service planning			
TP.2 Demand responsive and shared public transport	***TP-201. Paratransit fleet dispatch***	***APTS3 (US) – Demand Response Transit Operations*** ***APTS3 (CAN) – Demand Responsive Transit***	This service performs vehicle routing and scheduling as well as automatic operator assignment and monitoring for demand responsive transit services. In addition, this service performs similar functions to support dynamic features of flexible-route 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.	- Transit Vehicle Operating Scheduling - Transit Centre Paratransit Operations - Onboard Paratransit Operations
	TP-202. Dynamic	***APTS3 (US) – Demand***	This service includes the capability for a traveler request for personalized transit services to be made	- Transit Centre Paratransit Operations

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	ridesharing	***Response Transit Operations*** ***APTS3 (CAN) – Demand Responsive Transit***	through the Information Service Provider (ISP) Subsystem. The ISP may either be operated by a 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 that the paratransit service is a viable means of satisfying a traveler request and makes a reservation for the traveler. This service also provides dynamic ridesharing/ride matching services to non-transit 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.	- Onboard Paratransit Operations
IV.1 Pre-trip Information	***IV-101. Pre-trip information – Traffic and roadway***	***ATIS1 (US & CAN) – Broadcast Traveller Information***	This service provides pre-trip traffic and roadway information via several different sources including traffic broadcasts by radio, TV, etc., interactive traveller information via websites, telephones, yellow page reservation numbers, etc. The broadcasted traffic/roadway information includes	- ISP Traveller Data Collection - Personal Basic Information Reception - Remote Basic Information

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		ATIS2 (US & CAN) – Interactive Traveller Information	traffic conditions, advisories, general public transportation, toll and parking information, incident information, roadway maintenance and construction information, air quality and weather information through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). Interactive traveler information supports both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, roadway maintenance and construction, detours and pricing information. A range of two-way wide-area wireless and fixed-point to fixed-point communications systems may be used to support the required data communications between the traveler and Information Service Provider. A variety of interactive devices may be used by the traveler to access information prior to a trip including phone via a 511-like portal, Personal Digital Assistant, and personal computer, etc.	Reception - Traveller Telephone Information - Personal Interactive Information Reception - Remote Interactive Information Reception
	IV-102.	***ATIS2 (US &***	This service provides pre-trip information about	- ISP Traveller Data

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	Pre-trip information – Public transport (bus and rail)	***CAN) – Interactive Traveller Information*** ***APTS8 (US & CAN) – Transit Traveller Information***	public transportation via interactive traveller information sources. Interactive traveler information supports both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding transit services, transit transfer centers, etc. A range of two-way wide-area wireless and fixed-point to fixed-point communications systems may be used to support the required data communications between the traveler and transit information service provider. A variety of interactive devices may be used by the traveler to access information prior to a trip including phone via a 511-like portal, Personal Digital Assistant, and personal computer, etc.	Collection - Personal Basic Information Reception - Remote Basic Information Reception - Traveller Telephone Information - Personal Interactive Information Reception - Remote Interactive Information Reception
	IV-103. Pre-trip information – Commercial vehicle		This service provides pre-trip traveller information about commercial vehicles via interactive traveller information services. A variety of interactive devices may be used by the traveler to access information prior to a trip including phone via a 511-like portal, Personal Digital Assistant, and personal computer, etc.	- Traveller Telephone Information - Personal Interactive Information Reception - Remote Interactive Information

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	IV-104. Pre-trip information – Personal interactive			
	IV-105. Pre-Trip Information – Multimodal Routing Opportunities and Real Time Information	***ATIS2 (US & CAN) – Interactive Traveller Information*** ***APTS7 (US & CAN) – Multi-modal Coordination***	This service provides multimodal transportation traveller information like alternative modes of transportation, transfer centres, park and ride facilities, and multimodal trip plan via interactive traveller information. A variety of interactive devices may be used by the traveler to access information prior to a trip including phone via a 511-like portal, Personal Digital Assistant, and personal computer, etc.	- Traveller Telephone Information - Personal Interactive Information Reception - Remote Interactive Information
IV.2 On-trip Information	***IV-201. On-trip information – Roadside***	***ATMS06 (US & CAN) – Traffic Information Dissemination***	This service provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic and road conditions, closure and detour information, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. Careful placement of	- Roadway Equipment Coordination - Roadway Traffic Information Dissemination - TMC Traffic Information Dissemination

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information.	
	IV-202. On-trip information – In-vehicle signing	***ATIS9 (US & CAN) – In-Vehicle Signing***	This service supports distribution of traffic and travel advisory information to drivers through in-vehicle devices. It includes short range communications between roadside equipment and the vehicle and wireline connections to the Traffic Management Subsystem for coordination and control. This service also informs the driver of both highway-highway and highway-rail intersection status.	- Roadway In-Vehicle Signing - TMC Input to In-Vehicle Signing - In-Vehicle Signing System
	IV-203. On-trip information – Public transport vehicle	***APTS8 (US & CAN) – Transit Traveller Information***	This service provides transit users 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 service.	- ISP traveller Data Collection - Personal Interactive Information Reception - Remote Transit Information Services - Transit Centre Information Services
	IV-204.	***ATIS2 (US &***	This service provides parking related information	- Roadway Equipment

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	On-trip Information – Parking information	***CAN) – Interactive Traveller Information***	using roadside and interactive traveller information services. The roadside equipment include DMS signs and interactive sources include phone via a 511-like portal, Personal Digital Assistant, and personal computer, etc.	Coordination - Traveller Telephone Information - Personal Interactive Information Reception - Remote Interactive Information
	IV-205. On-trip information through mobile devices	***ATIS4 (US & CAN) – Dynamic Route Guidance***	This service offers advanced route planning and guidance that is responsive to current conditions. The package combines the autonomous route guidance user equipment with a digital receiver capable of receiving real-time traffic, transit, and road condition information, which is considered by the user equipment in provision of route guidance.	- Personal Autonomous Route Guidance - Personal Basic Information Reception - Personal Location Determination - Vehicle Location Determination
IV.3 Travel services information	***IV-301. Travel services information – In-vehicle***	***ATIS2 (US & CAN) – Interactive Traveller Information***	This service provides travel services information using standard yellow pages and interactive traveller information like phone, websites, etc. A variety of interactive devices may be used by the traveler to access information prior to a trip including phone via a 511-like portal, Personal	- Infrastructure Provided Yellow Pages & Reservation - Personal Interactive Information Reception - Interactive Vehicle

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
		ATIS7 (US & CAN) – Yellow Pages and Reservations	Digital Assistant, and personal computer, etc.	Reception
	IV-302. Travel services information – Personal interactive			
	IV-303. Travel services information – Dedicated location	***ATIS2 (US & CAN) – Interactive Traveller Information***	This service provides traveller services information at dedicated locations like transit stations/transfer centres, visitor information centres, rest areas, etc. A variety of interactive devices may be used including DMS sings, kiosks, brochures, etc.	- Interactive Infrastructure Information - Personal Interactive Information Reception - Remote Interactive Information Reception
IV.4 Route Guidance & navigation-Pre trip	***IV-401. Dynamic in-vehicle route guidance and navigation programming /setup***	***ATIS3 (US & CAN) – Autonomous Route Guidance***	This service relies on in-vehicle sensory, location determination, computational, map database, and interactive driver interface equipment to enable route planning and detailed route guidance based on static, stored information.	- Personal Autonomous Route Guidance - Personal Location Determination - Vehicle Autonomous Route Guidance

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	IV-402. Integrated multi-modal trip guidance	***ATIS5 (US & CAN) – ISP Based Route Guidance***	This service offers the user trip planning and guidance services. It generates a trip plan, including a multimodal route and associated service information (e.g., parking information), based on traveler preferences and constraints. Routes are based on static information on network conditions.	- Personal Trip Planning and Route Guidance - Remote Interactive Information Reception - ISP Traveller Data Collection - Infrastructure Provided Trip Planning
	IV-403. Pedestrian and bicycle route guidance		This service provides pre-trip route guidance to pedestrians and bikeways via interactive traveller information and ISP based route guidance. The information provided includes information about bike trails, pedestrian friendly communities/areas, ADA compliant walkways, etc. A variety of devices including a telephone service like 511, kiosks, personal computers, etc. are used to provide such information.	- Traveller Telephone Information - Personal Interactive Information Reception - Remote Interactive Information
IV.5 Route guidance & navigation-On trip	***IV-501. Autonomous in-vehicle navigation***	***ATIS3 (US & CAN) – Autonomous Route Guidance***	This service relies on in-vehicle sensory, location determination, computational, map database, and interactive driver interface equipment to enable route planning and detailed route guidance based on static, stored information.	- Personal Autonomous Route Guidance - Personal Location Determination - Vehicle Autonomous Route Guidance

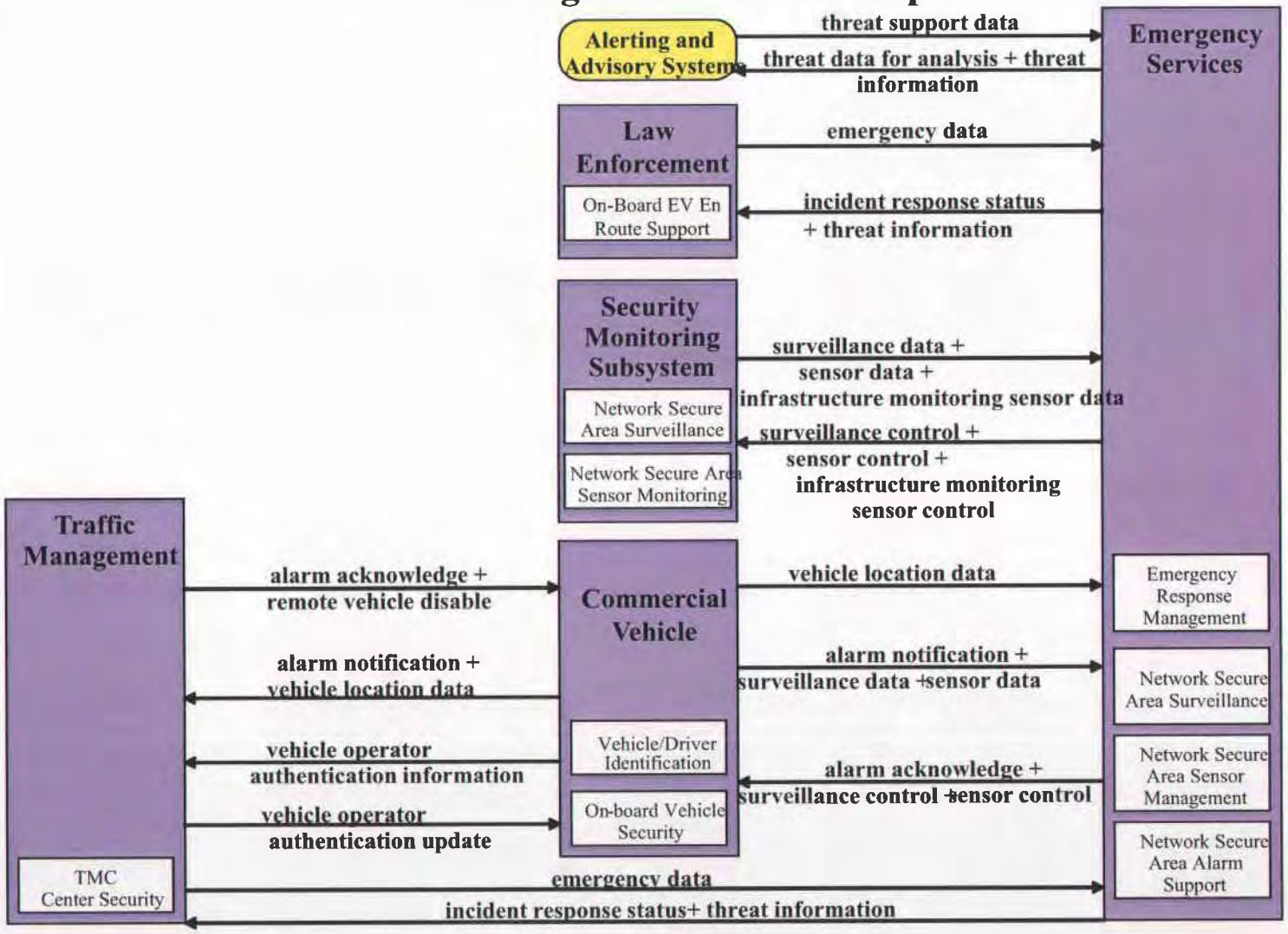
Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	IV-502. Dynamic in-vehicle route guidance and navigation (based on real-time network information)	***ATIS4 (US & CAN) – Dynamic Route Guidance***	This service offers advanced route planning and guidance that is responsive to current conditions. The package combines the autonomous route guidance user equipment with a digital receiver capable of receiving real-time traffic, transit, and road condition information, which is considered by the user equipment in provision of route guidance.	- Personal Autonomous Route Guidance - Personal Location Determination - Vehicle Autonomous Route Guidance - Basic Information Broadcast - ISP Traveller Data Collection - Vehicle Location Determination - Basic Vehicle Reception
	IV-503. Integrated multi-modal	***ATIS5 (US & CAN) – ISP Based Route***	This service offers en-route guidance services. It generates a trip plan, including a multimodal route and associated service information (e.g., parking	- Personal Trip Planning and Route Guidance

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	trip guidance	***Guidance***	information), based on traveler preferences and constraints. Routes are based on real time network conditions. The route determination functions are performed in the Information Service Provider Subsystem in this service. The trip plan may be confirmed by the traveler and advanced payment and reservations for transit and alternate mode (e.g., airline, rail, and ferry) trip segments, and ancillary services (e.g., parking reservations) are accepted and processed.	- Remote Interactive Information Reception - ISP Traveller Data Collection
	IV-504. Pedestrian and bicycle route guidance		This service provides directions for pedestrians and cyclists to the location for the crosswalks and bike trails. This package supports audio/advanced directions to such facilities.	
IV.6 Trip planning support	***IV-601. Individual trip planning***	***ATISS (US & CAN) – ISP Based Route Guidance***	This service provides personalized multimodal trip planning and route guidance based on the user preferences and constraints	- Personal Trip Planning and Route Guidance - Remote Interactive Information Reception - ISP Traveller Data Collection - Infrastructure Provided Trip Planning
	IV-602. Data	***AD1 (US &***	This service provides a focused archive that houses	- Government Reporting

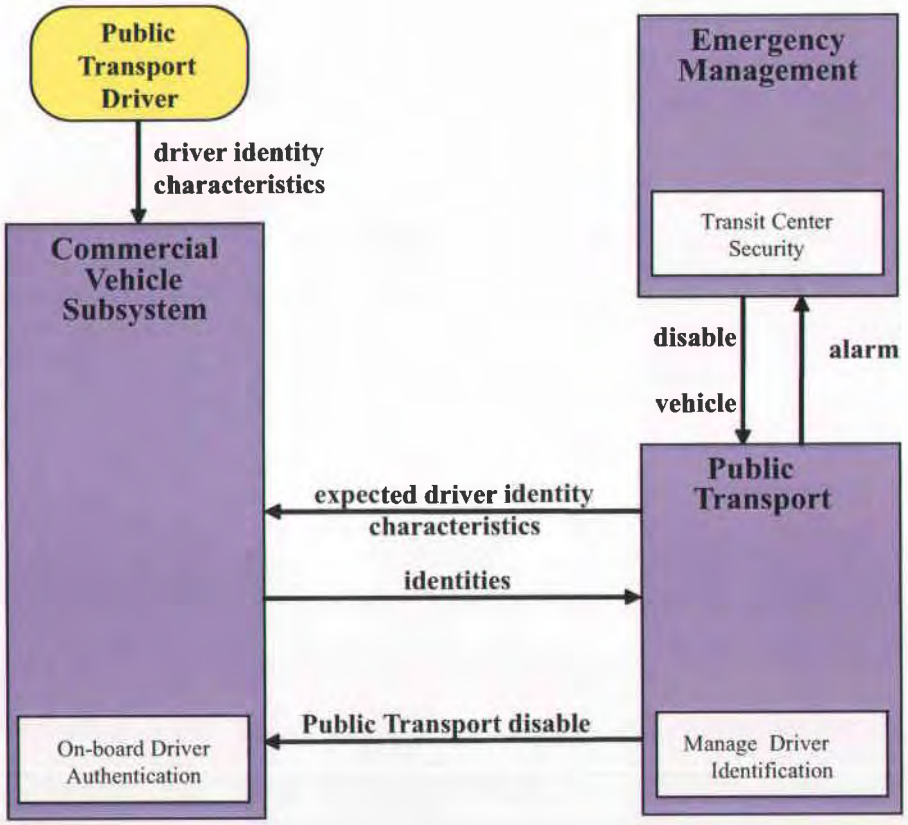
Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
	Archival	***CAN) – ITS Data Mart***	data collected and owned by a single agency, district, private sector provider, research institution, 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.	System Support - ITS Data Repository - Traffic and Roadside Data Archival - CV Data Collection - Emergency Data Collection - Emissions Data Collection - ISP Data Collection - MCM Data Collection - Parking Data Collection - Roadway Data Collection - Traffic Data Collection - Transit Data Collection - Toll Data Collection
	IV-603. Data warehouse	***AD2 (US & CAN) – ITS Data Warehouse***	This service includes all the data collection and management capabilities provided by the ITS Data Archival, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are	- Government Reporting System Support - ITS Data Repository - Online Analysis and Mining - Traffic and Roadside Data Archival - CV Data Collection

Service Group	Service	Corresponding US/Canada Market Packages, International Service Definitions	New Service Definition	Functional Components (equipment packages)
			necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this service in addition to the basic query and reporting user access features offered by the ITS Data Archival.	- Emergency Data Collection - Emissions Data Collection - ISP Data Collection - MCM Data Collection - Parking Data Collection - Roadway Data Collection - Traffic Data Collection - Transit Data Collection - Toll Data Collection

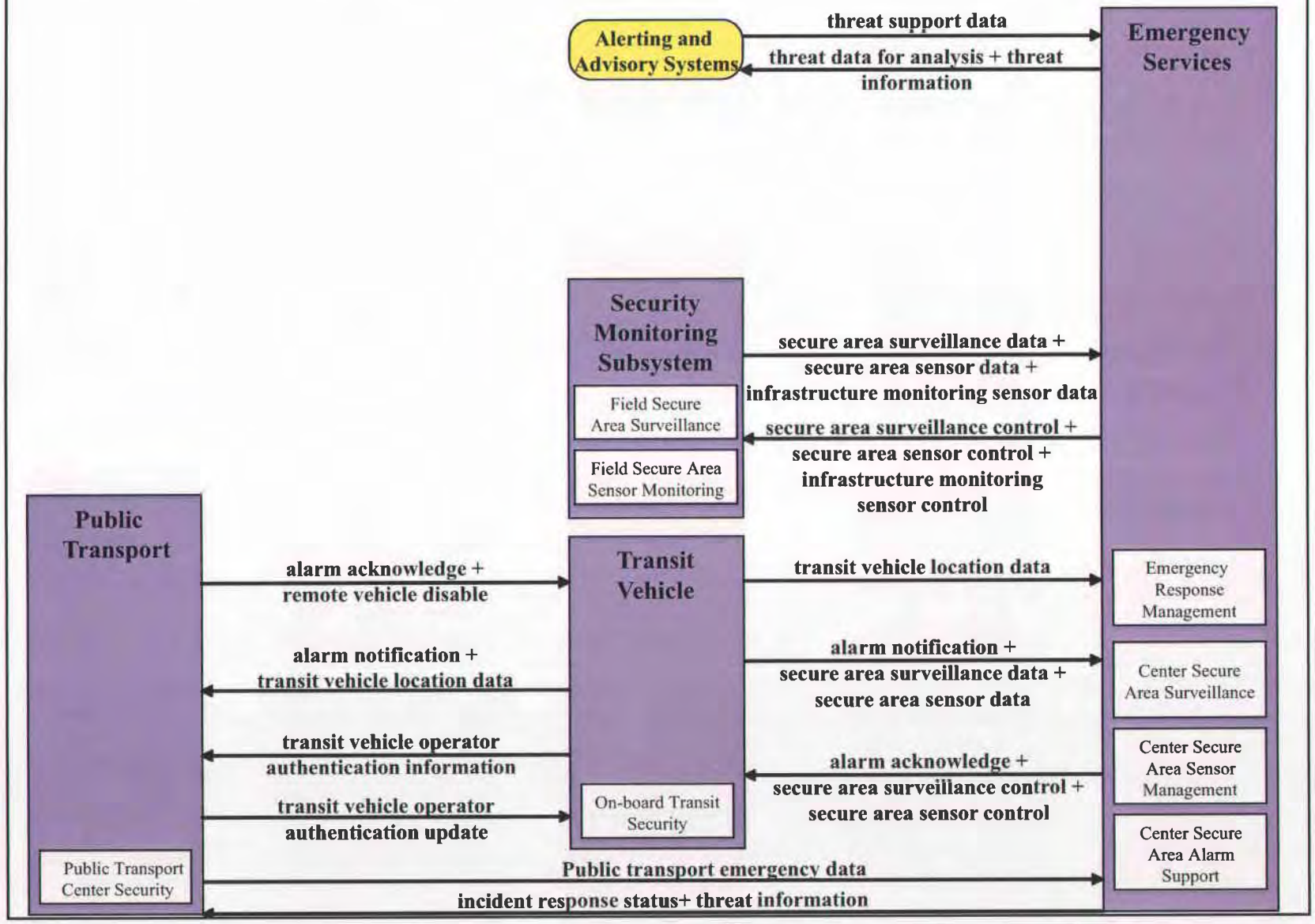
SN101 Monitoring and Control of Suspicious Vehicles



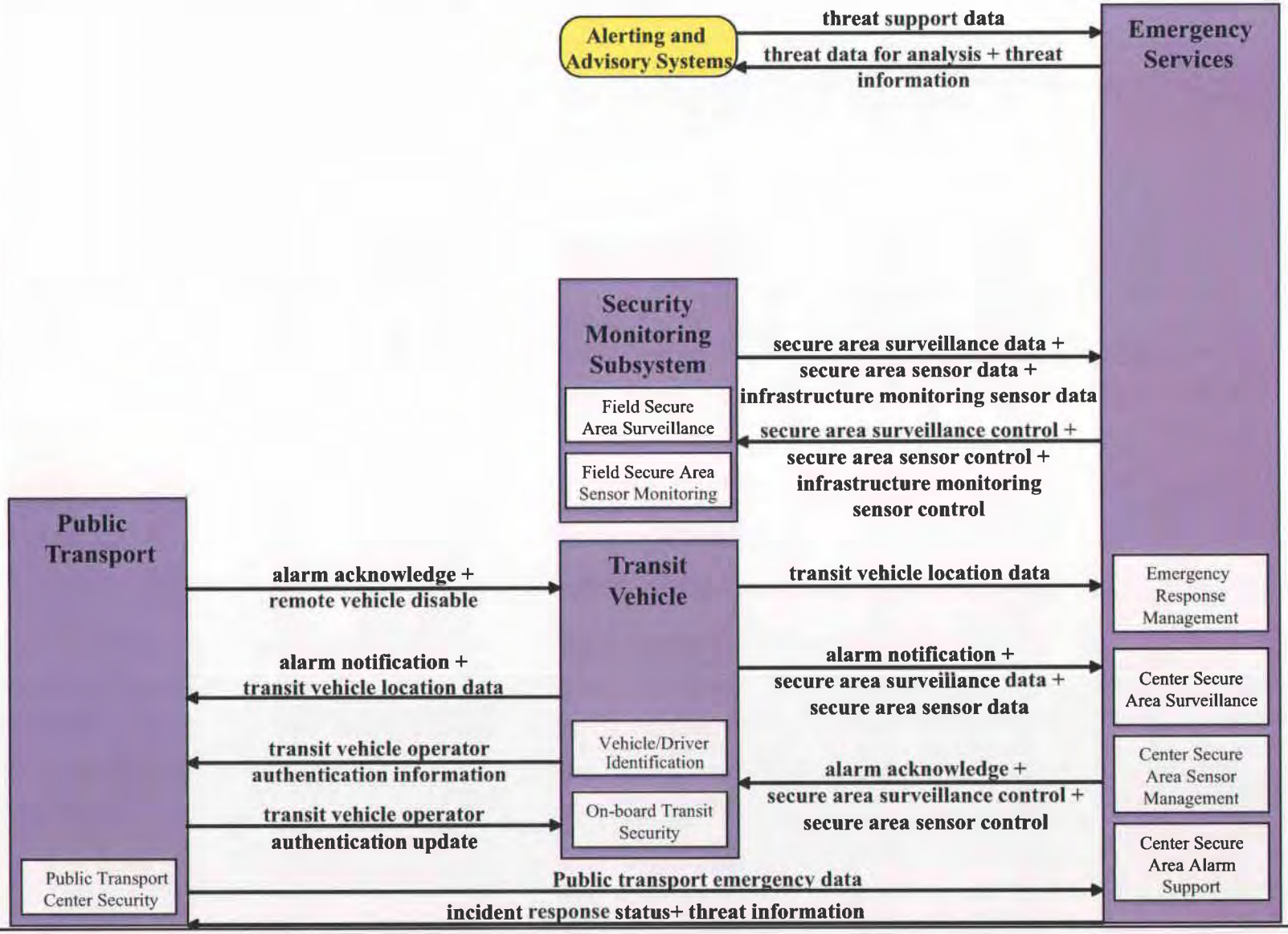
SP101 – Public Travel Security



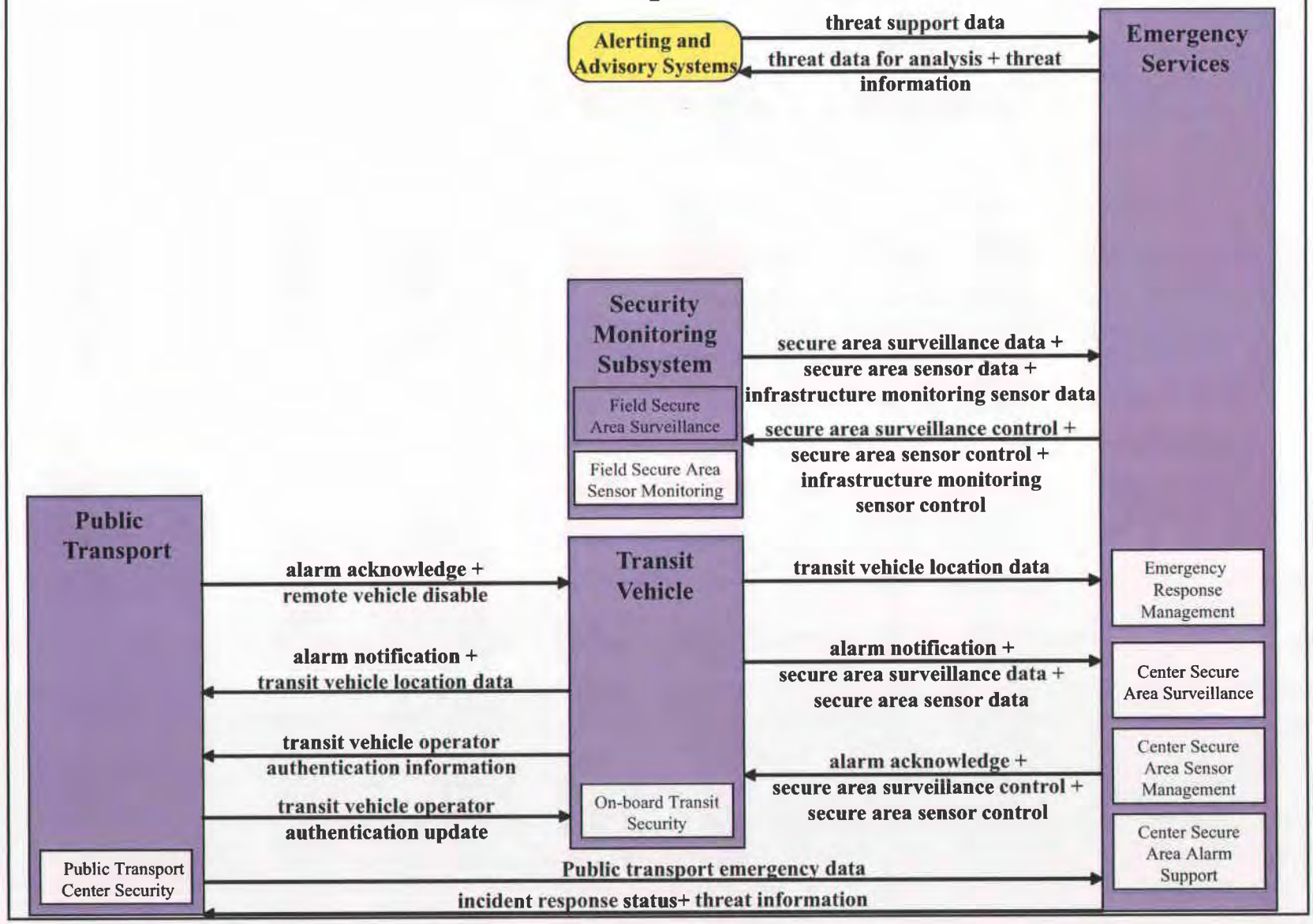
SP102 Mayday Alert for Public Transport



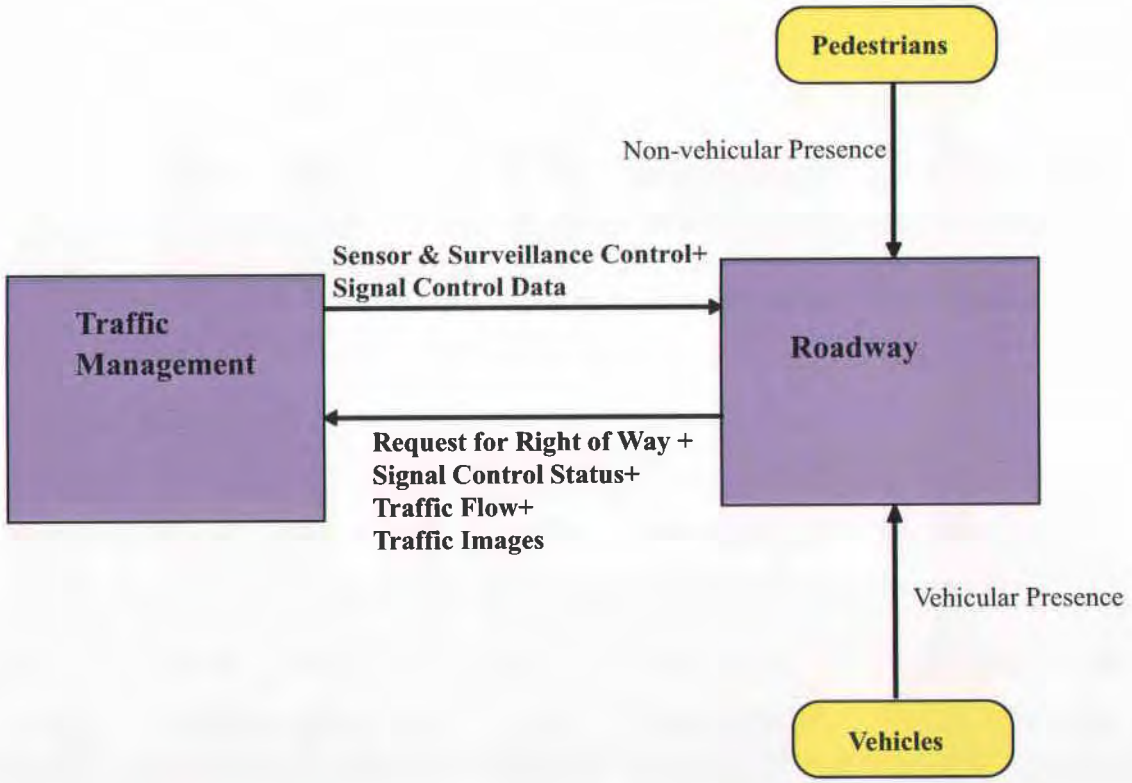
SP103 Intrusion Detection



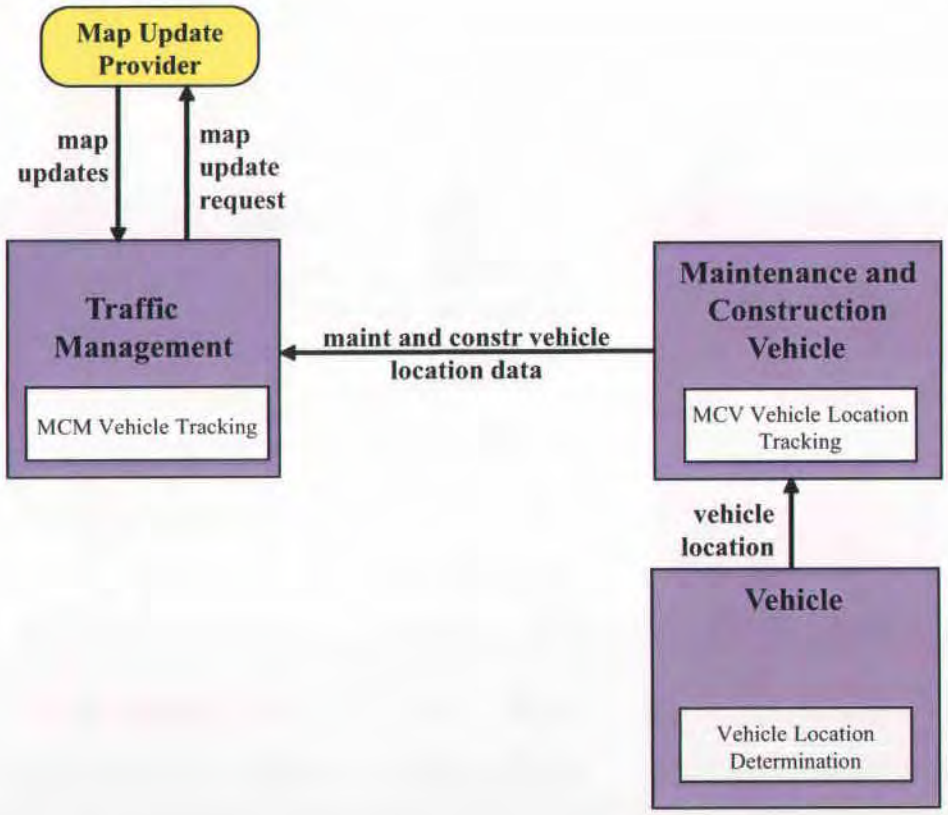
SP104 Public Transport Surveillance



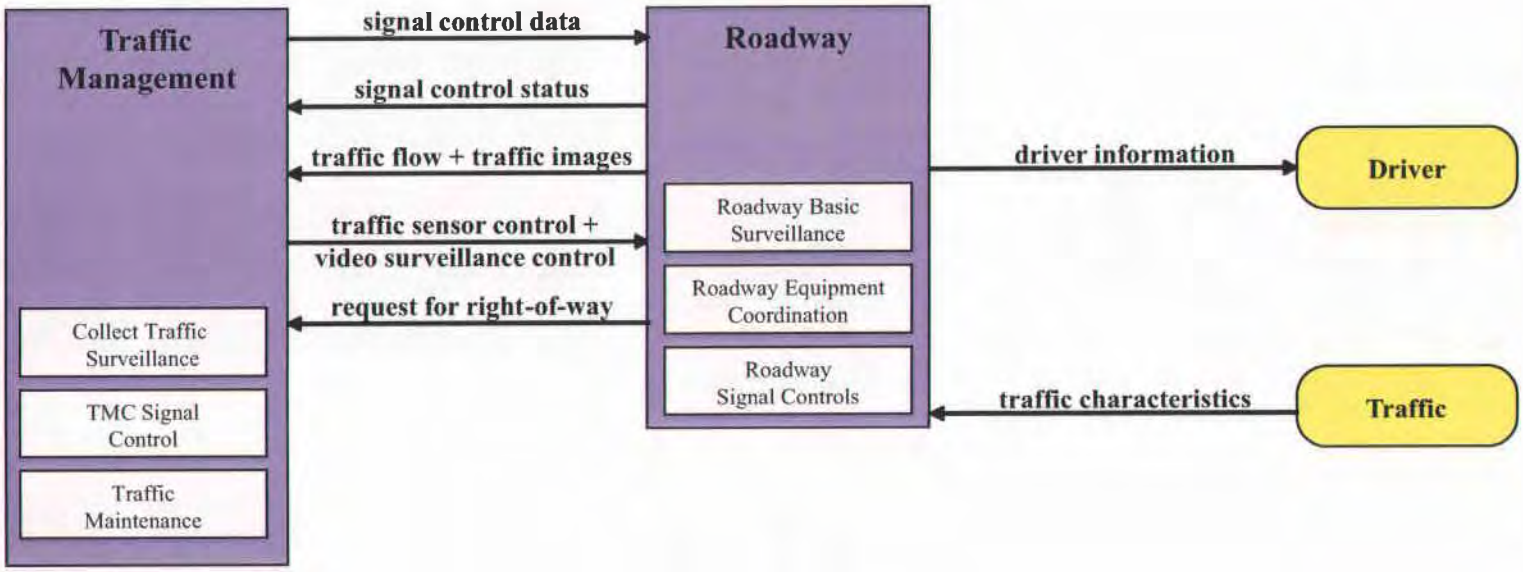
SP201 Non-Motorized Vehicles and Pedestrians Monitoring



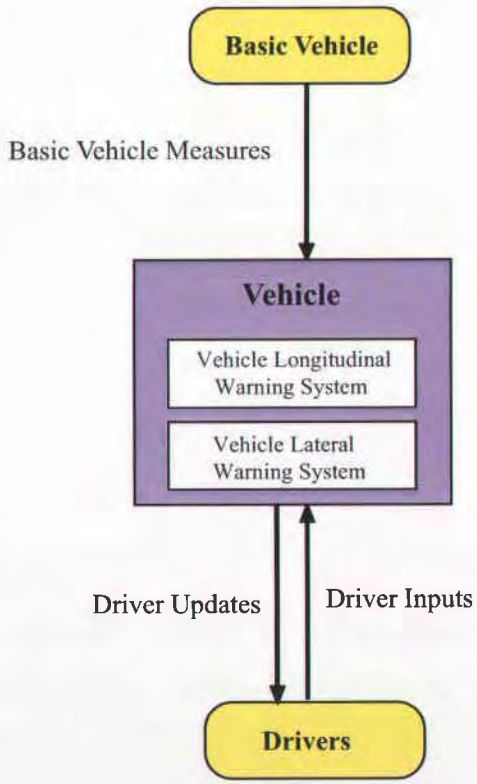
SP202 Systems to Monitor Specialized Vehicles



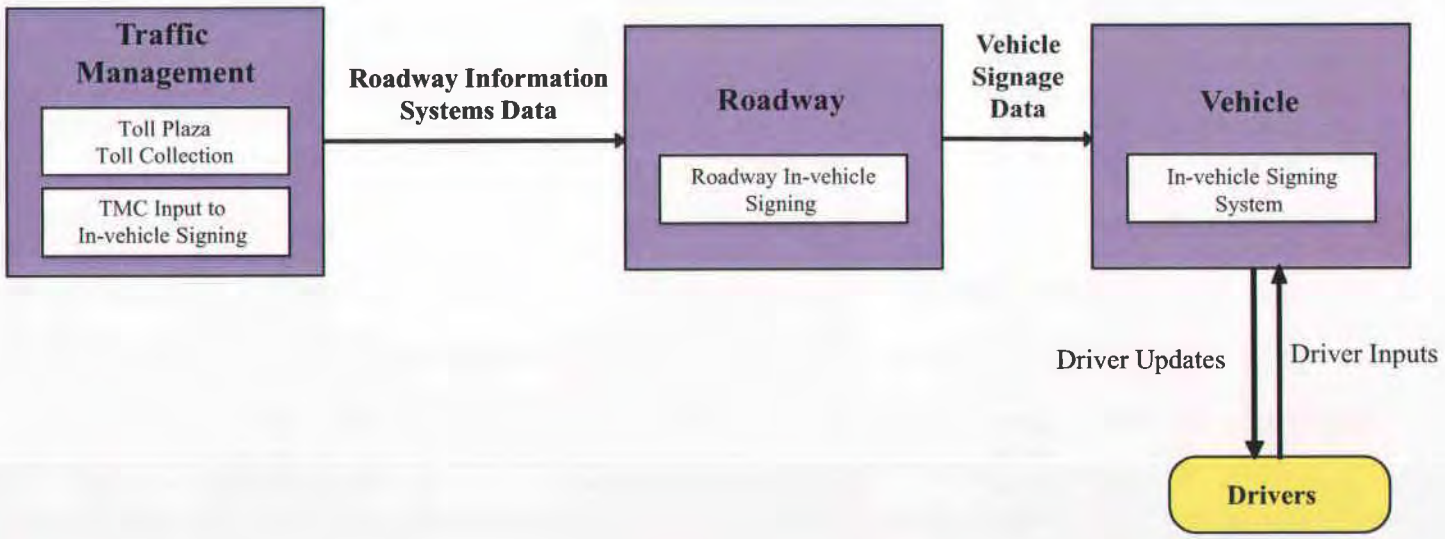
SP401 Signal Display Advanced Warning



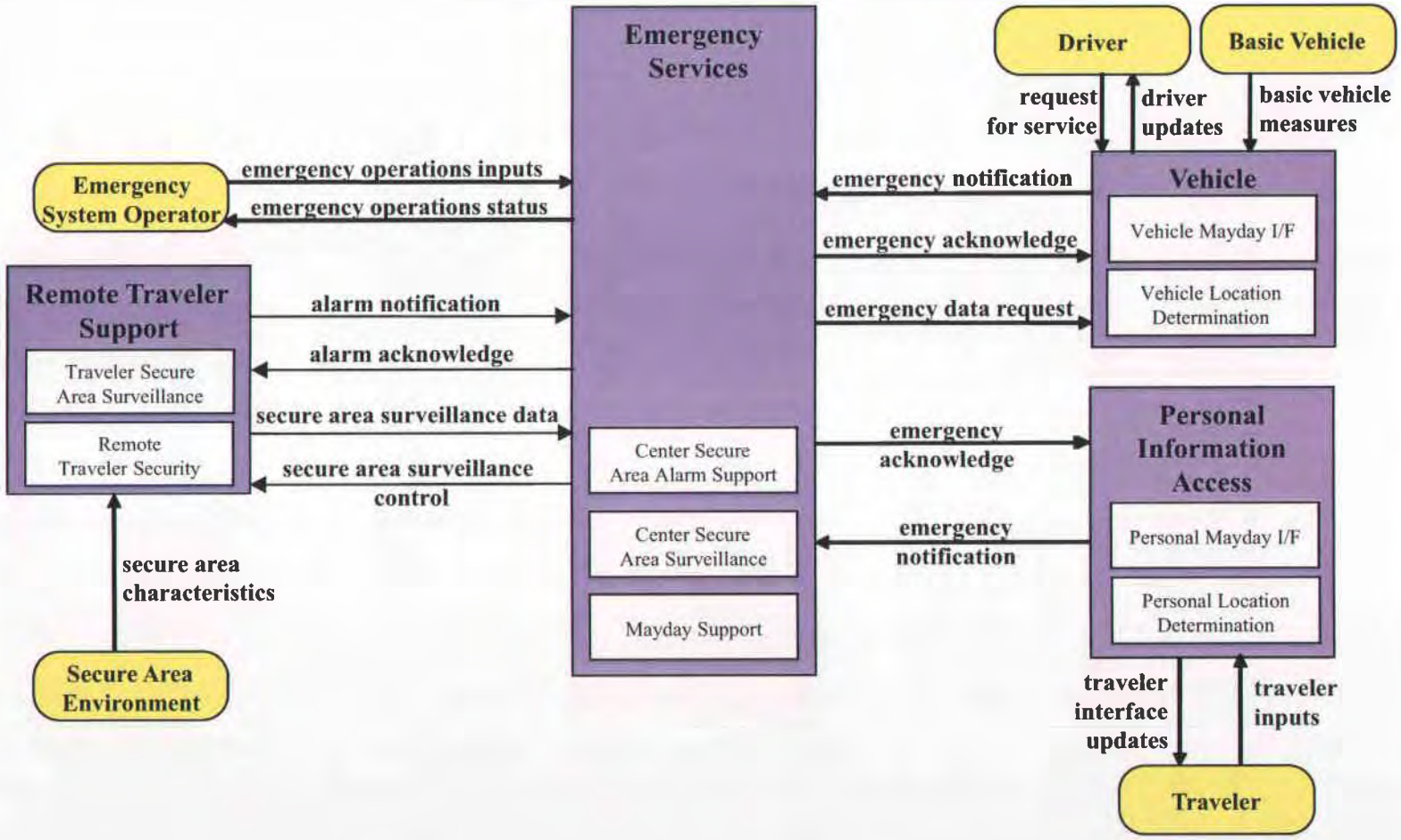
SP402 On-coming Vehicle Advanced Warning



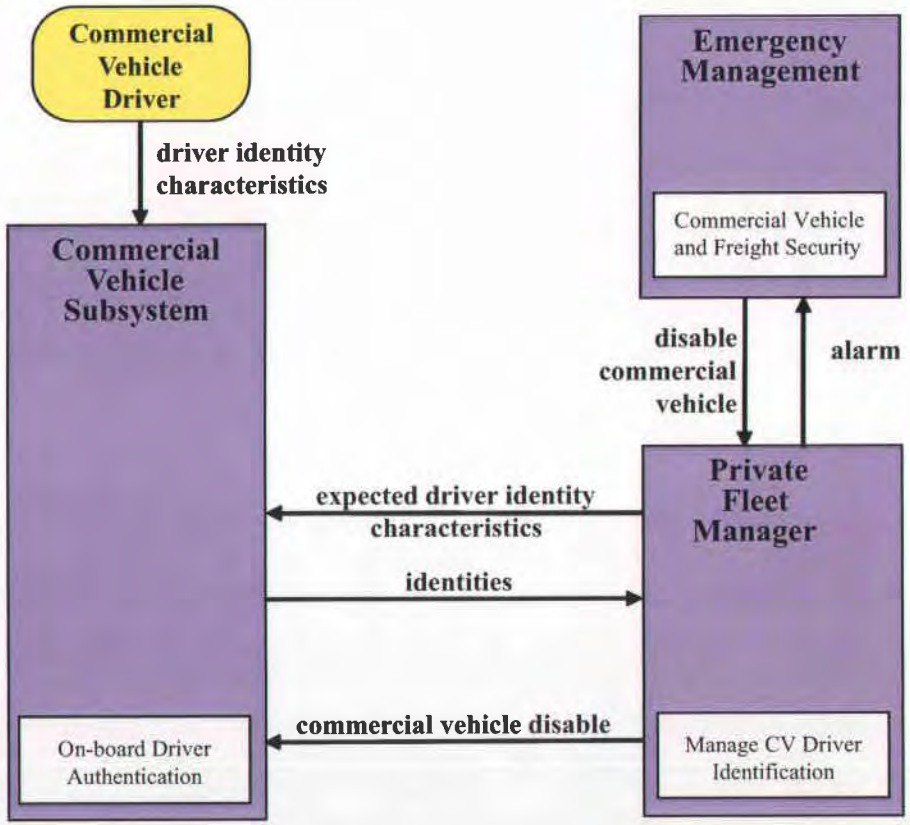
SP403 In-Vehicle Signage and Warning System



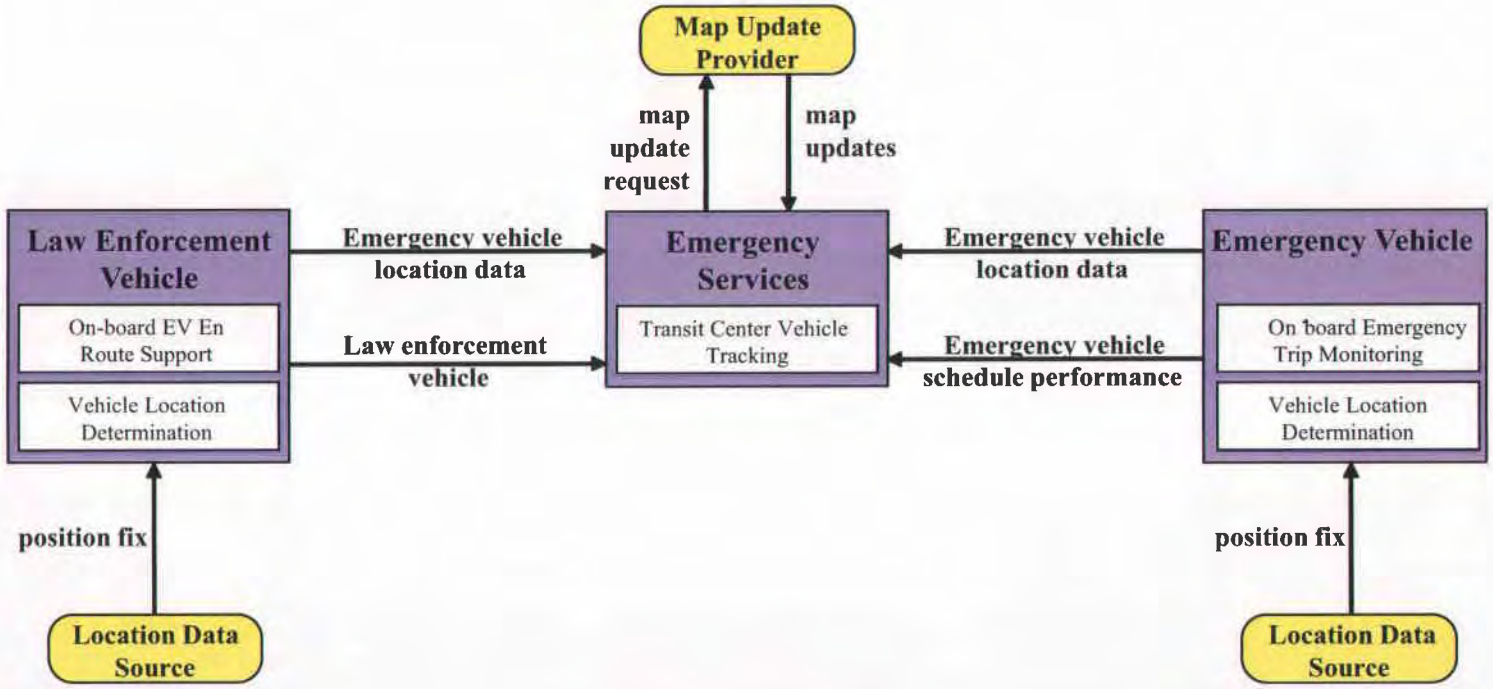
SE101 – Automated Mayday and 9-1-1 Dispatch



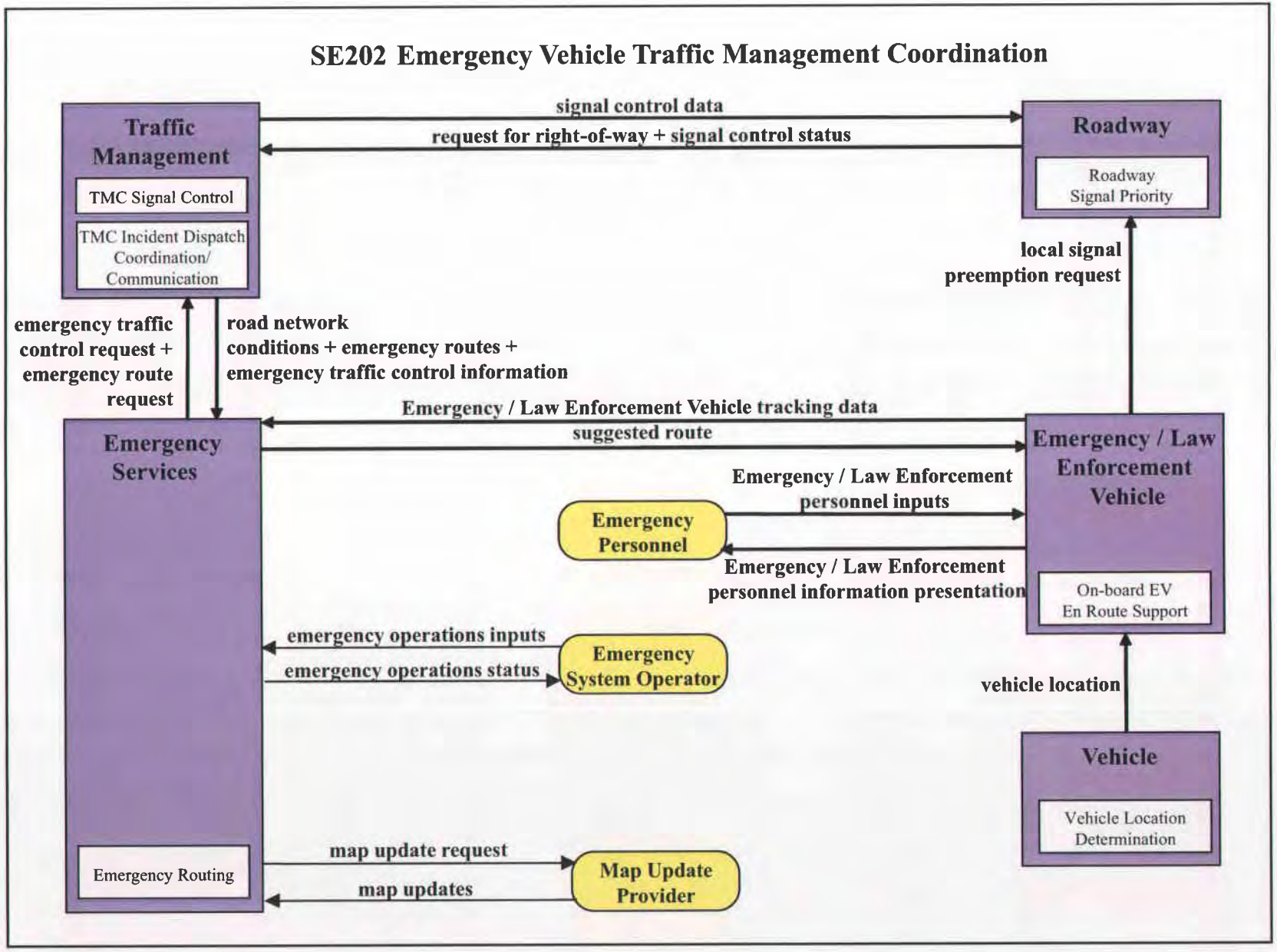
SE102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring



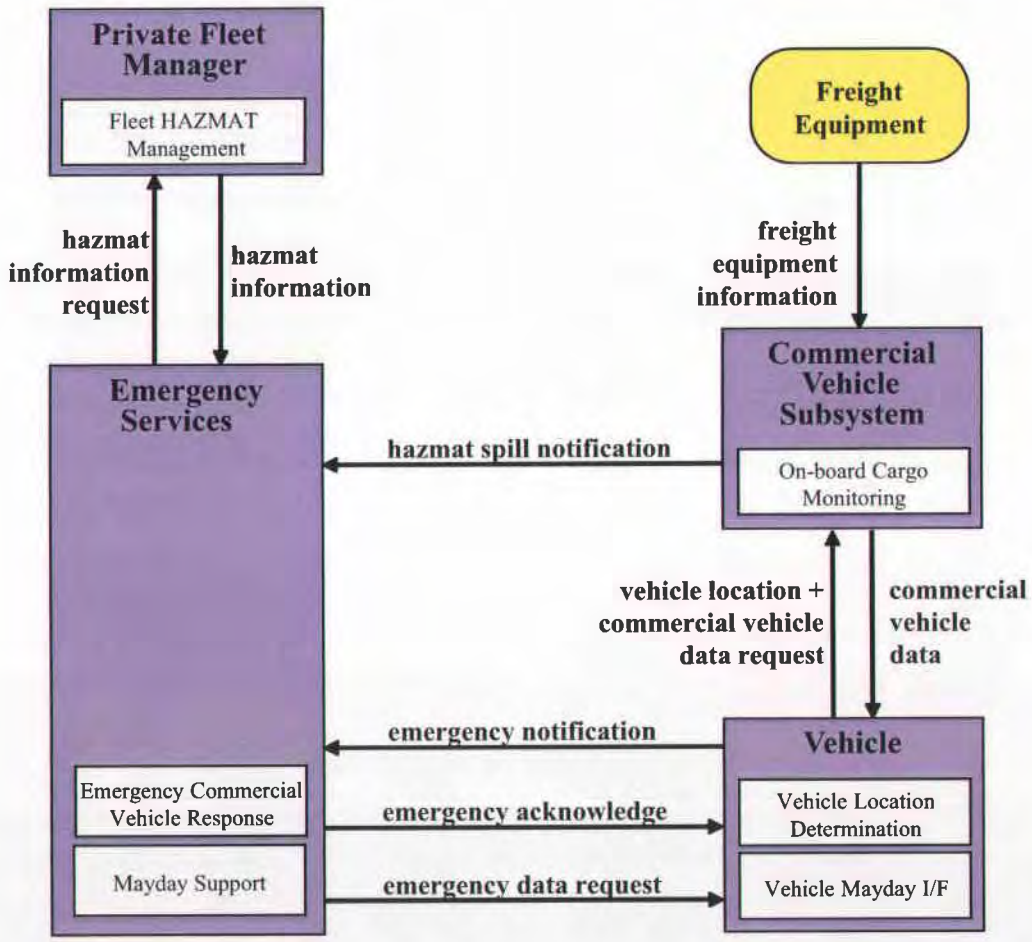
SE201 Emergency Vehicle Fleet Tracking



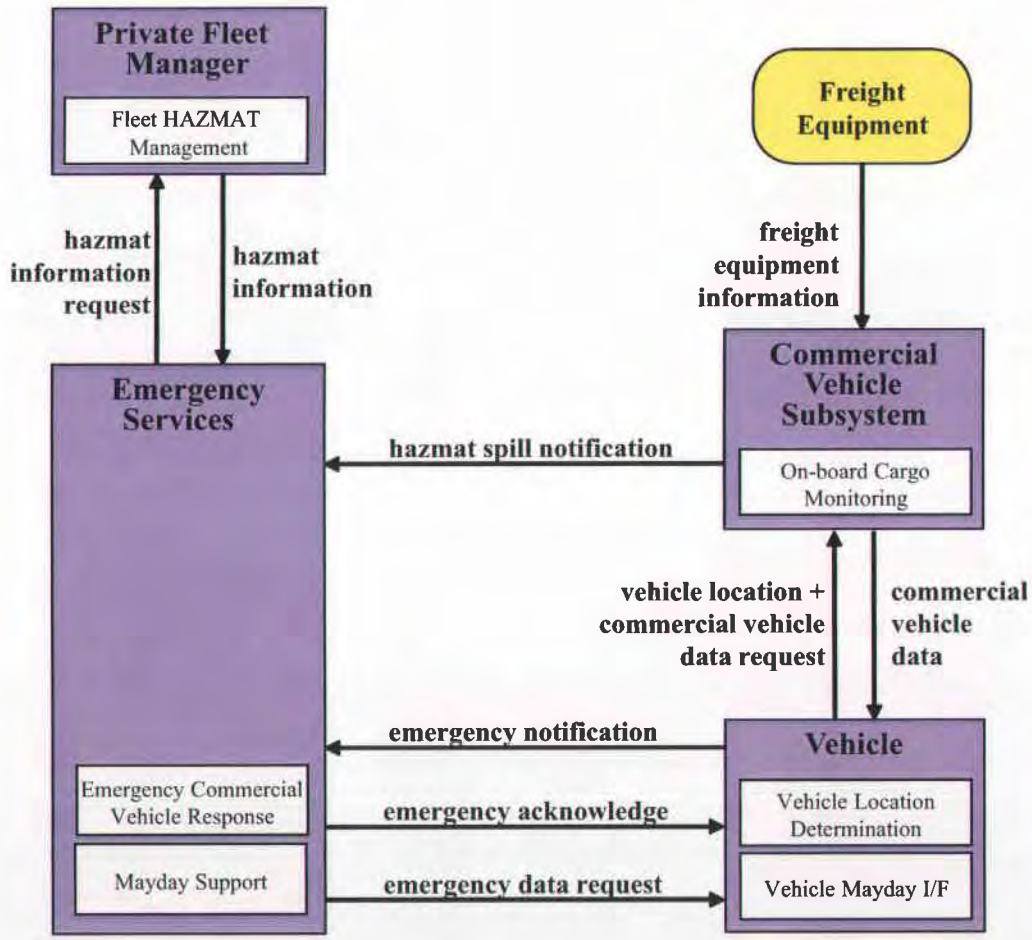
SE202 Emergency Vehicle Traffic Management Coordination



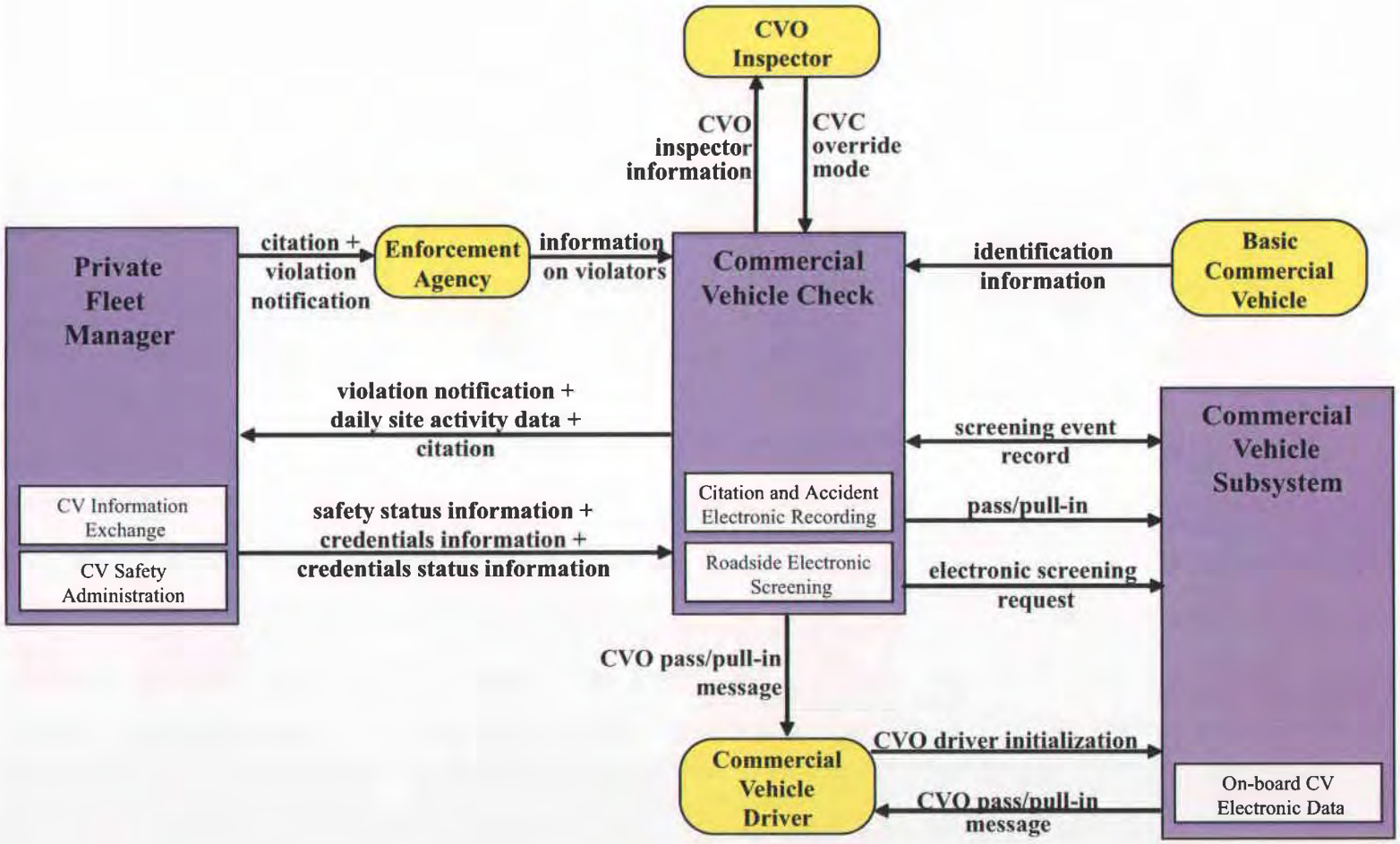
SE301- HAZMAT Vehicle Tracking



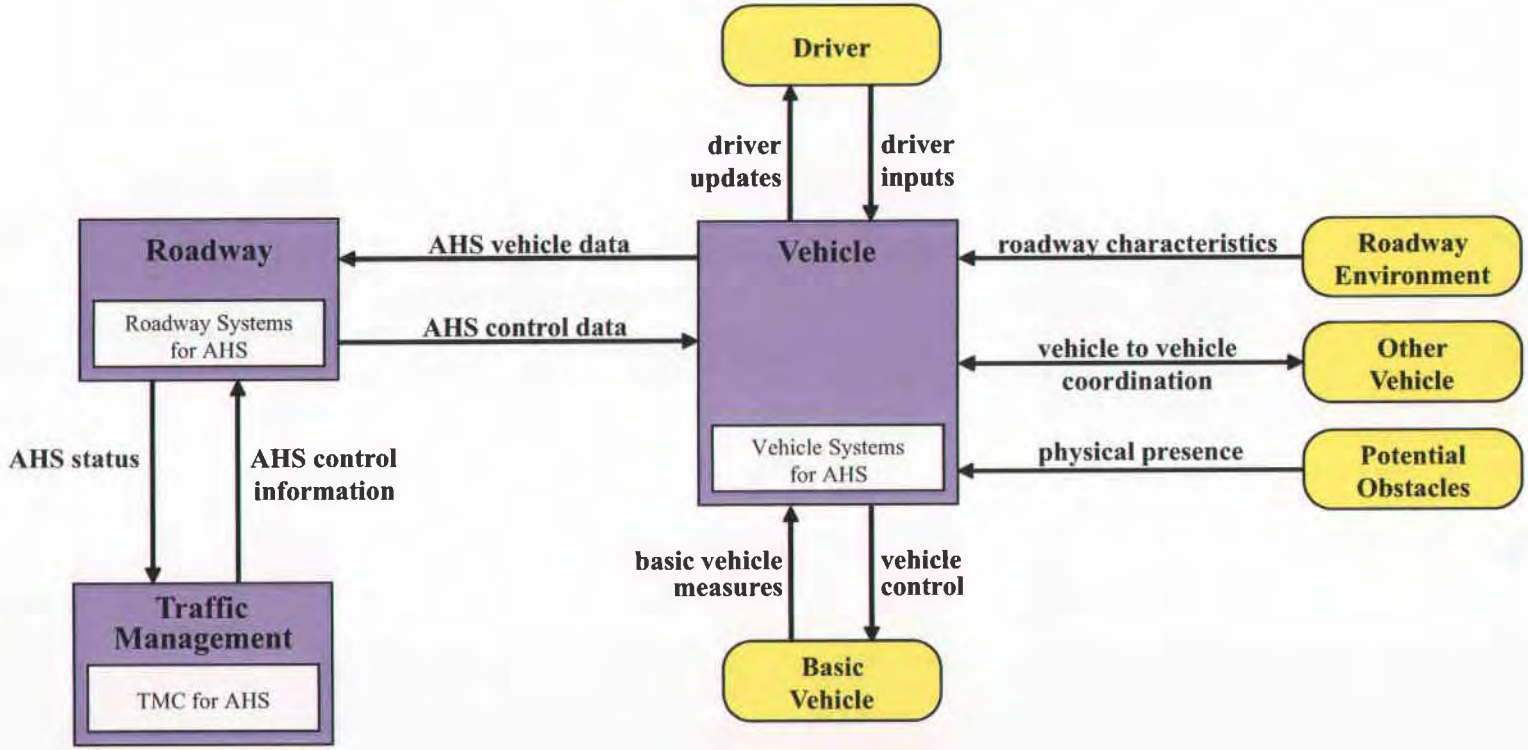
SE302 Automated HAZMAT 9-1-1 Notification



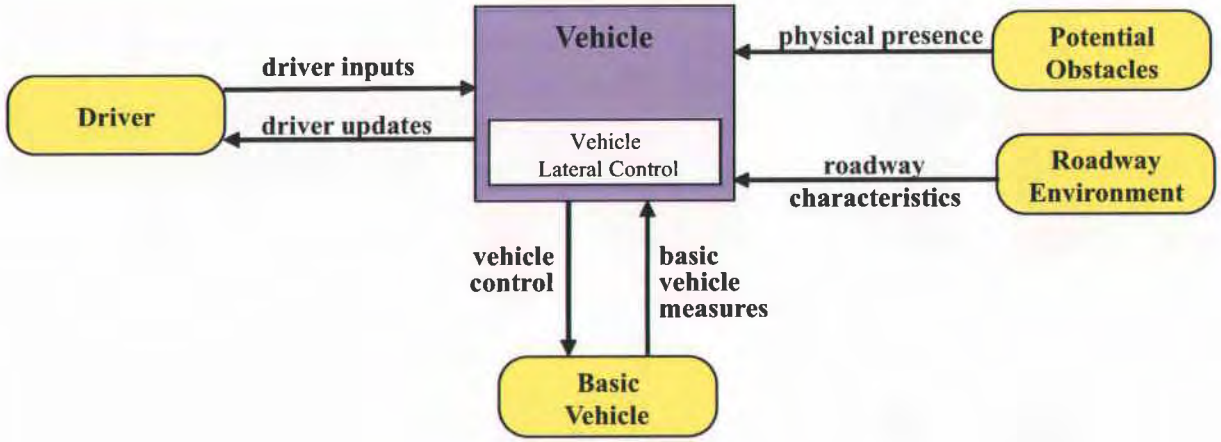
SE303 HAZMAT Pre-clearance Services



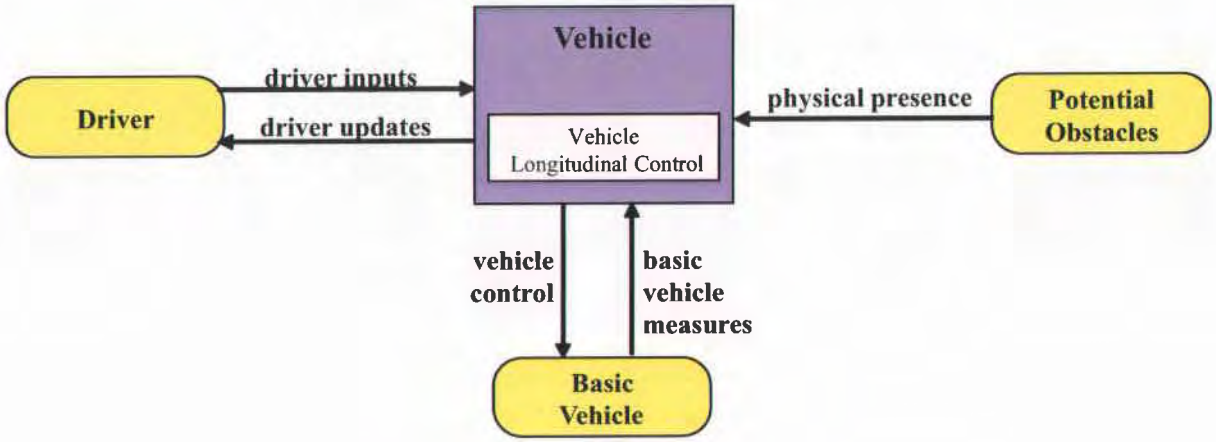
SV201 Automated Highway Operations



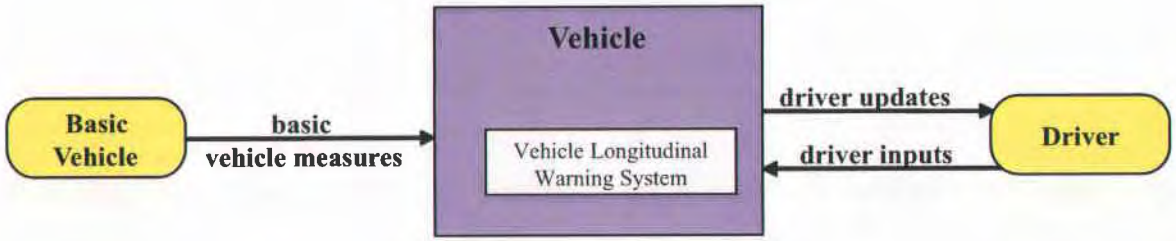
SV202 - Automated Low Speed Maneuvering



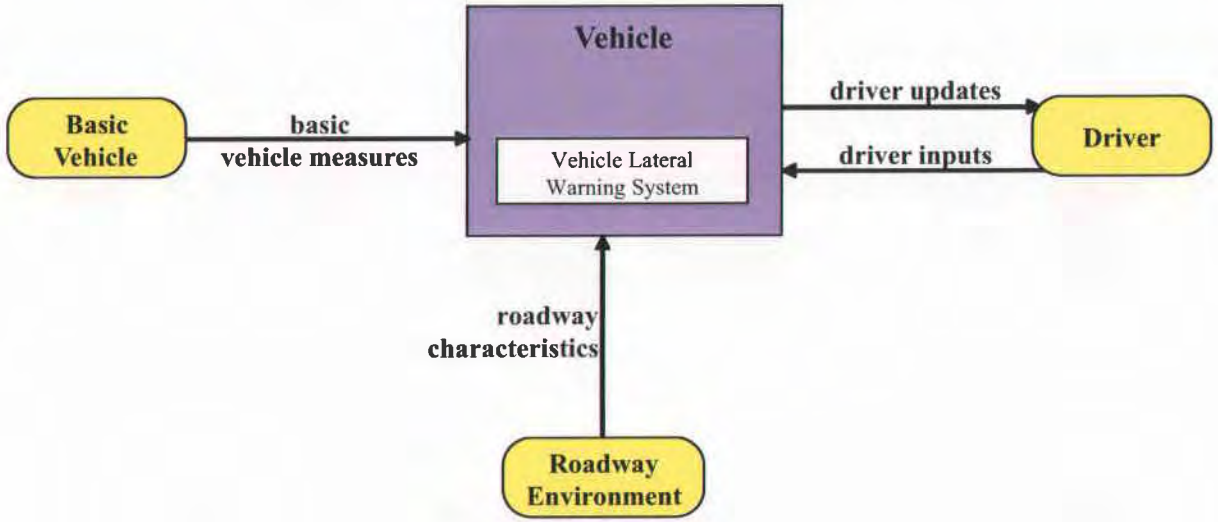
SV203 Automated Cruise Control



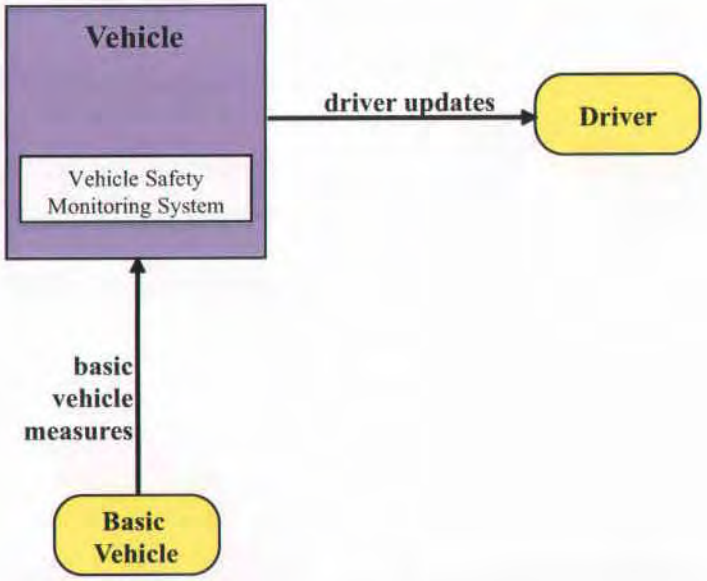
SV301 Longitudinal Collision Avoidance



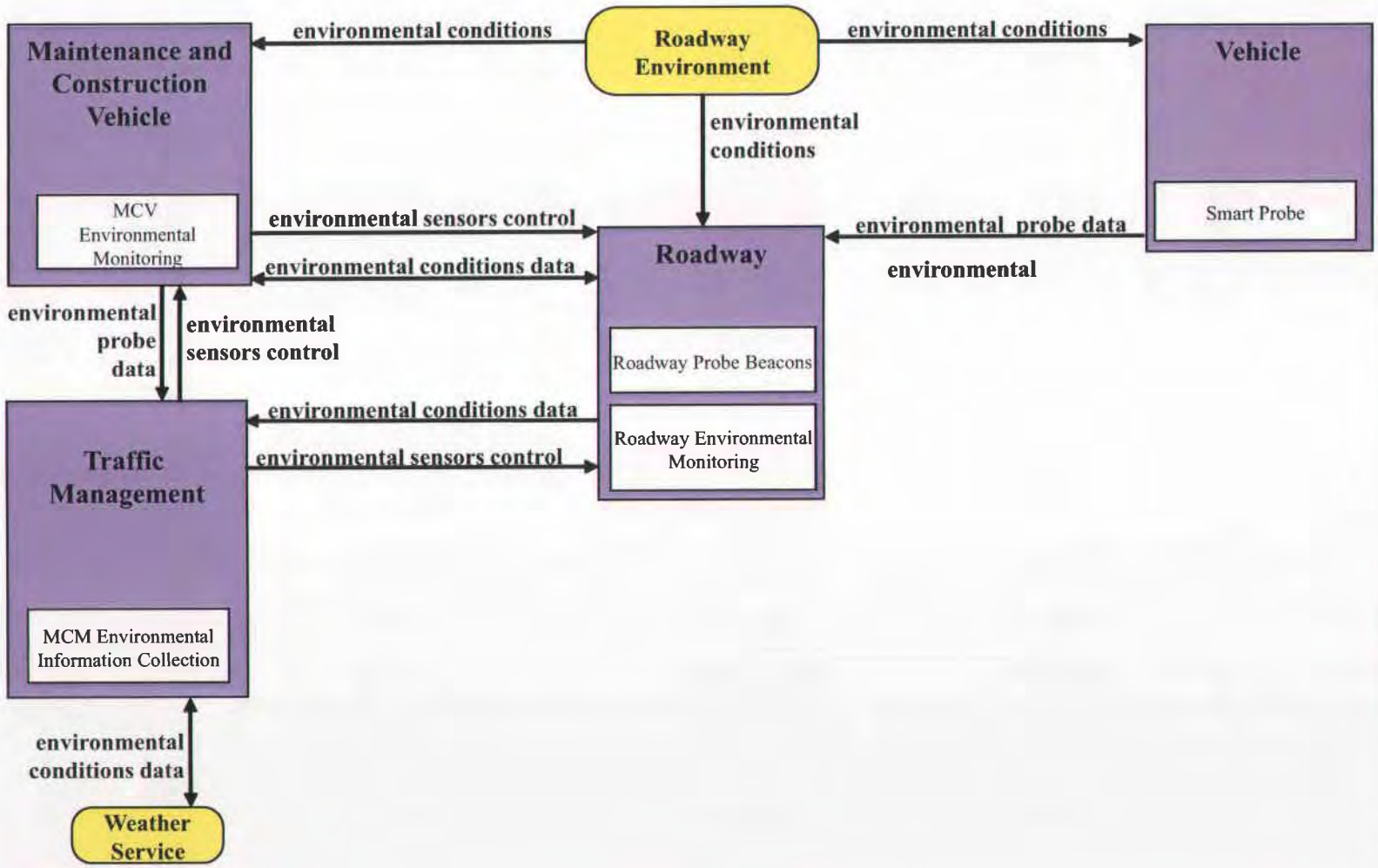
SV302 Lateral Collision Avoidance



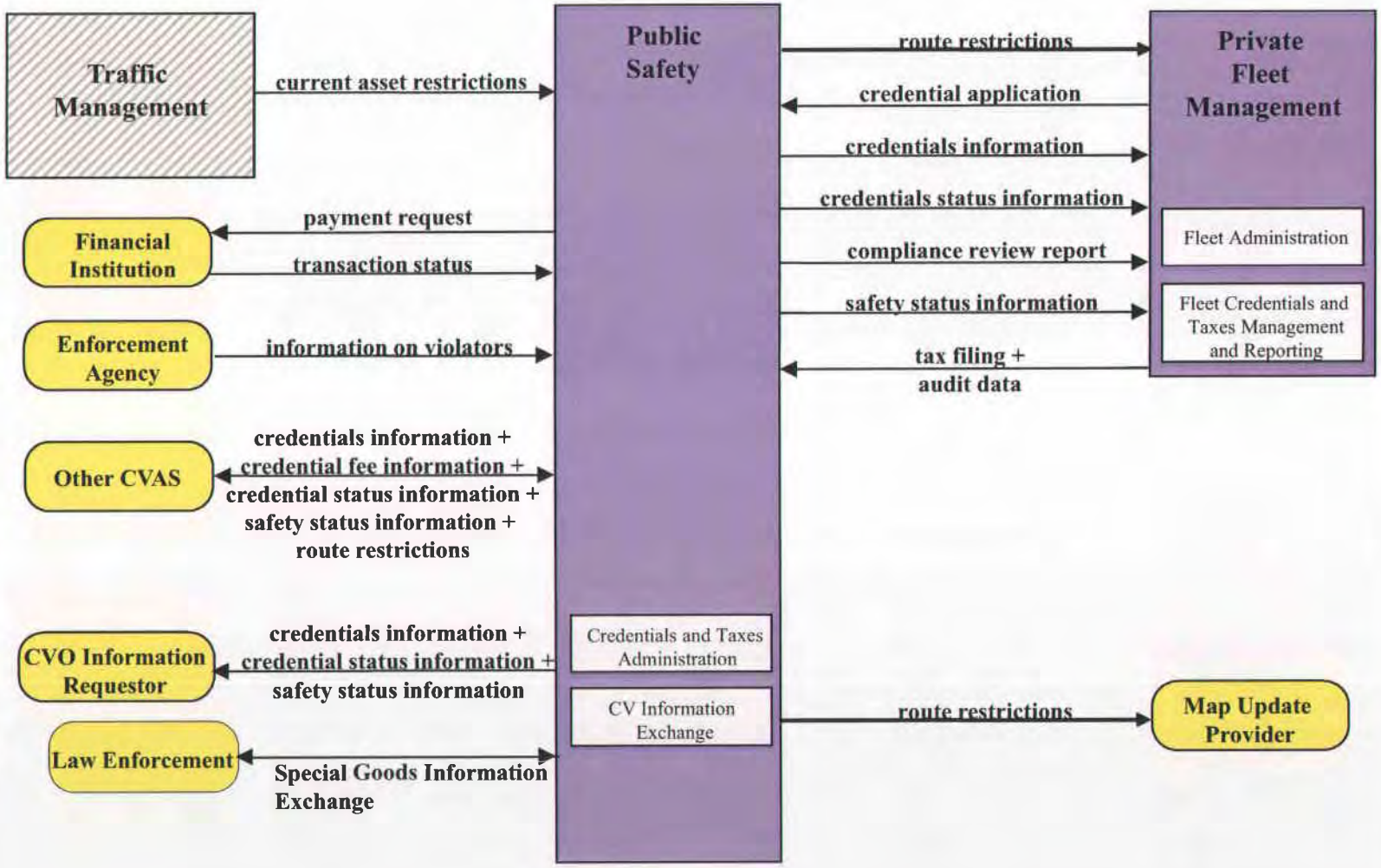
SV401 Vehicle Internal Systems Monitoring



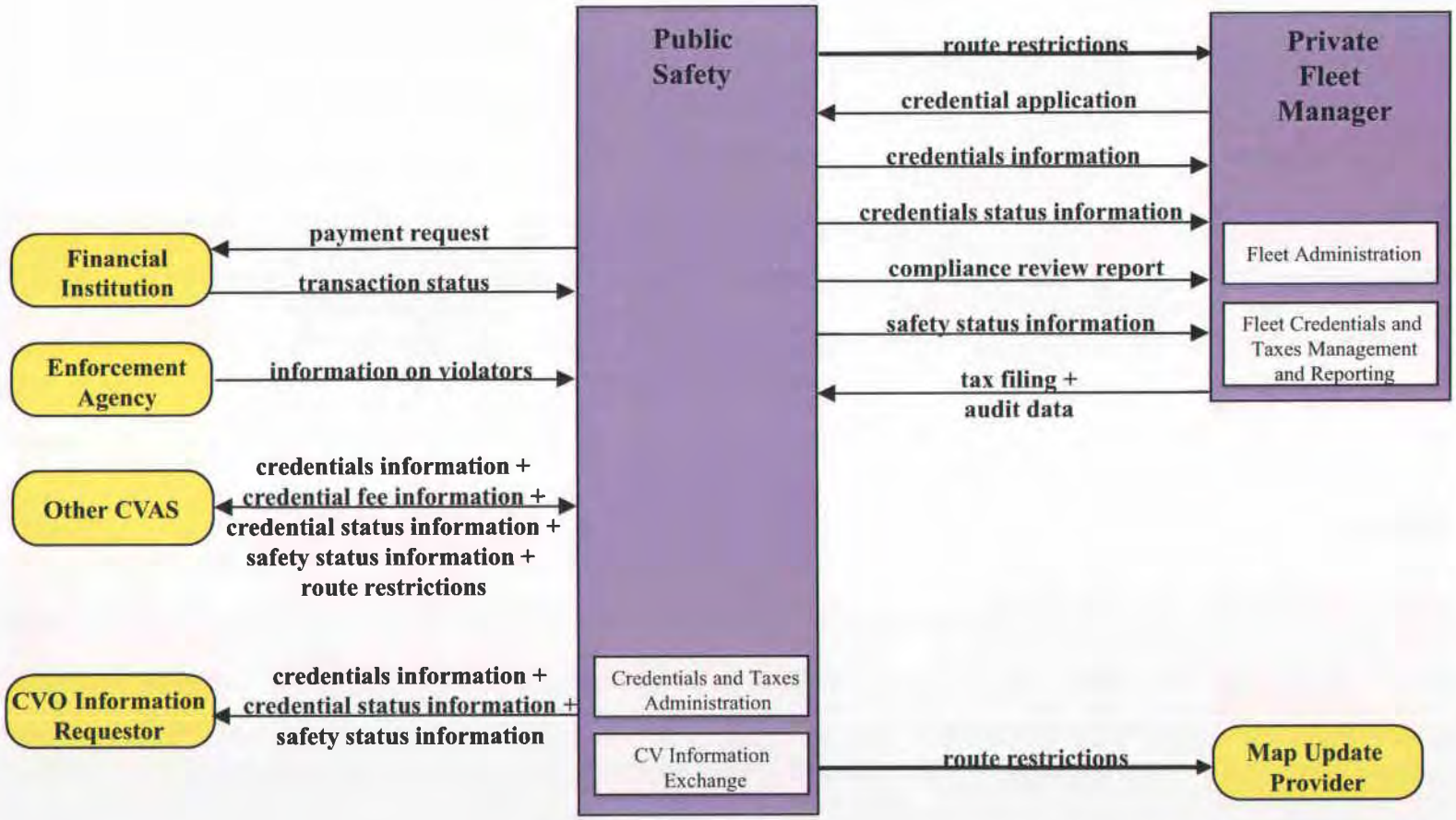
SV402 Vehicle External Conditions Monitoring



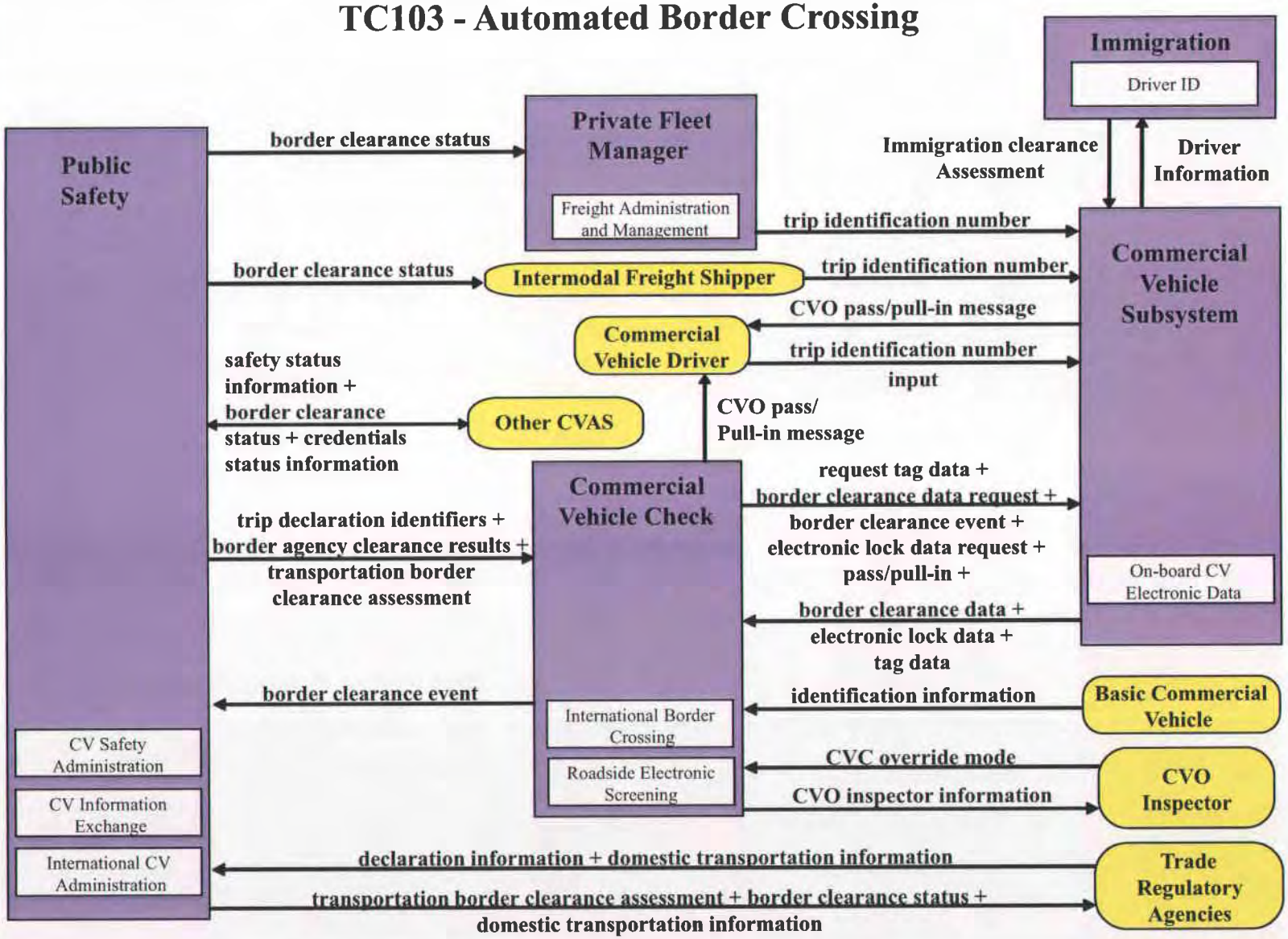
TC101 Automated Credential Filing



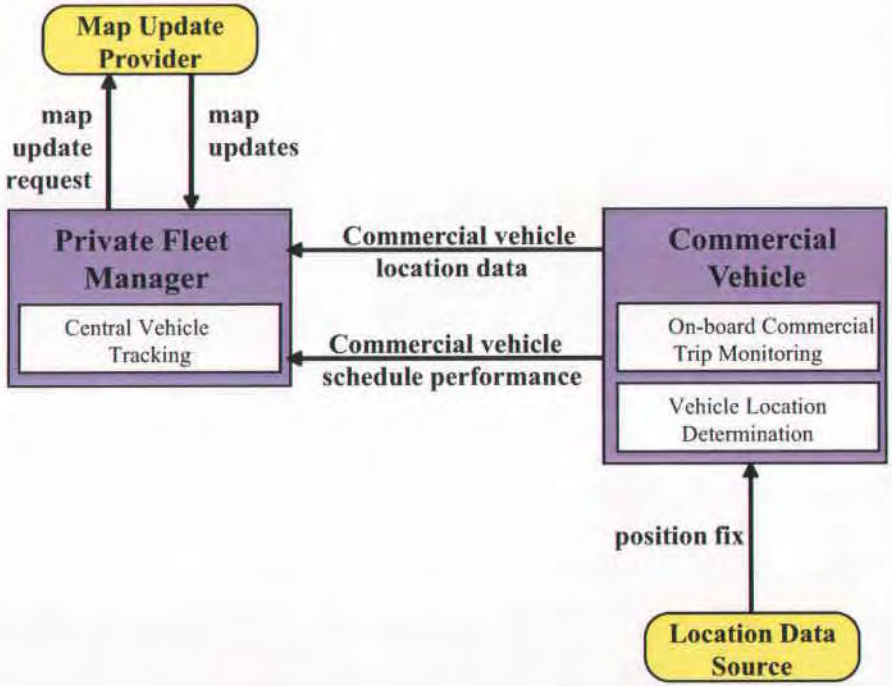
TC102 Automated Commercial Vehicle Administration



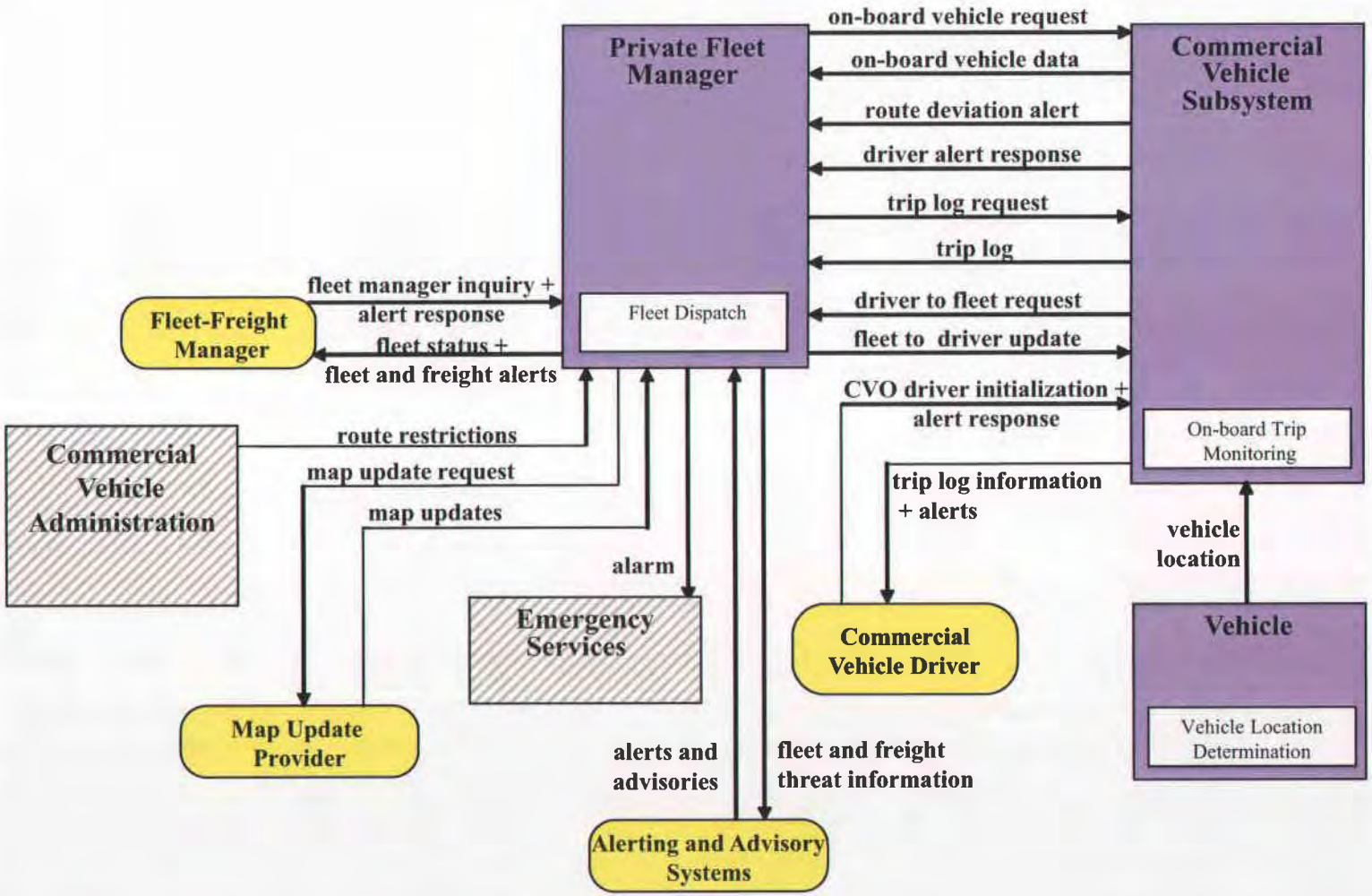
TC103 - Automated Border Crossing



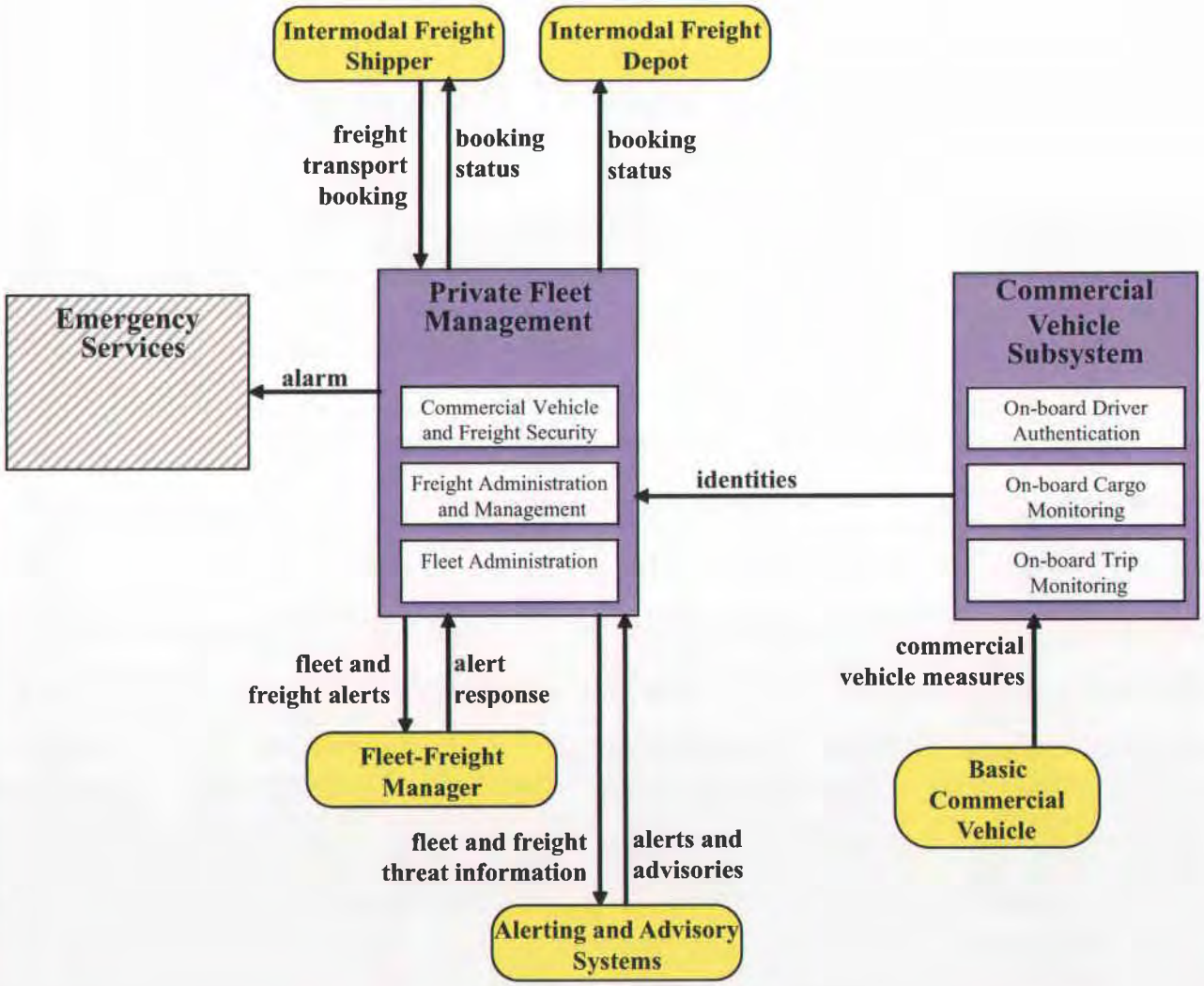
TC201 Commercial Vehicle Fleet Tracking



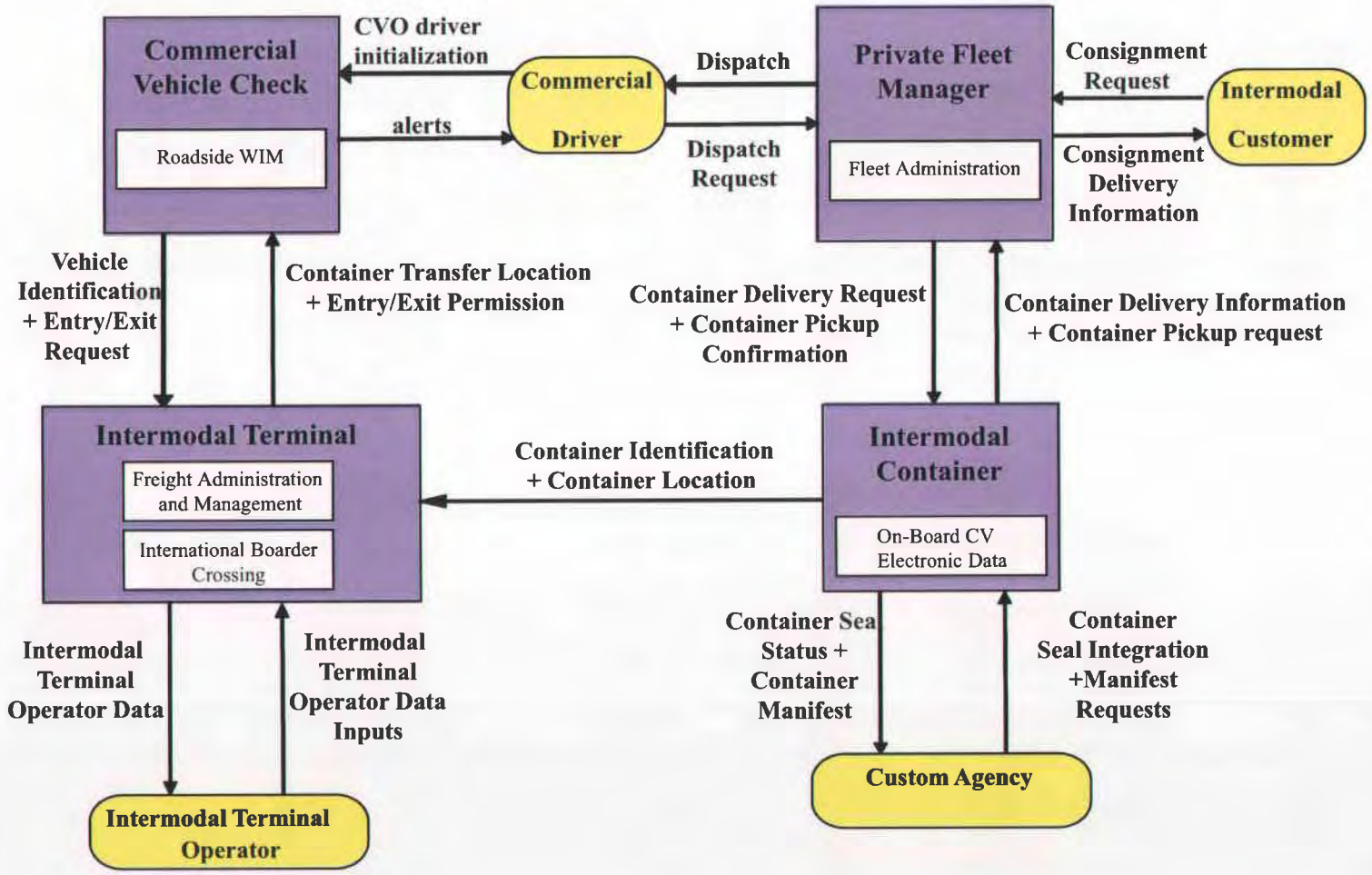
TC202 Commercial Vehicle Fleet Dispatching



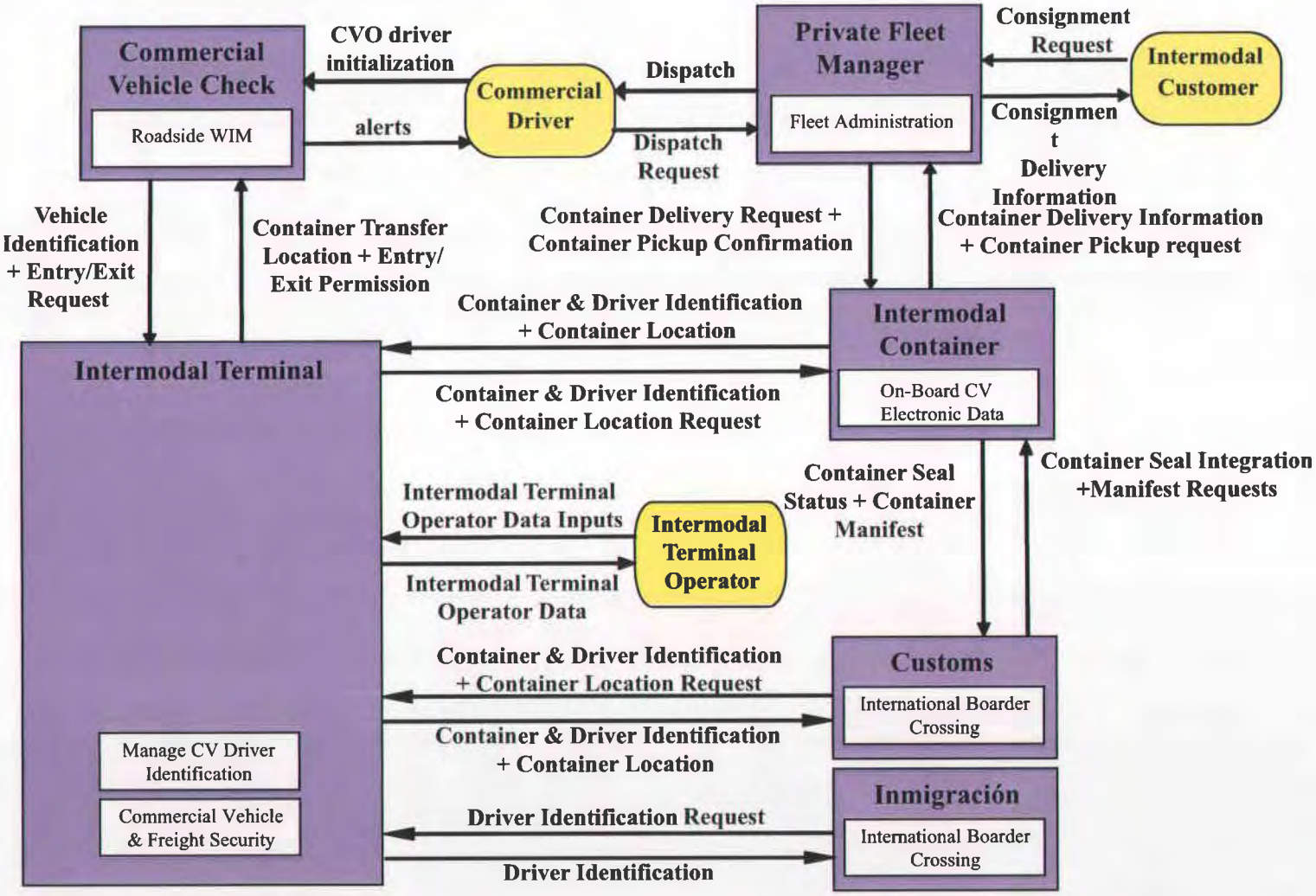
TC203 Freight Container Tracking



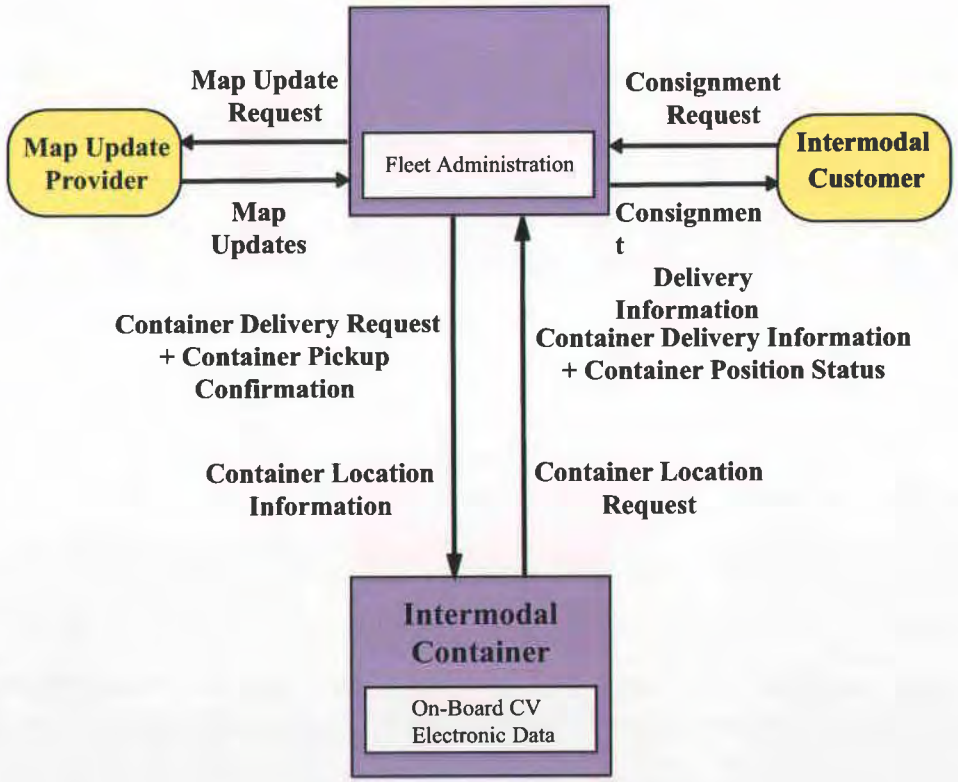
TC301 Vehicle and Container Arrival Information Exchange



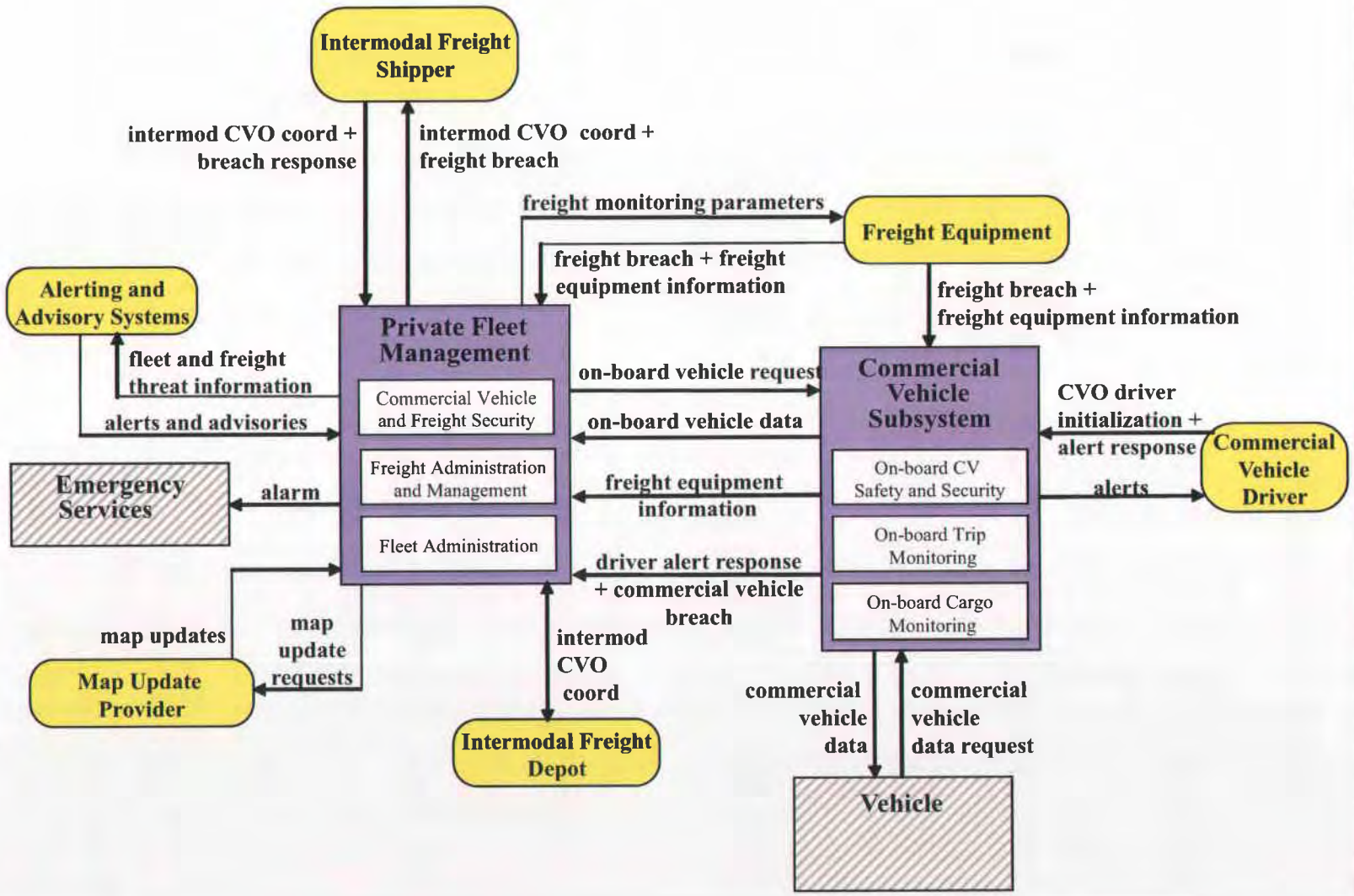
TC401 Intermodal Care and Facility Management



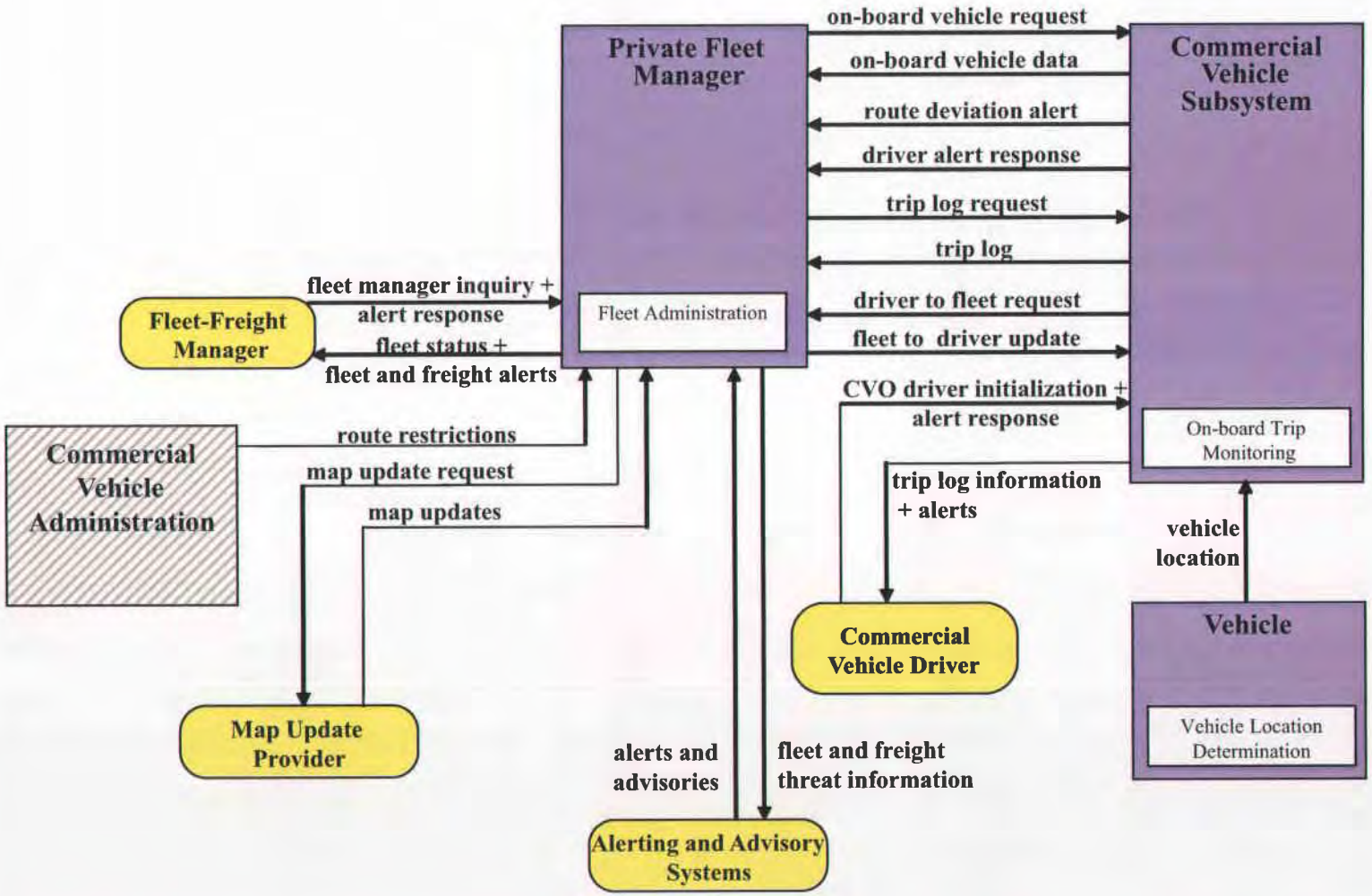
TC402 Intermodal Vehicle and Container Monitoring



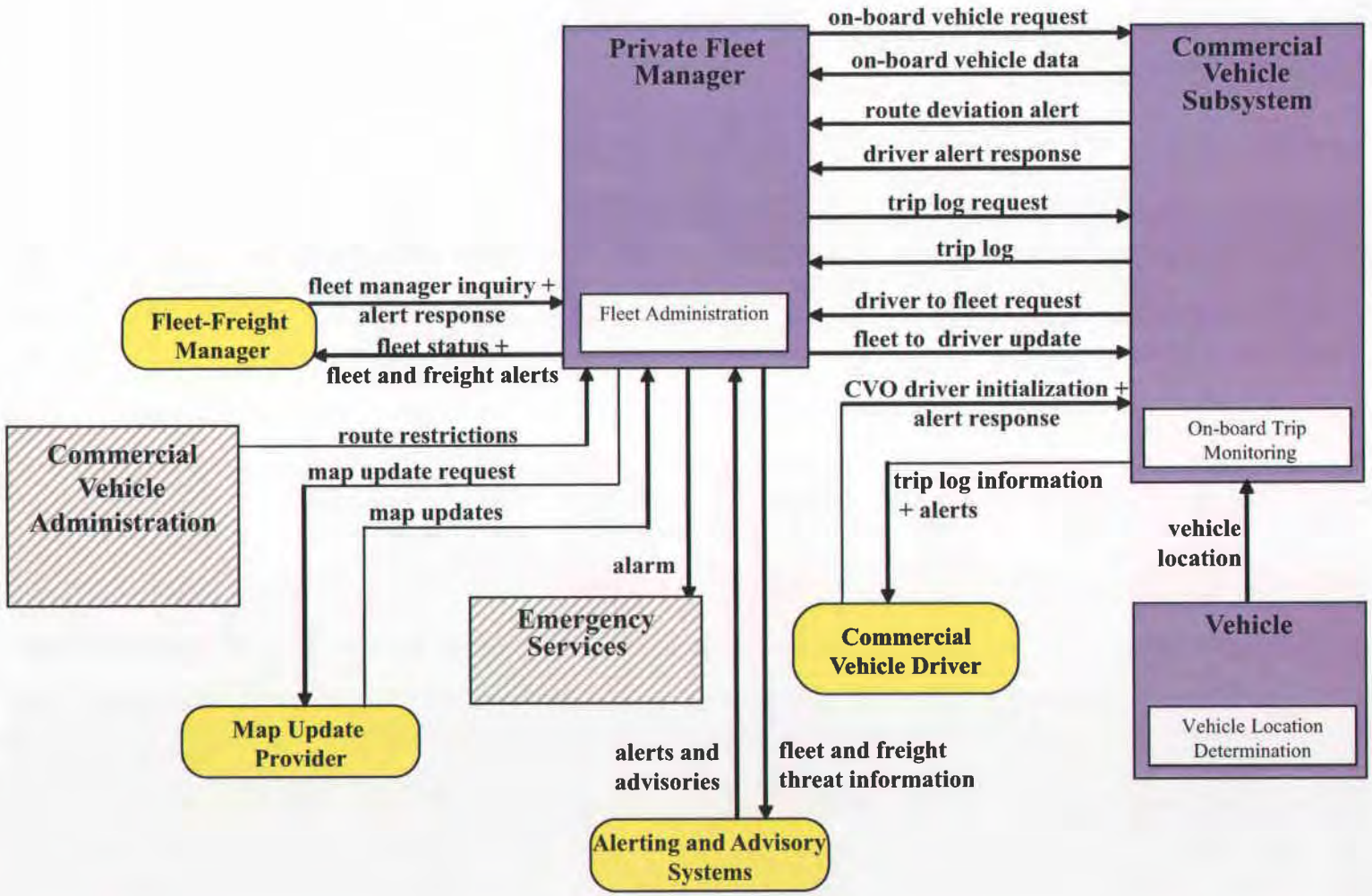
TC501 Dangerous Goods Movement Data Registry



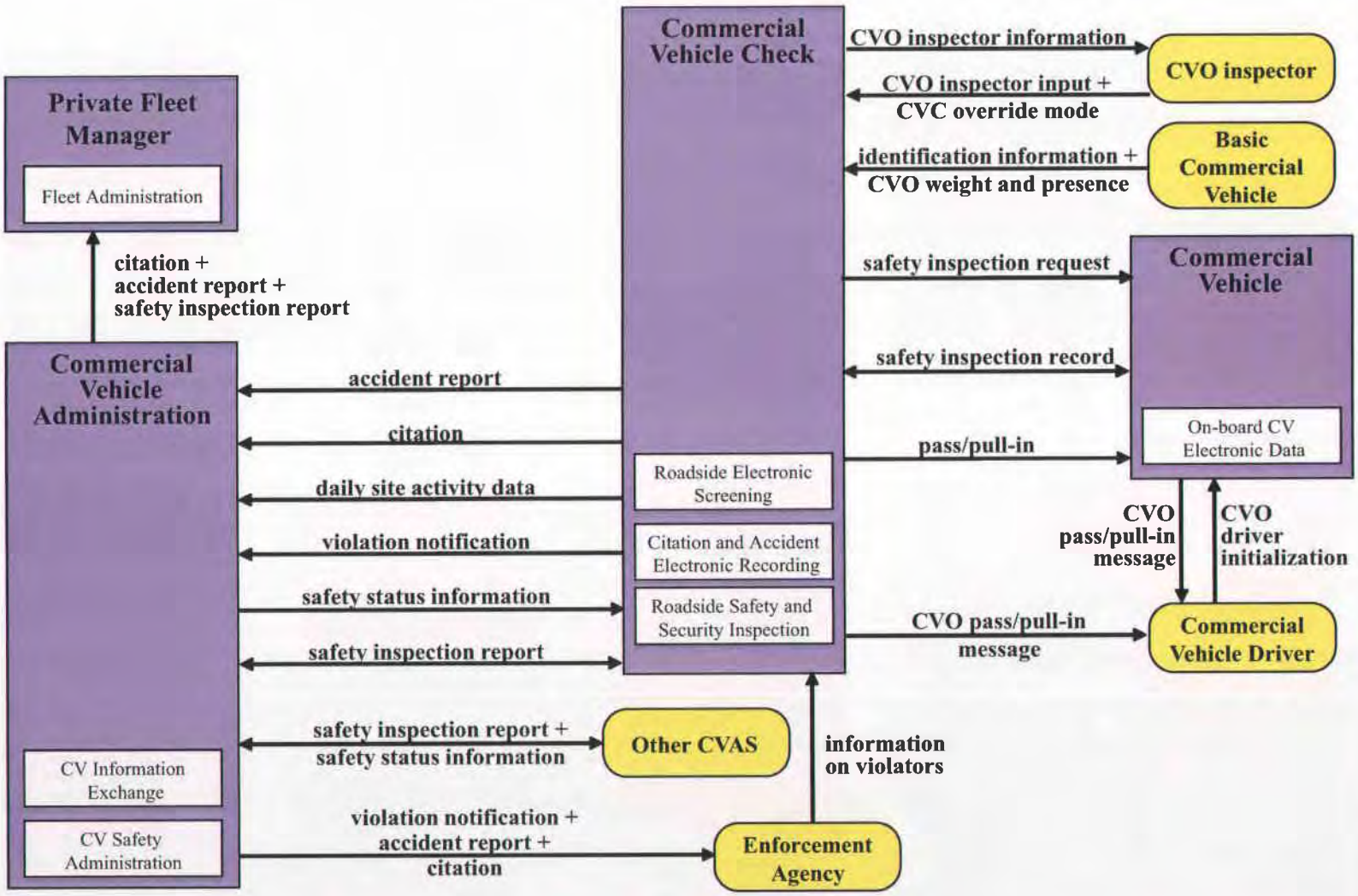
TC502 Dangerous Goods Movement Fleet Coordination



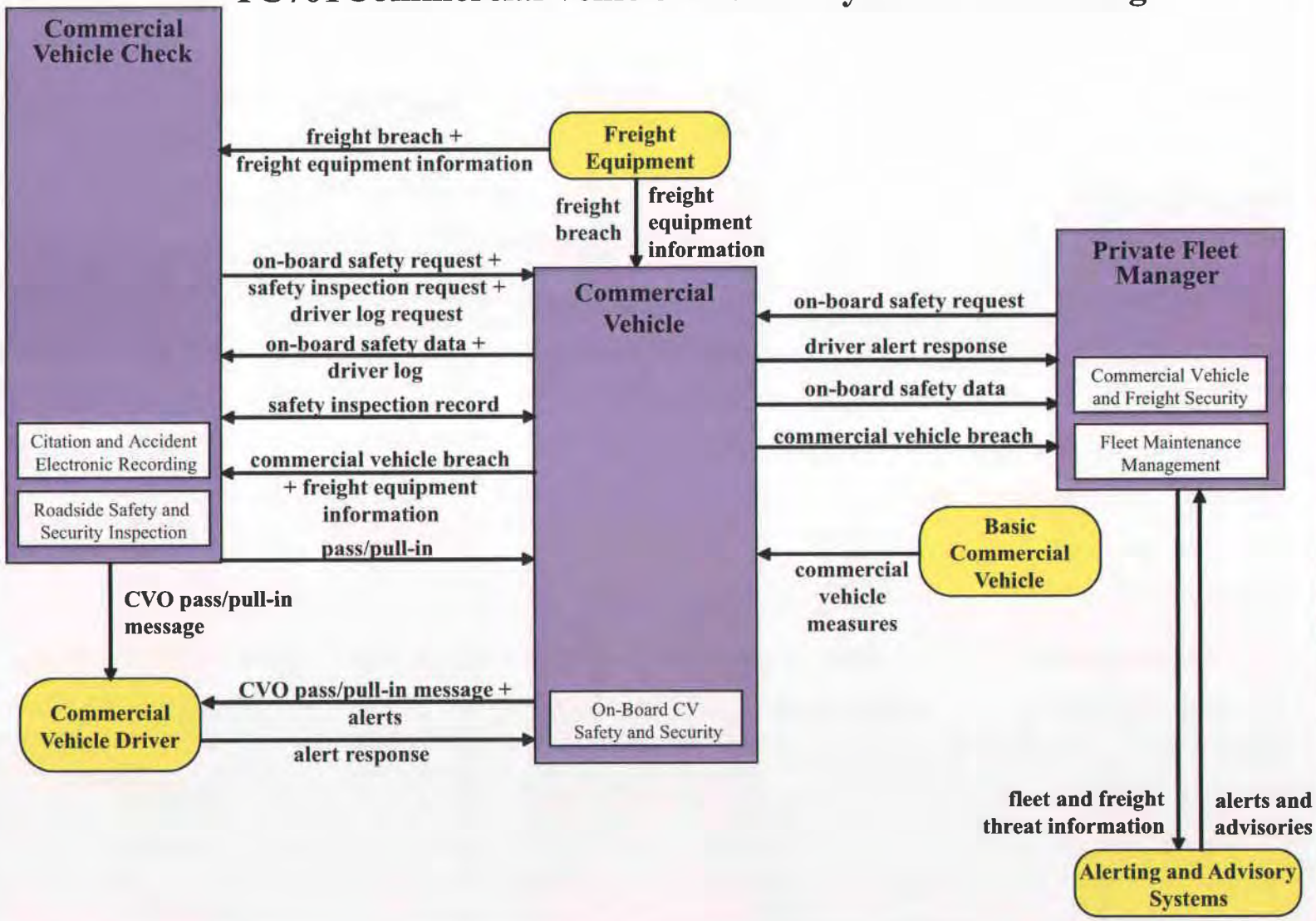
TC503 Dangerous Goods Movement Safety Coordination



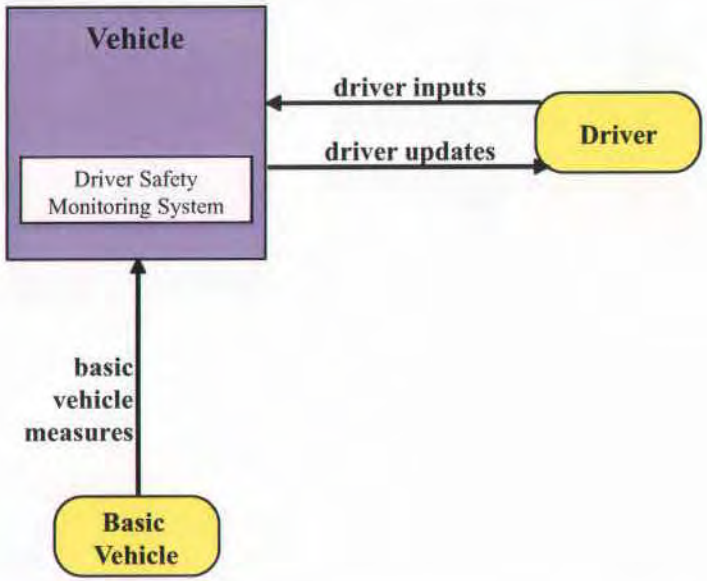
TC601 Remote Access to Commercial Vehicle Safety Data



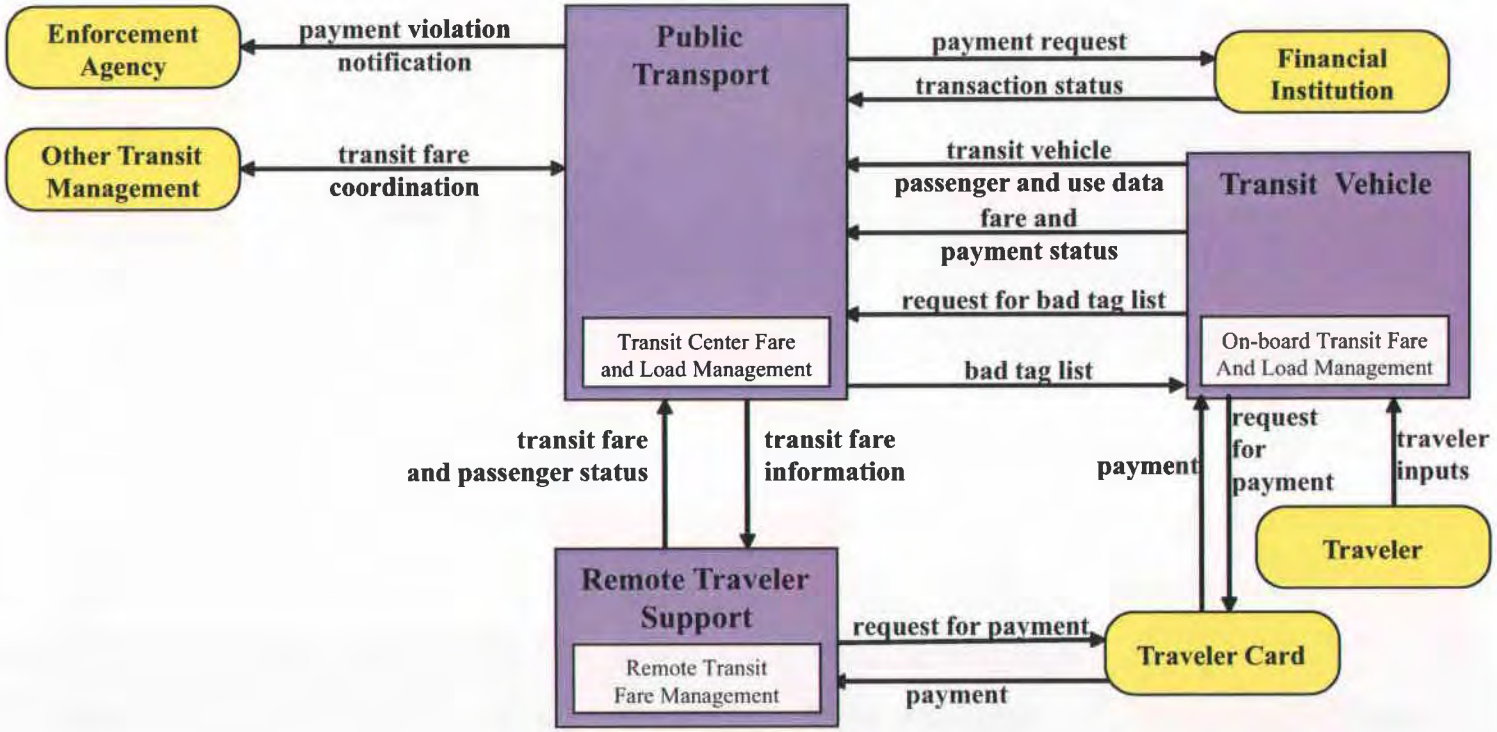
TC701 Commercial Vehicle Internal Systems Monitoring



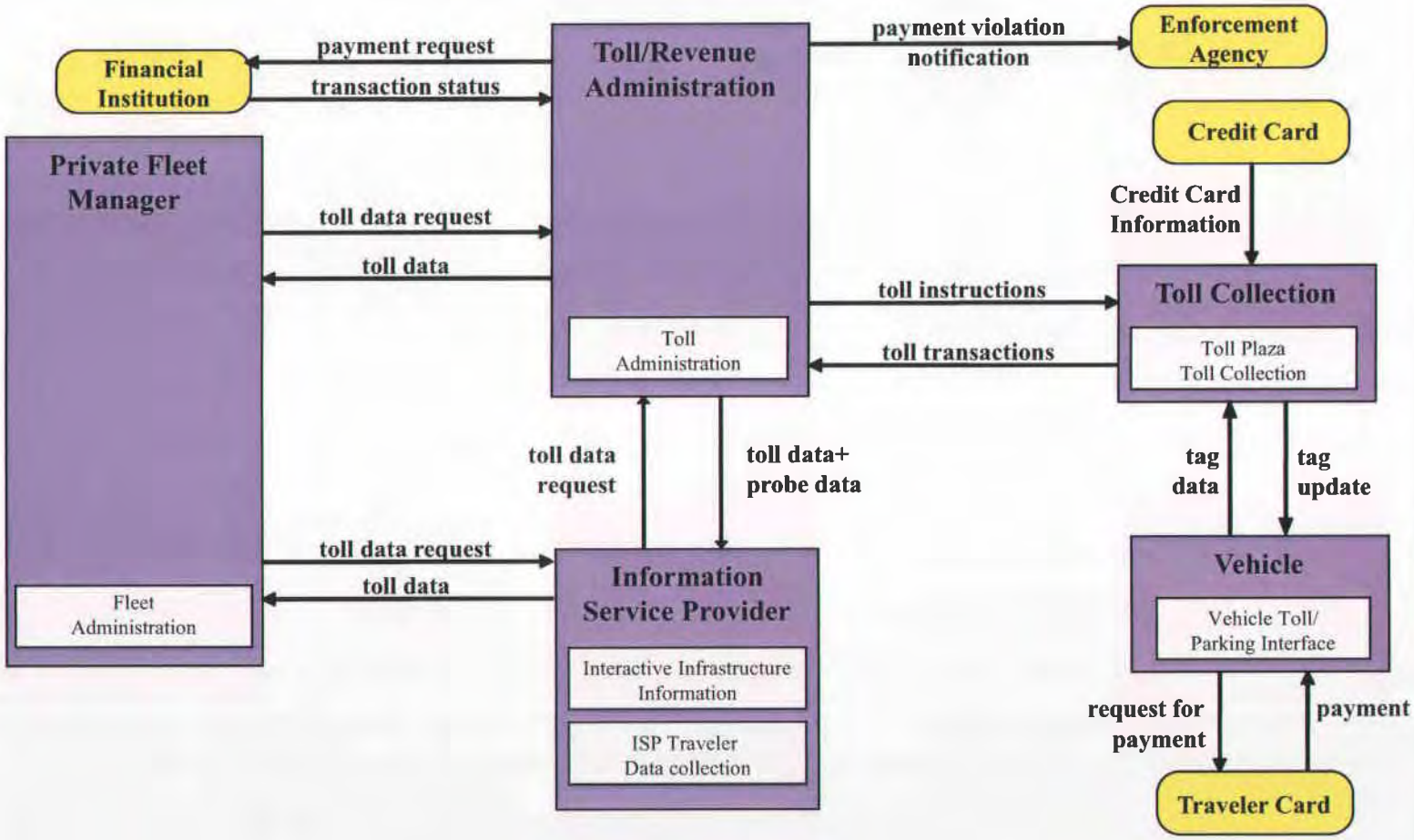
TC702 Commercial Vehicle Driver Alertness Monitoring



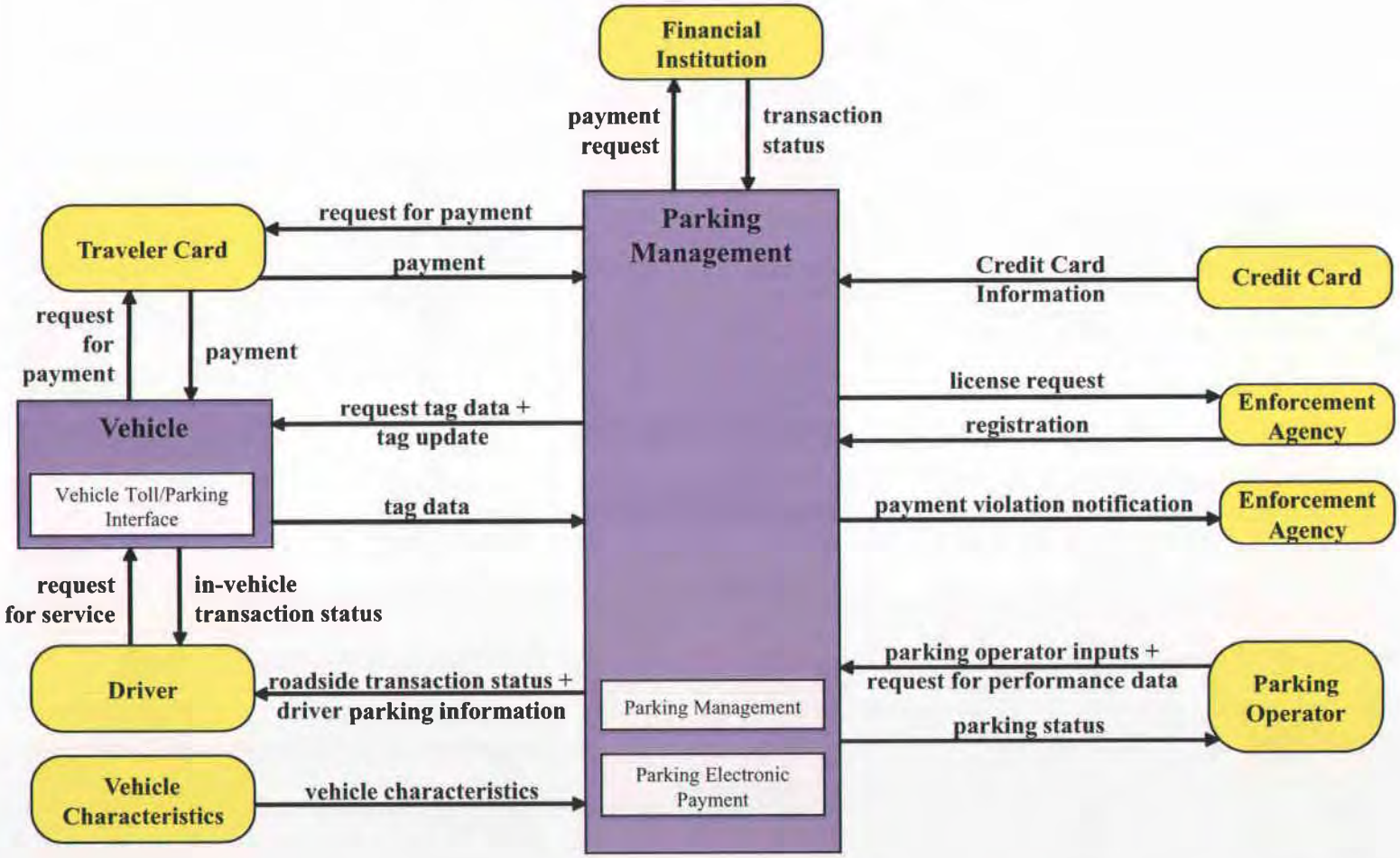
PE101 Electronic Transit Fare Payment



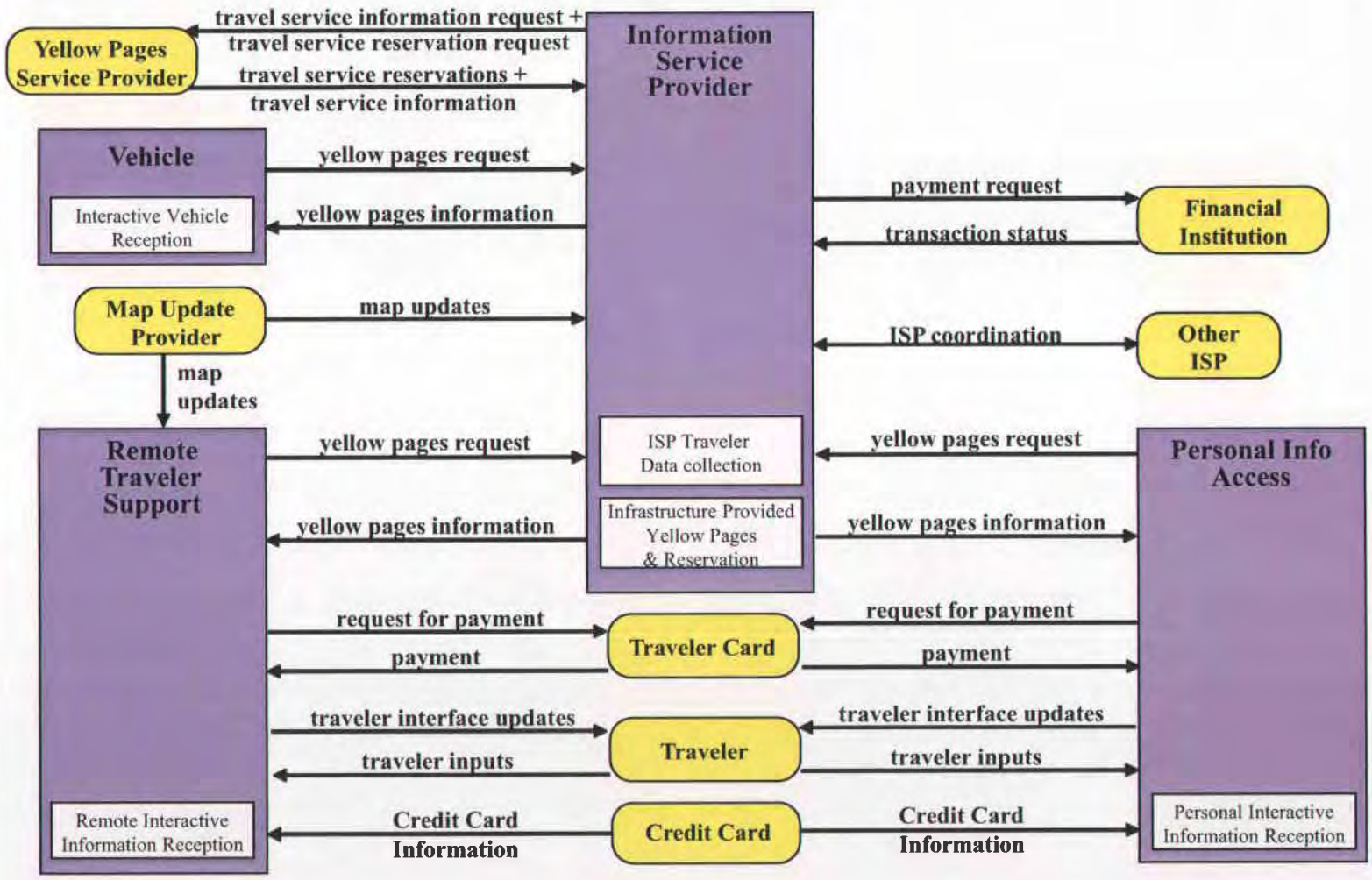
PE102 Electronic Toll Collection



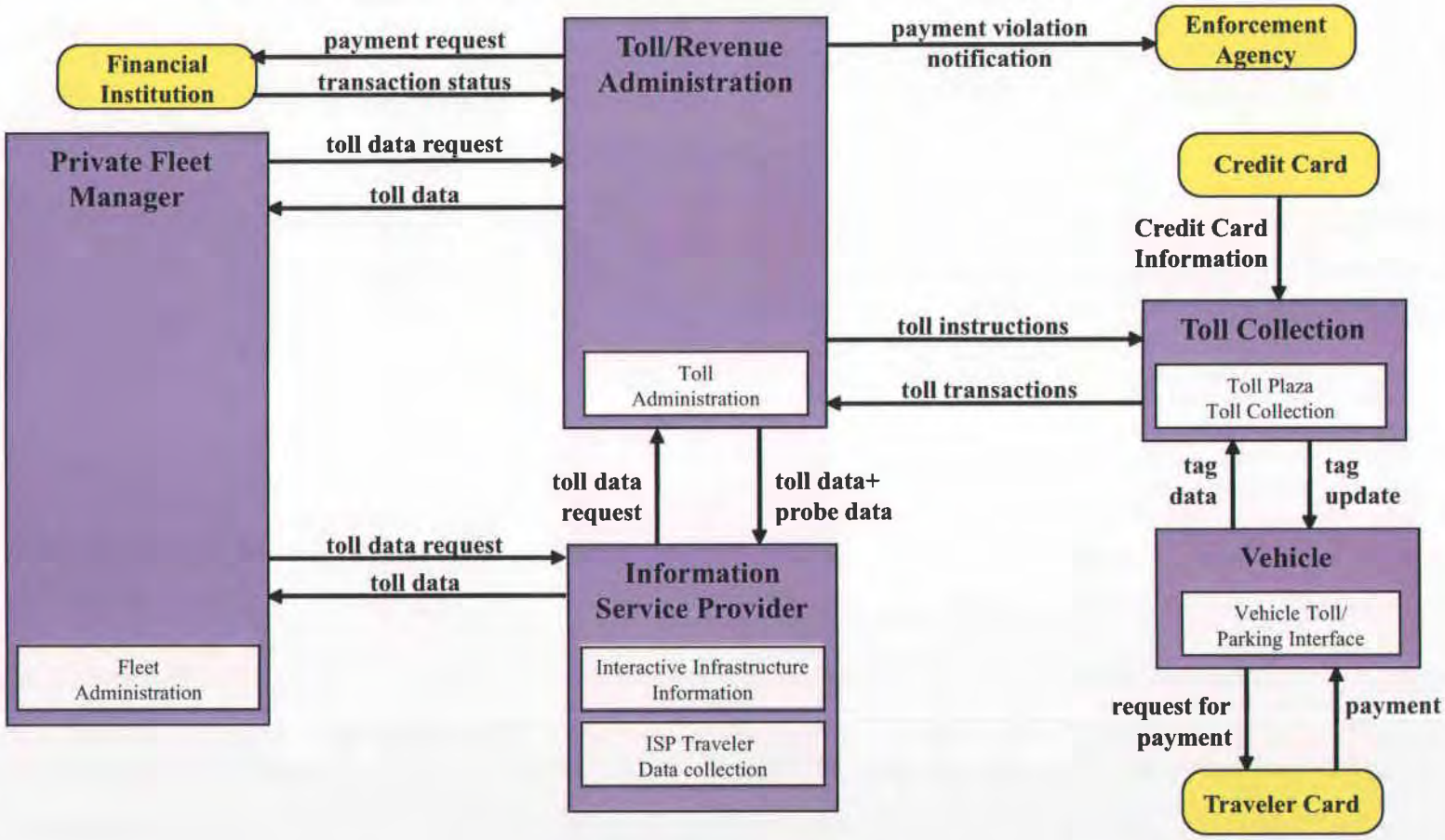
PE103 Electronic Parking Payment



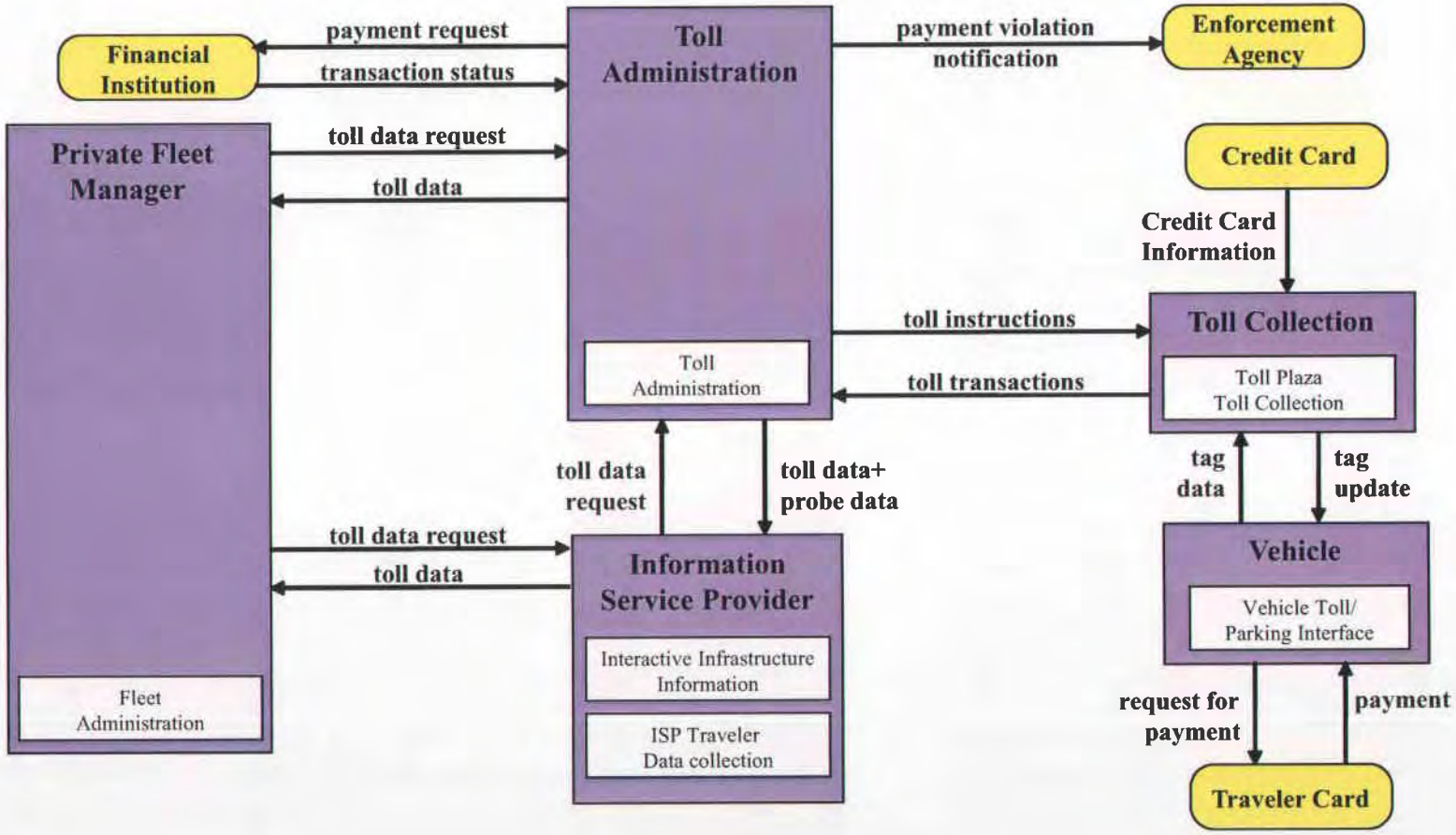
PE104 Electronic Services Payment



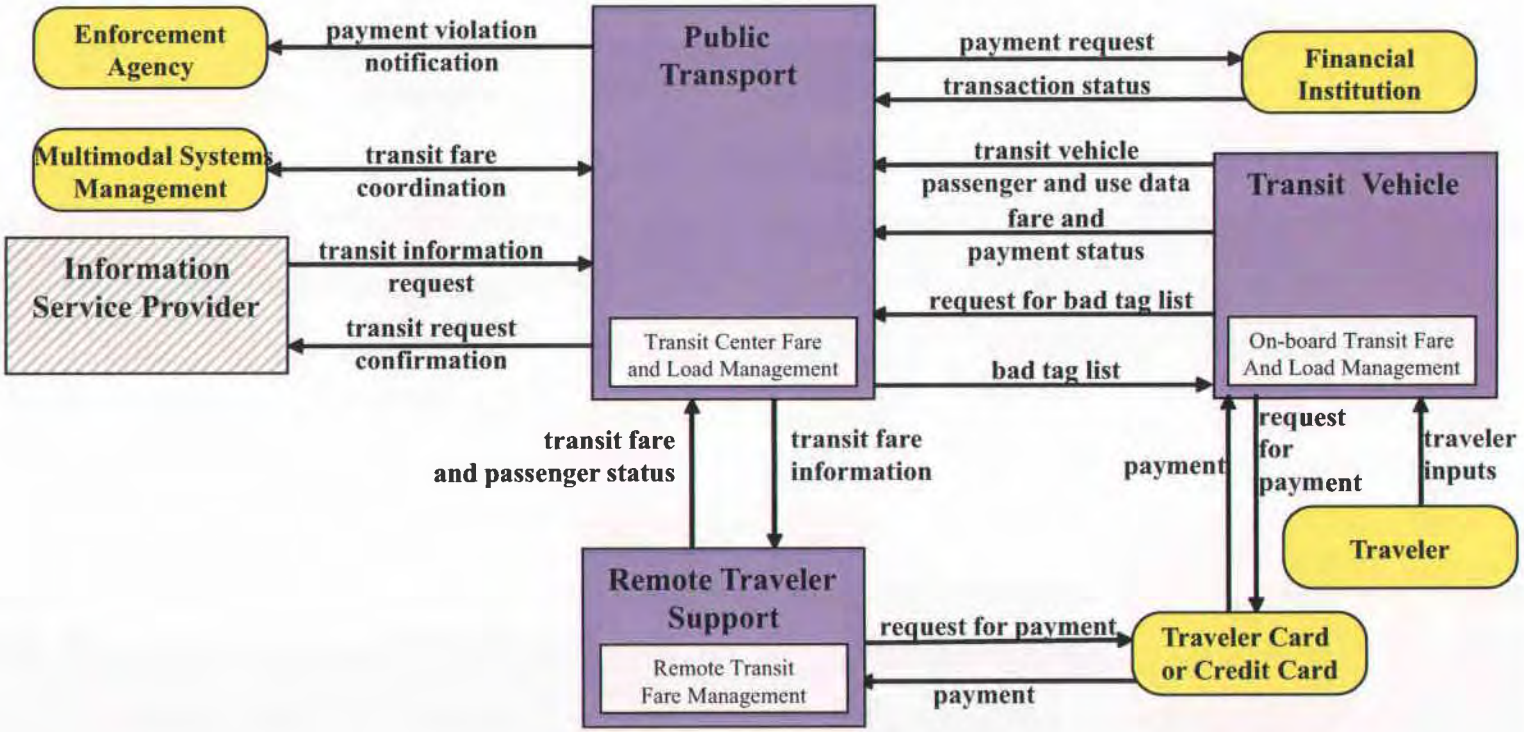
PE105 Electronic Distance Based Road User Fee Collection



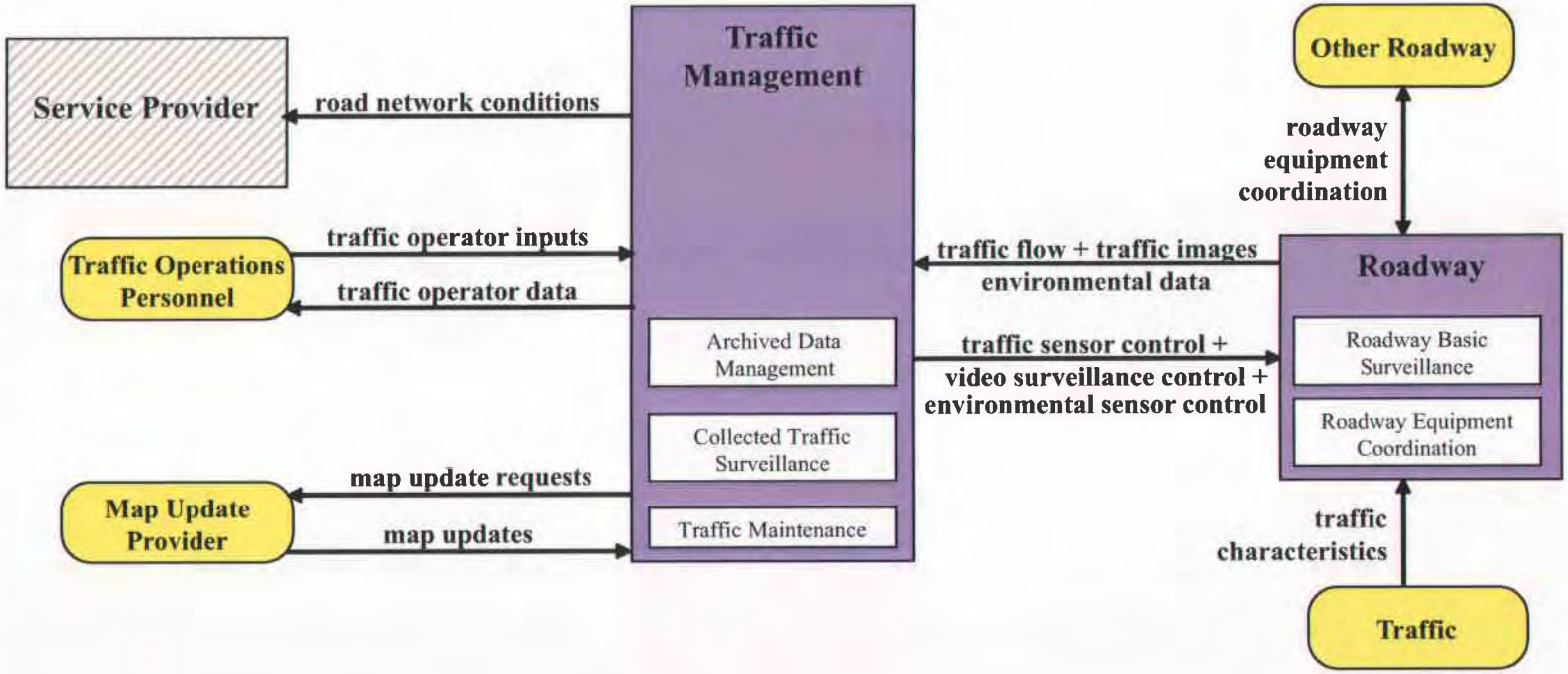
PE201 Integration of Multi-jurisdictional Payment Systems



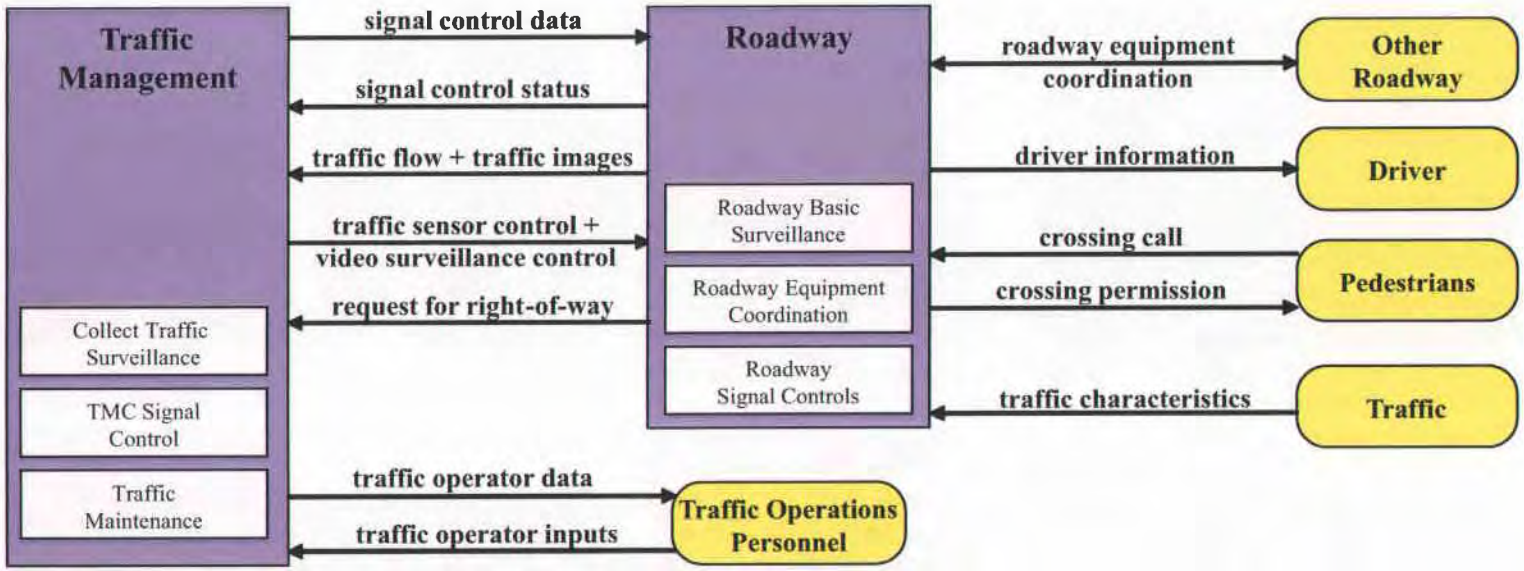
PE202 Integration of Regional Multimodal Payment Systems



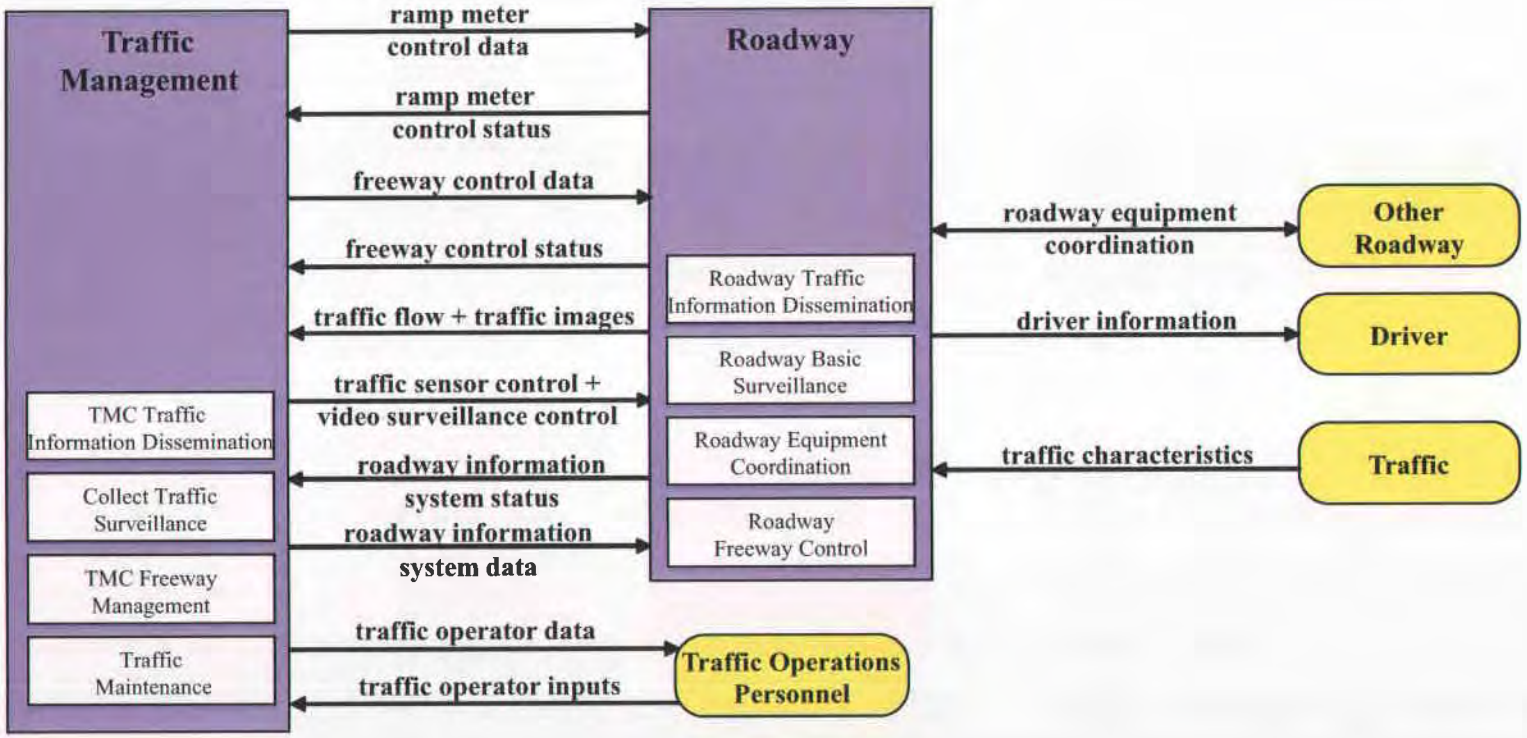
GOT - 101 – Traffic Monitoring



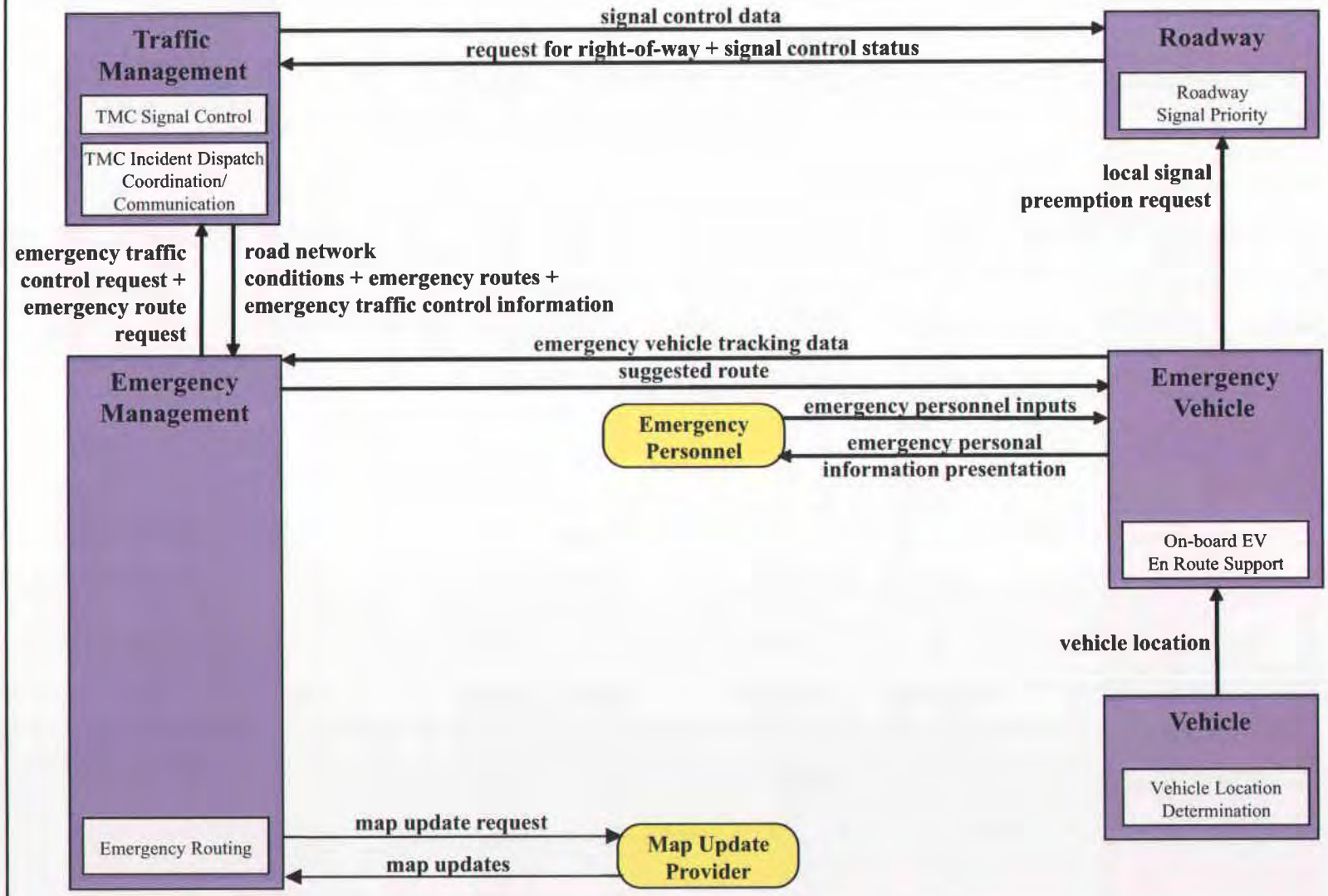
GOT – 102 - Surface Street Control



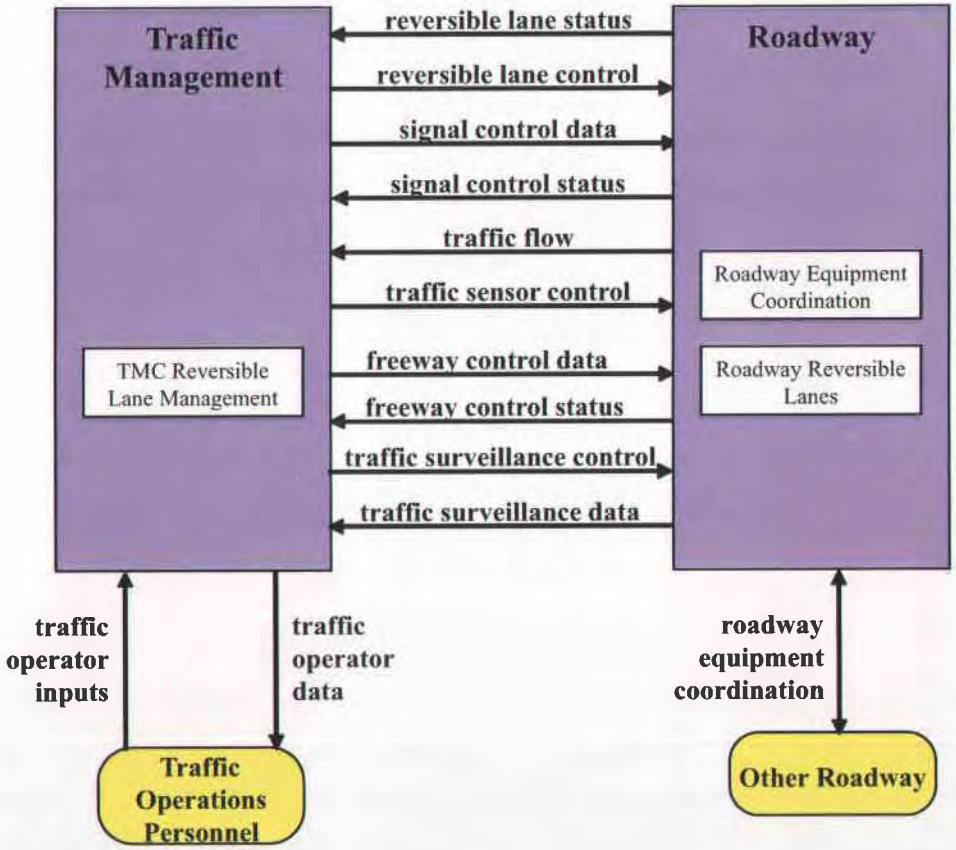
GOT – 103 - Freeway Control



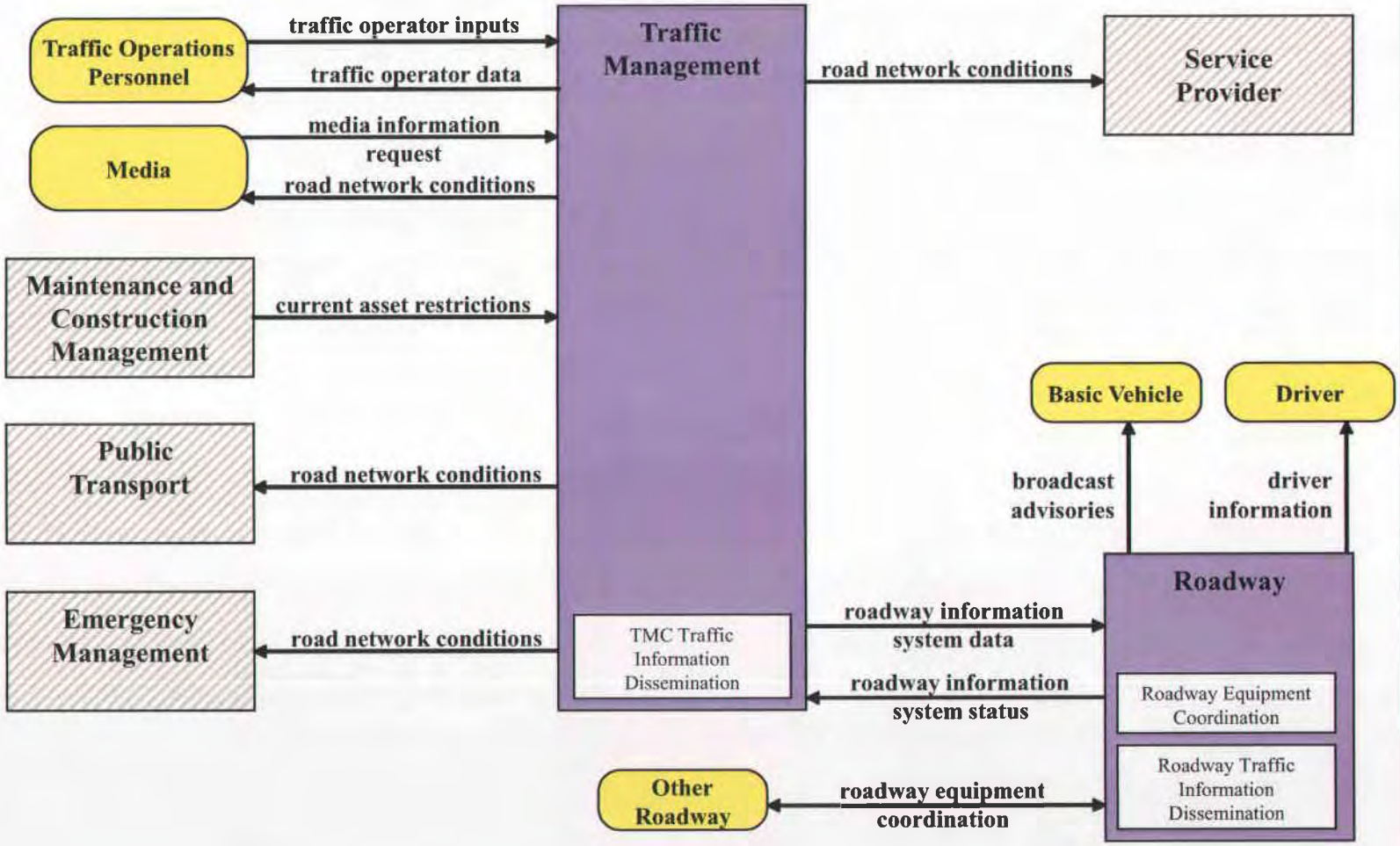
GOT 104 Preferential Treatment for Traffic Control (Signal Priority)



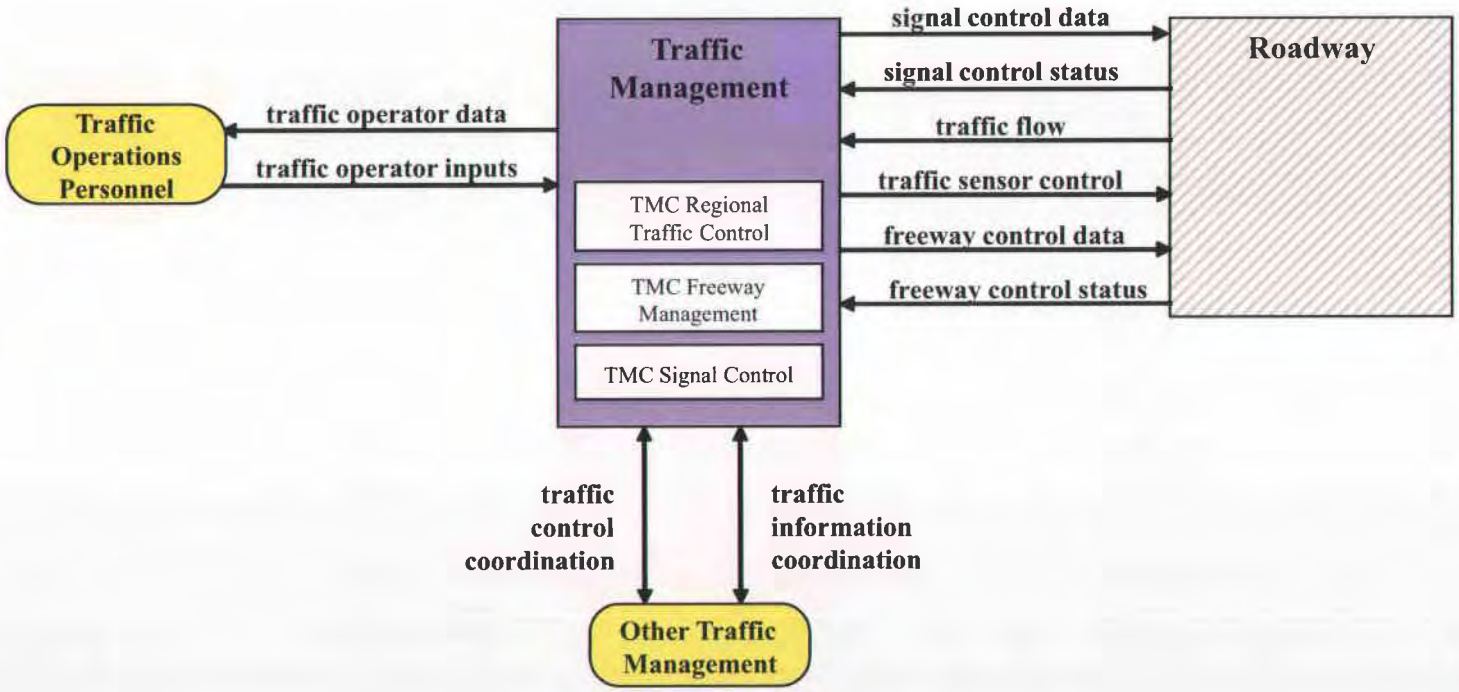
GOT - 105 - Reversible Lane Management



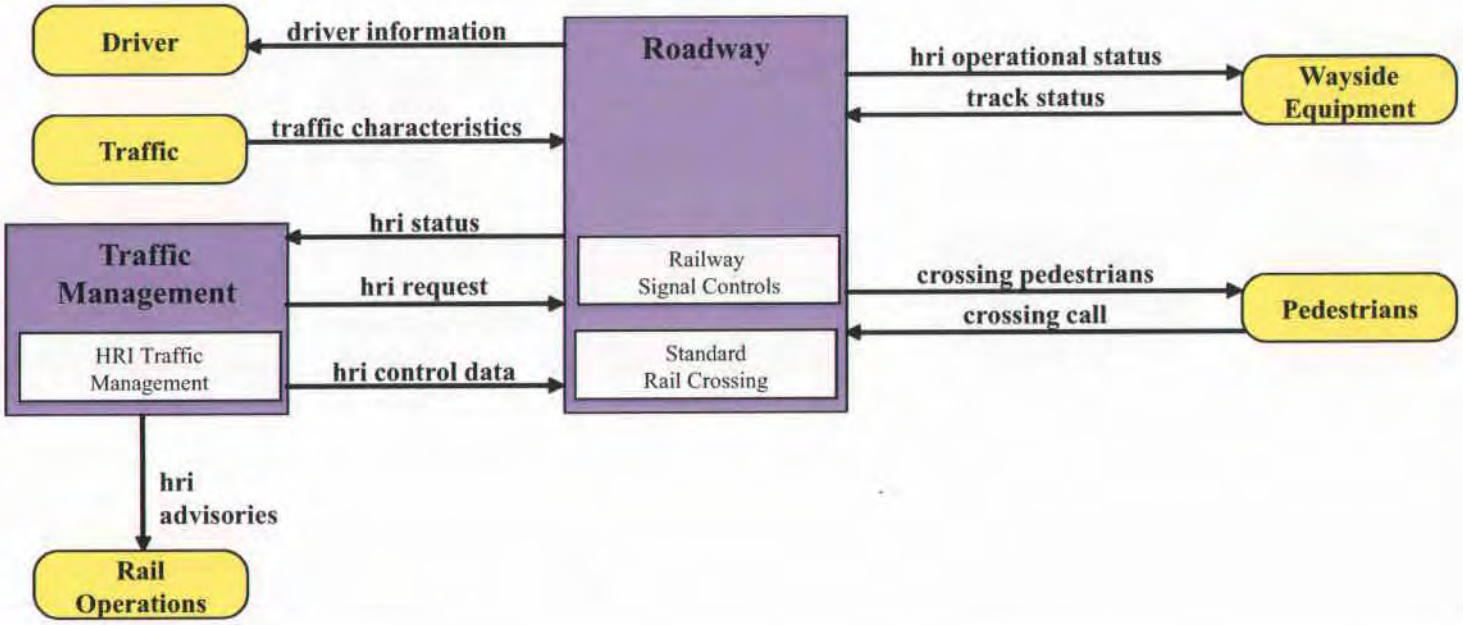
GOT – 106 - Traffic Information Dissemination



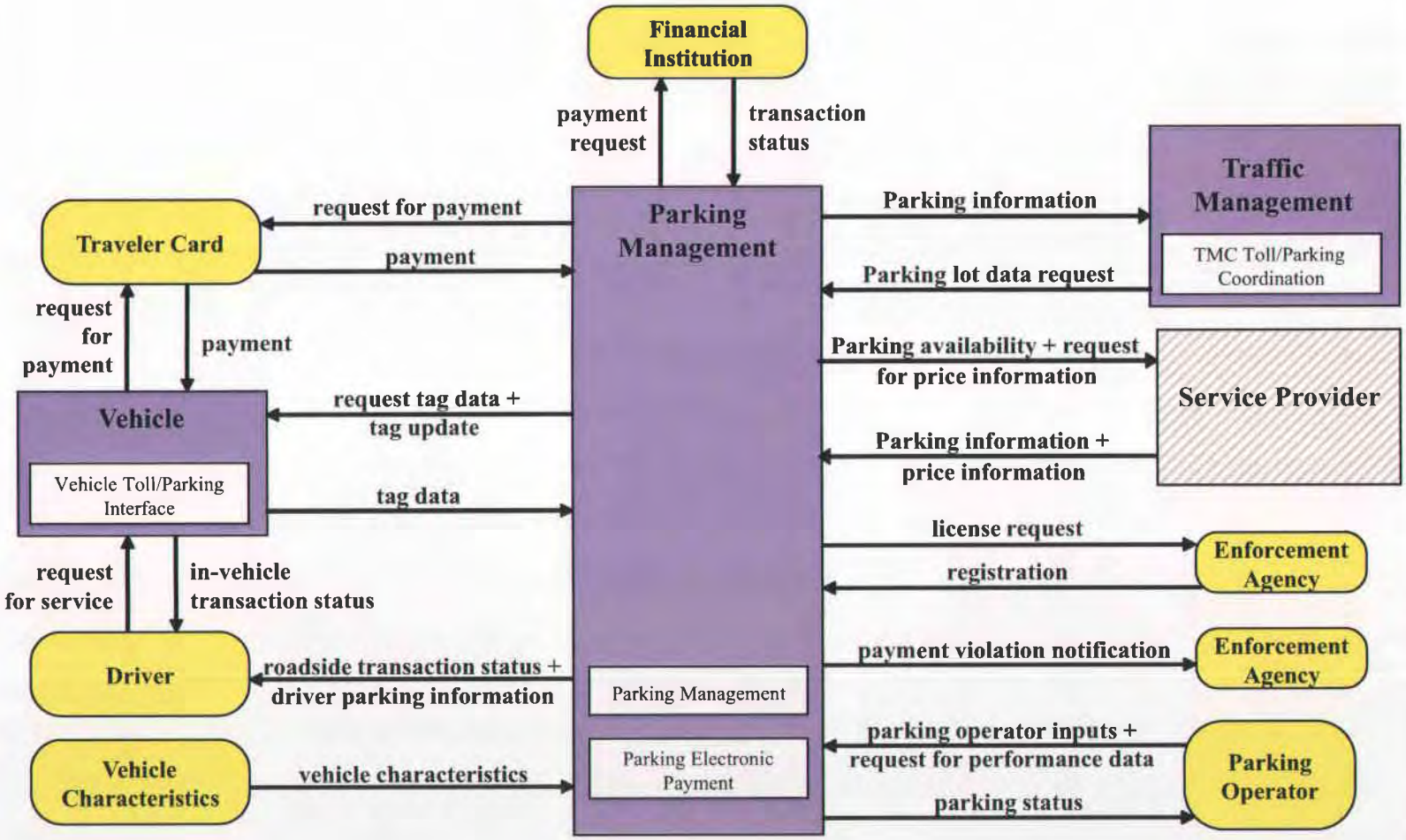
GOT – 107 – Coordination of Surface Street & Freeway Control



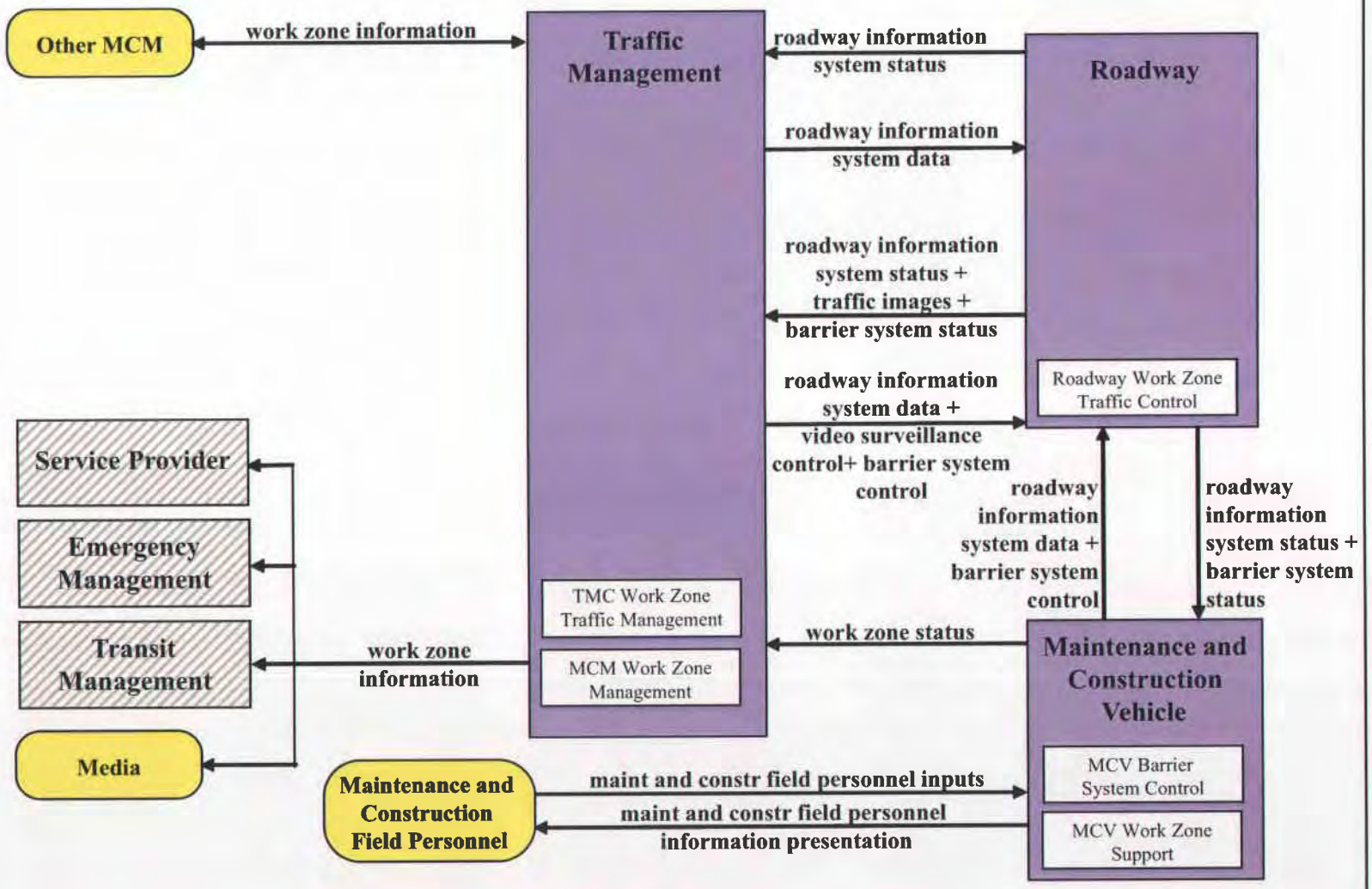
GOT – 108 – Intermodal – Highway Junction Management



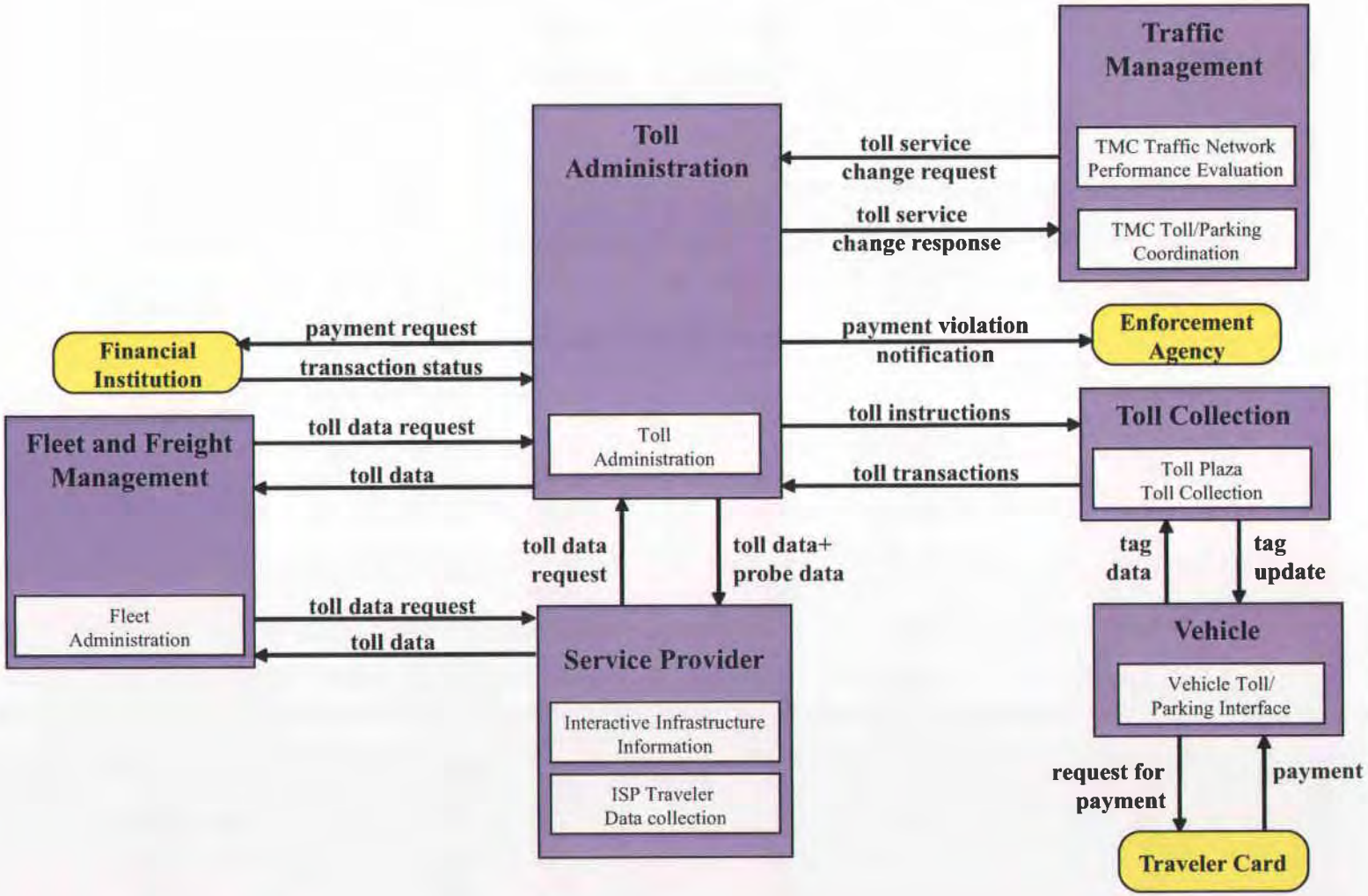
GOT – 109 - Parking Management



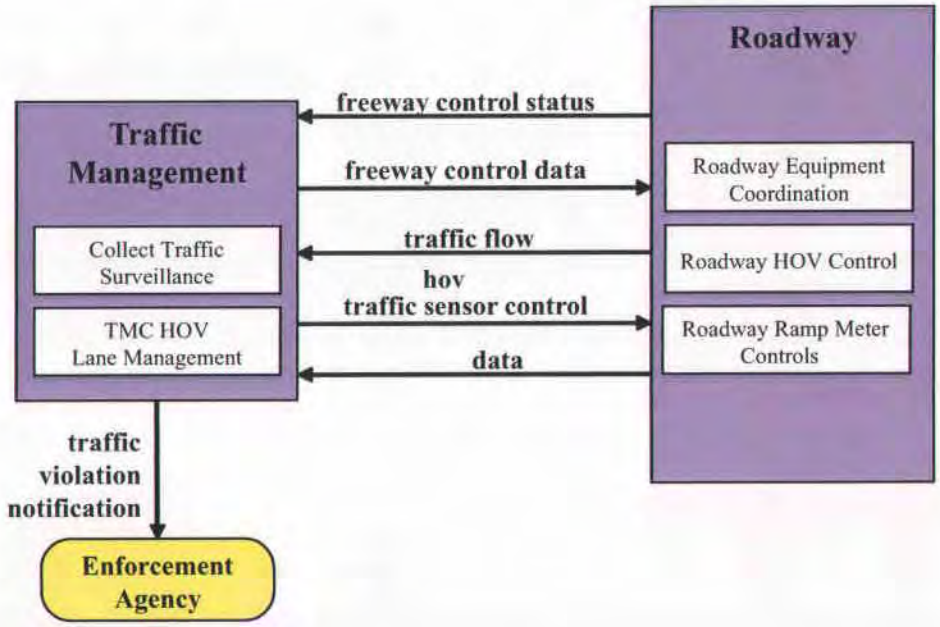
GOT – 110 - Work Zone Traffic Management



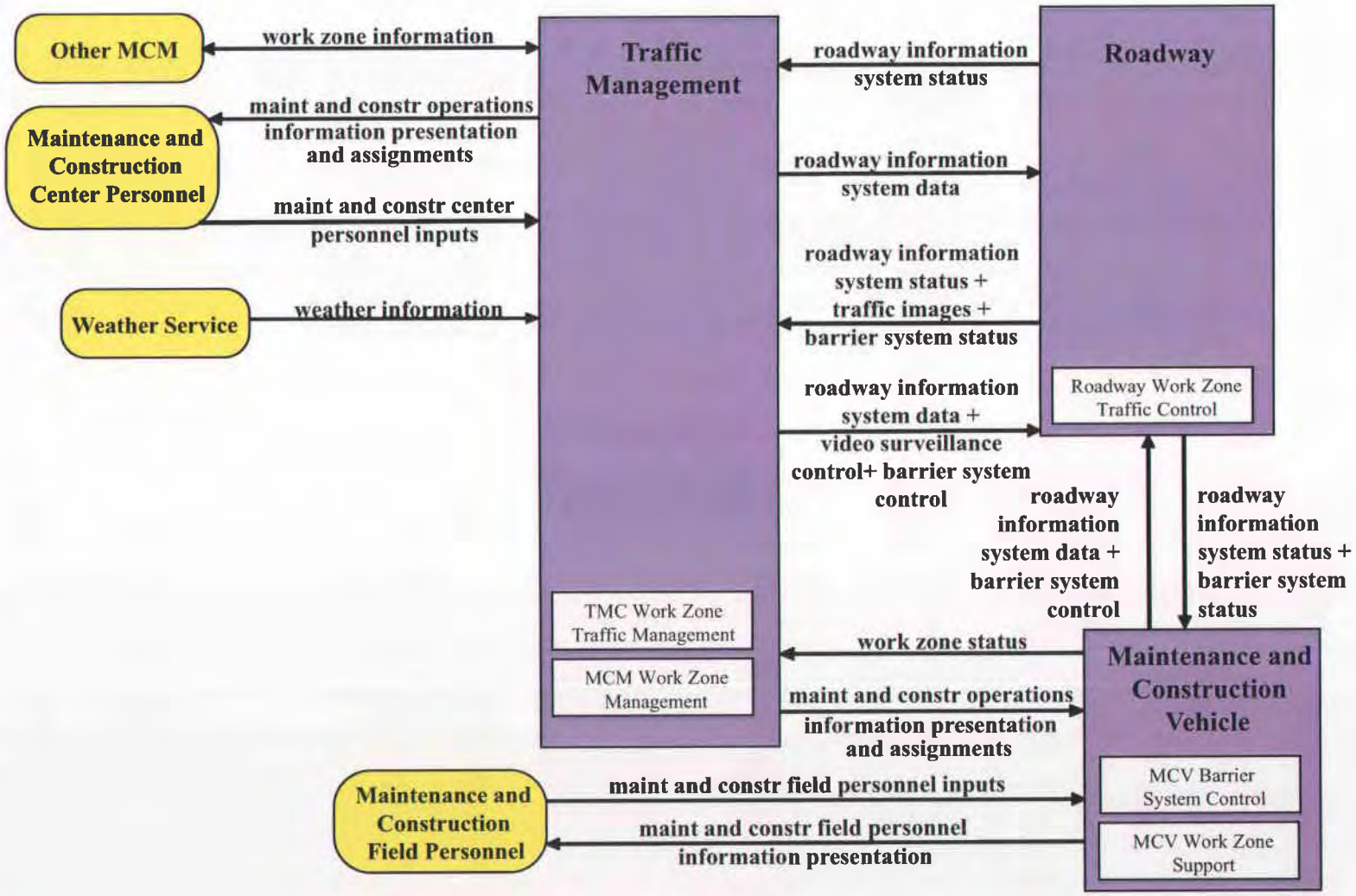
GOT – 201 – Variable Road Pricing (Related to Toll Collection)



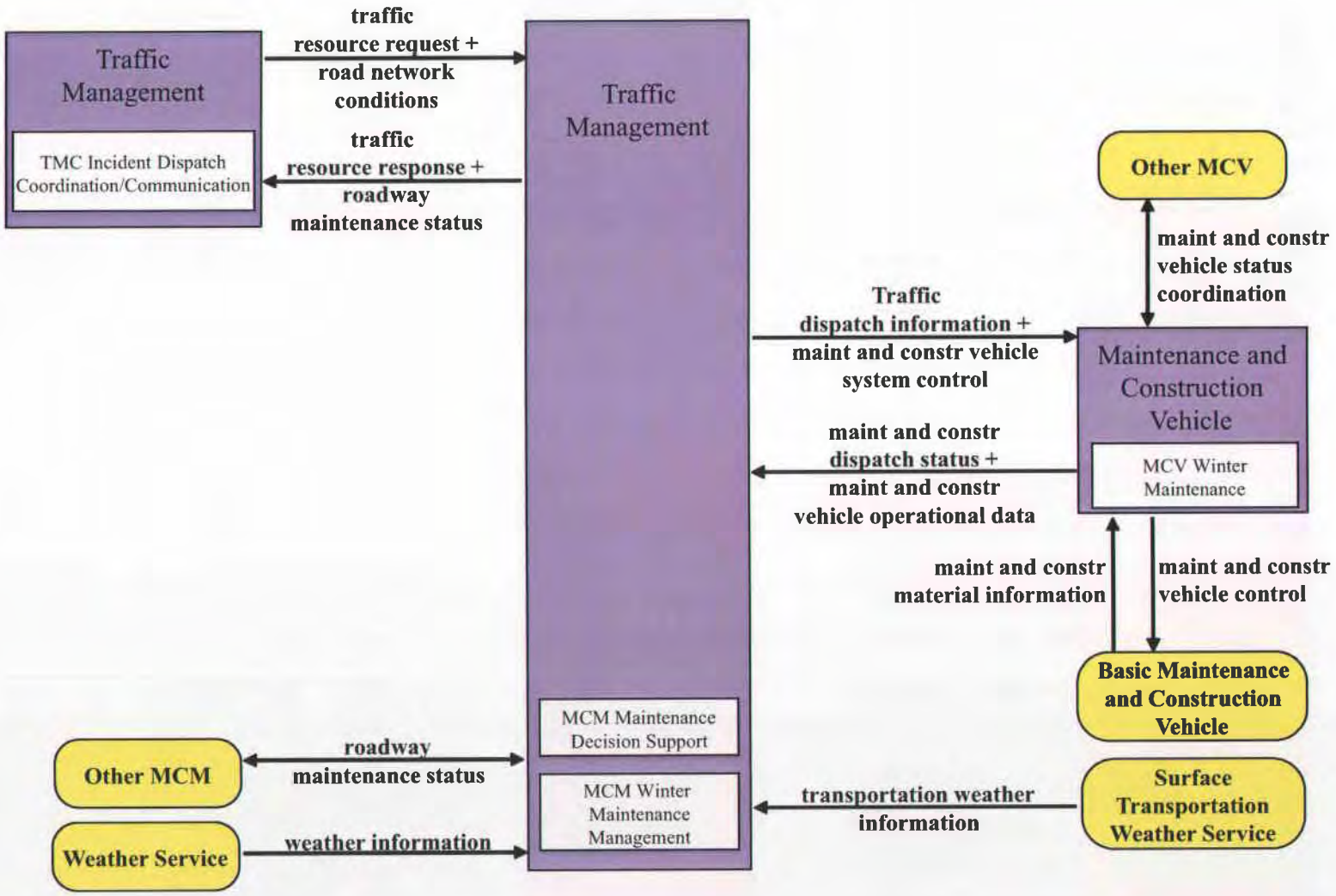
GOT – 203 – High Occupancy Lane Management



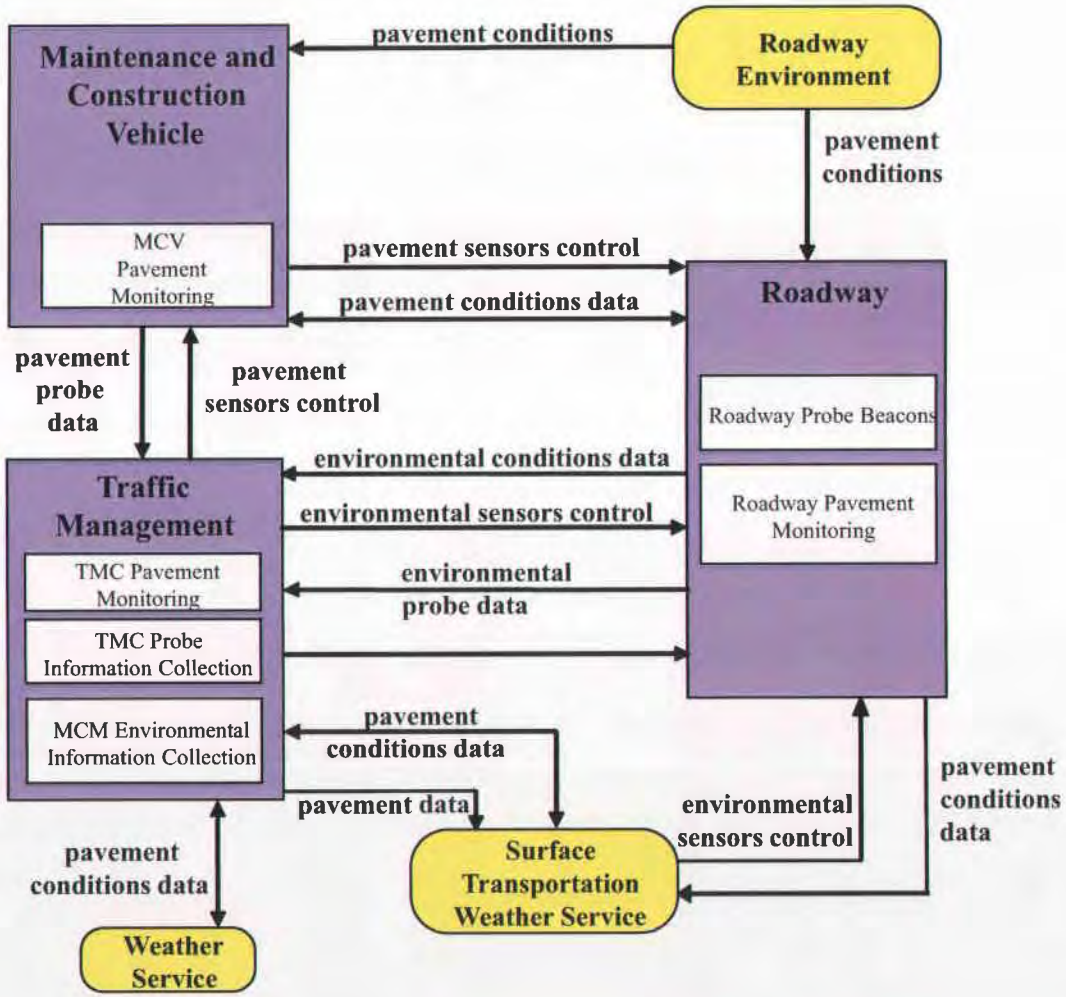
GOT – 301 – Roadway Construction and Maintenance Management



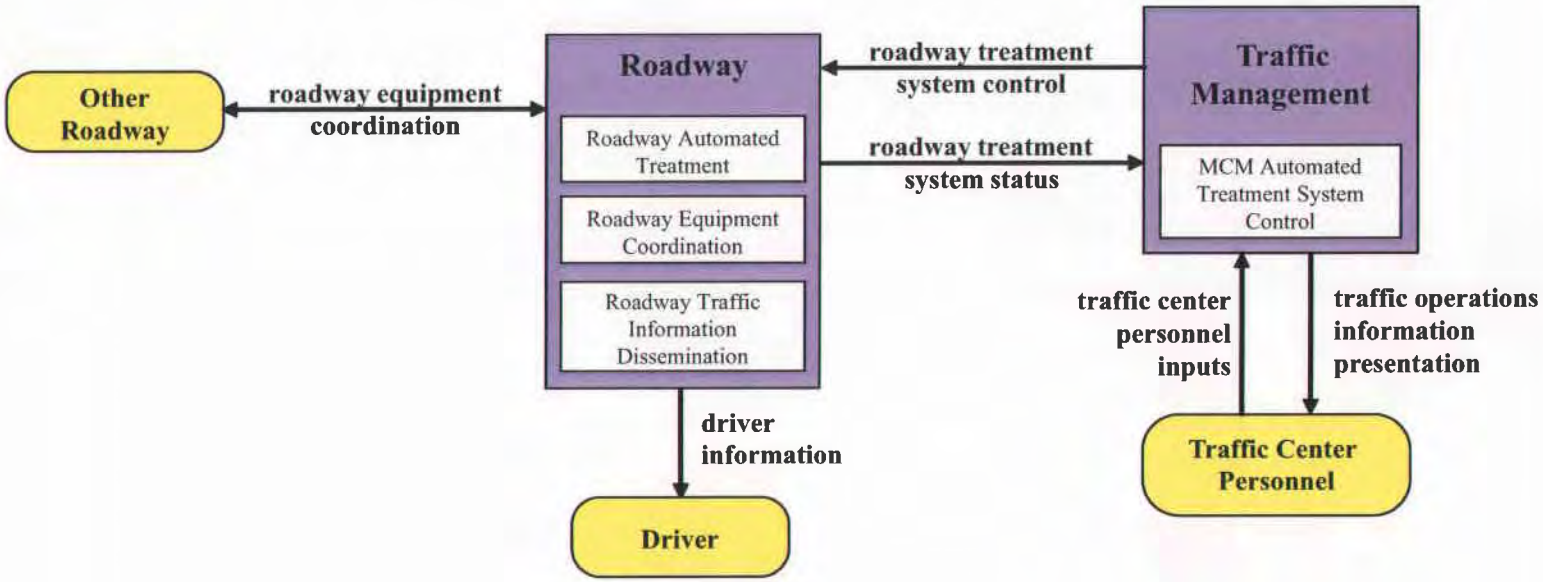
GOT – 302 - Winter Maintenance (High Altitude)



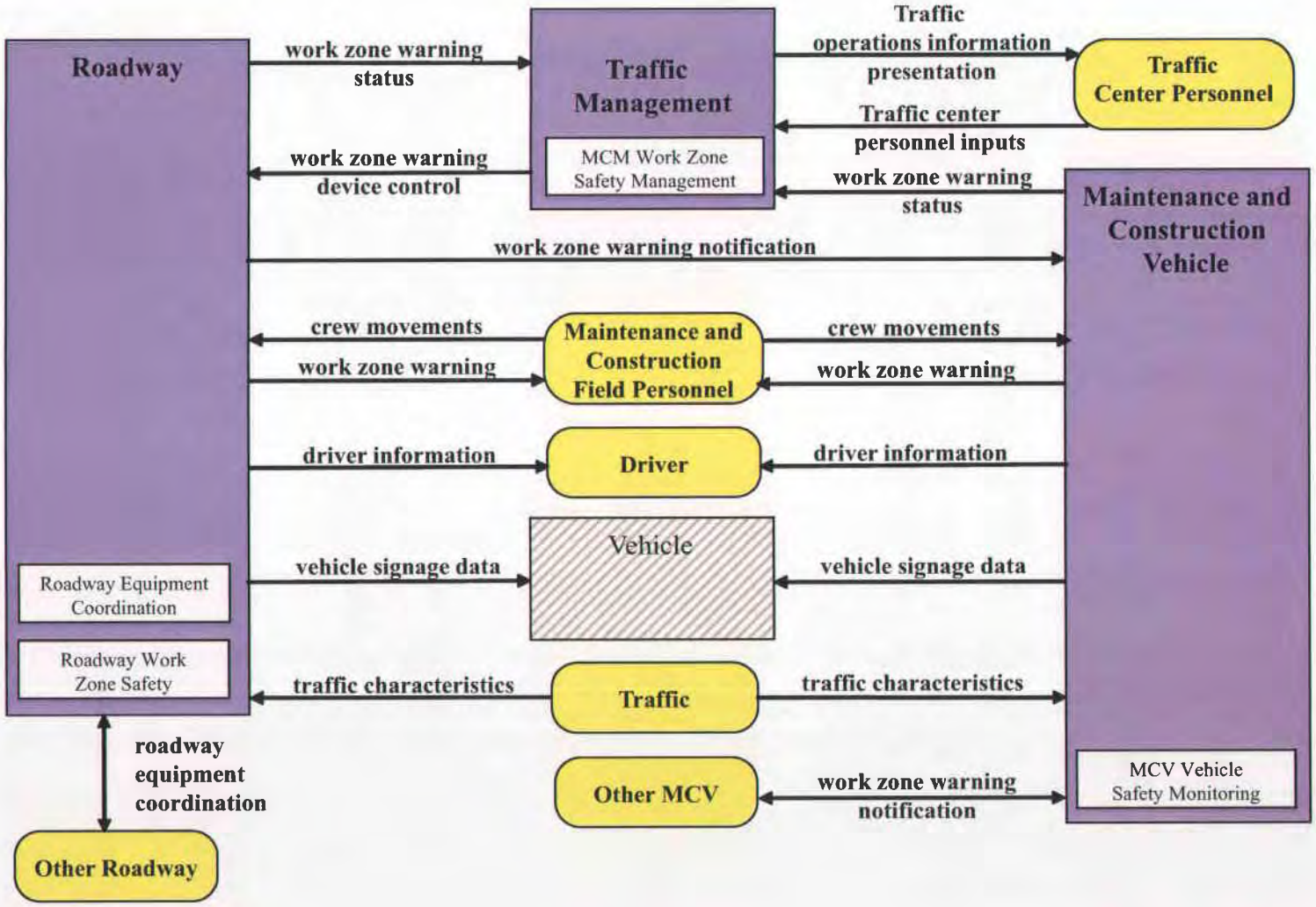
GOT – 303 – Pavement Management



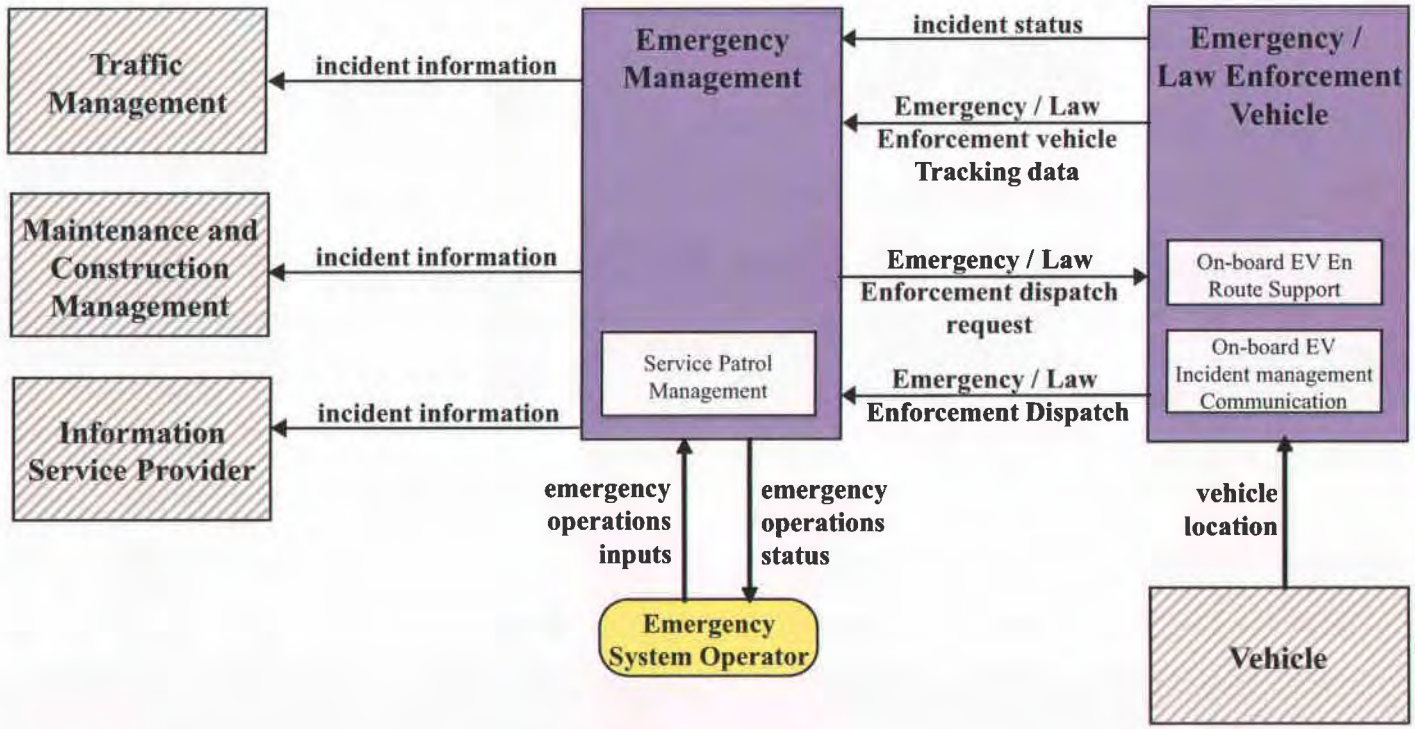
GOT – 304 - Automated Roadway Management



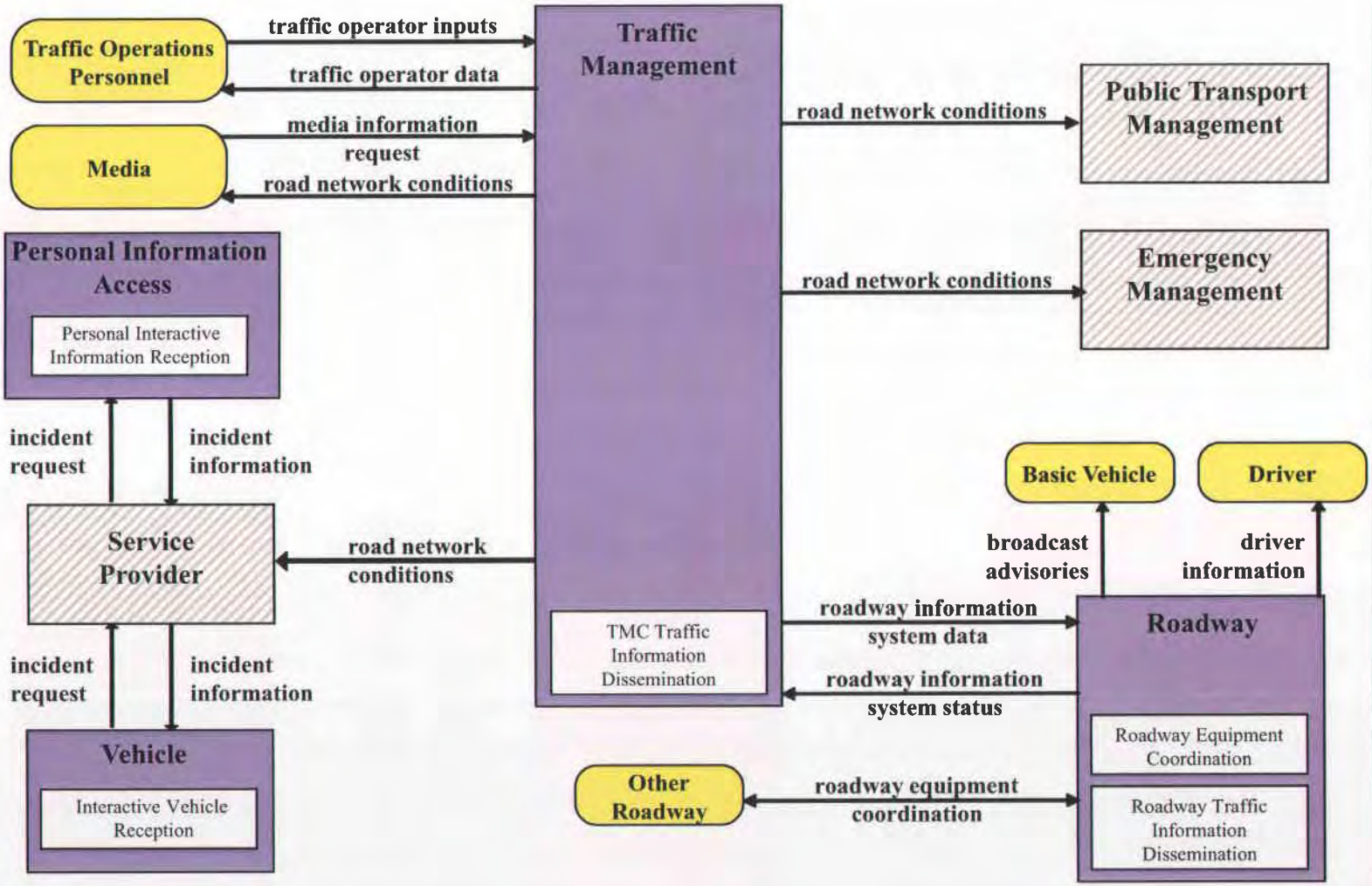
GOT – 305 - Work Zone Safety Monitoring



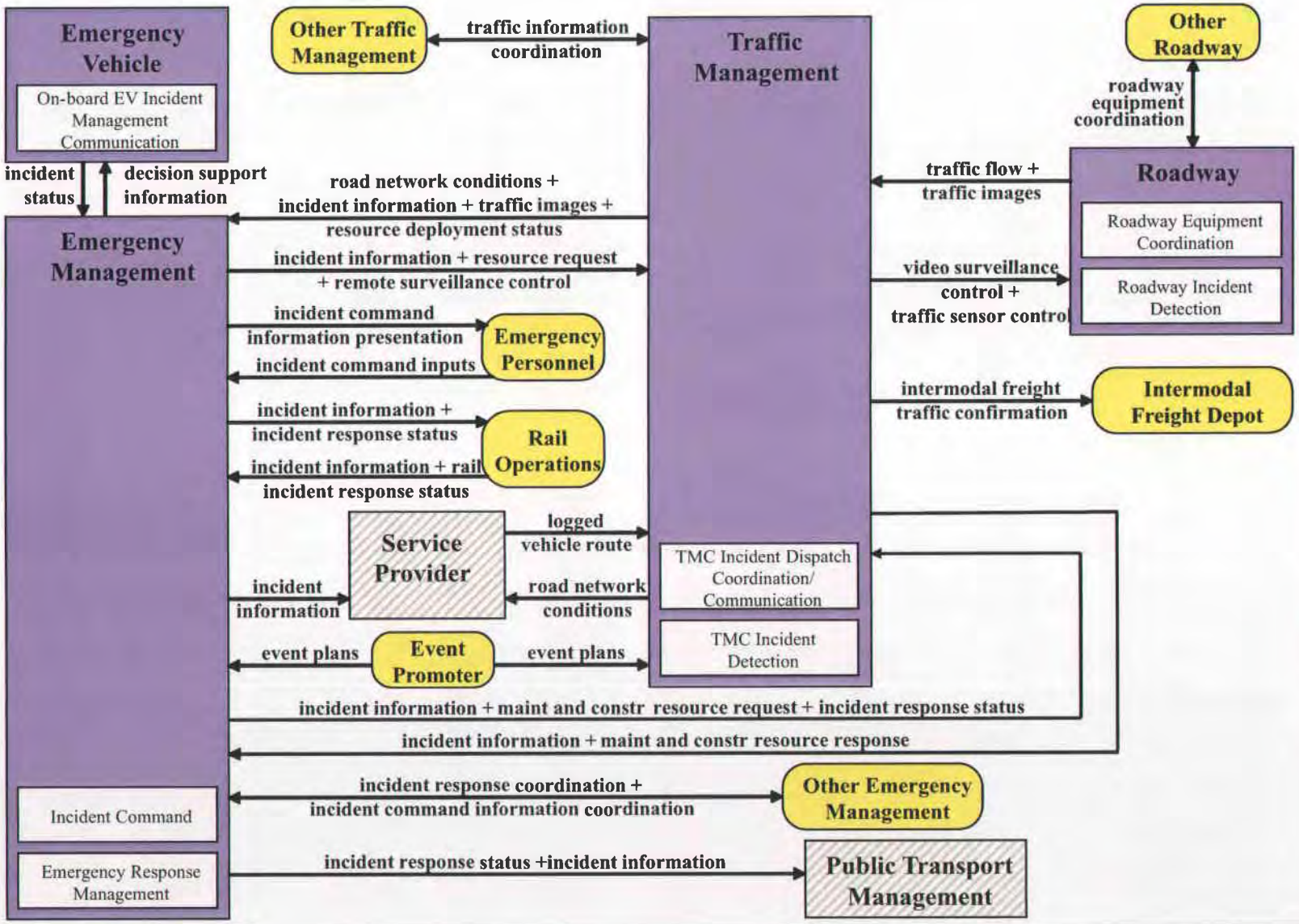
GOT – 401 – Incident On-Site Motorist Assistance



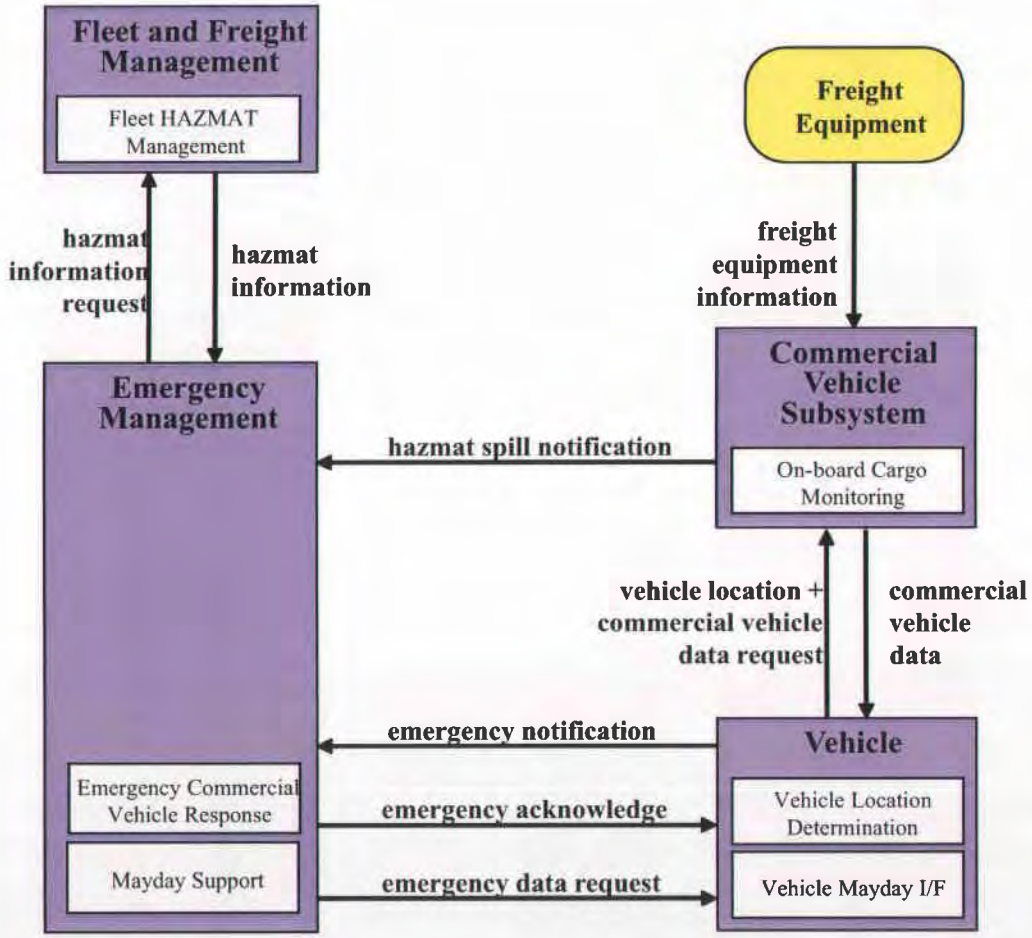
GOT – 402 – Incident On-Site Traveler Assistance



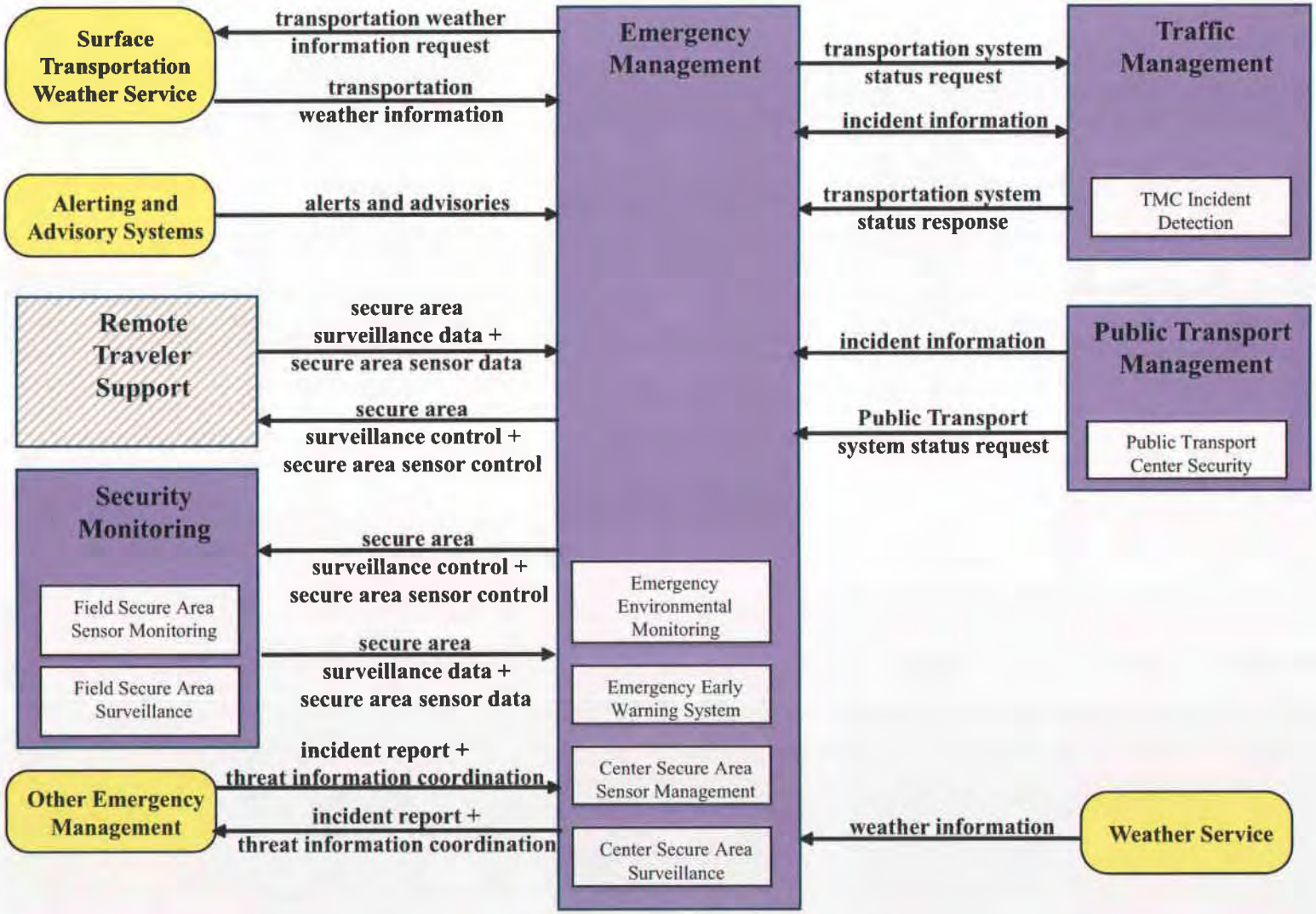
GOT - 403 – Incident Coordination and Clearance



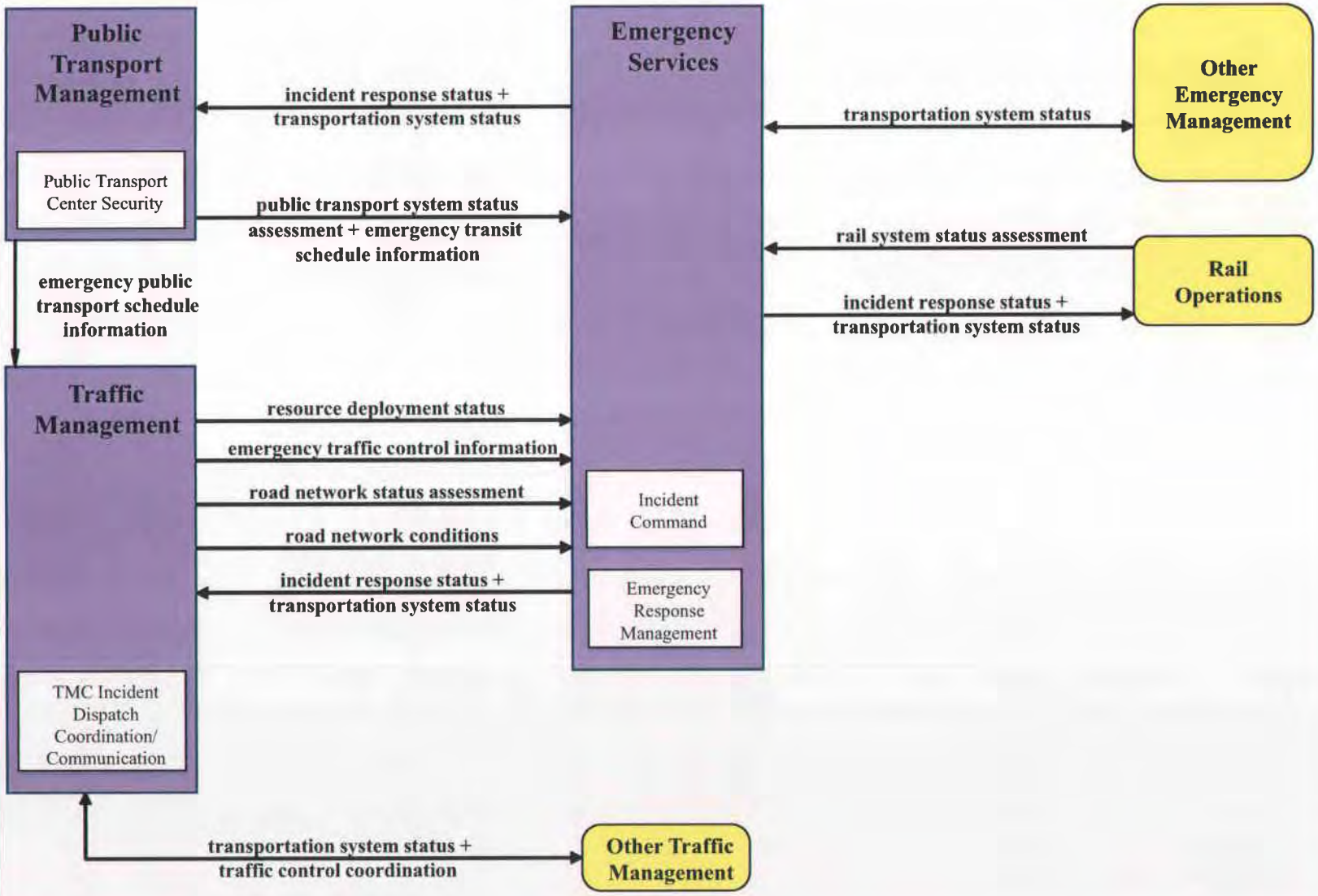
GOT – 404 – Hazardous Materials Monitoring and Management



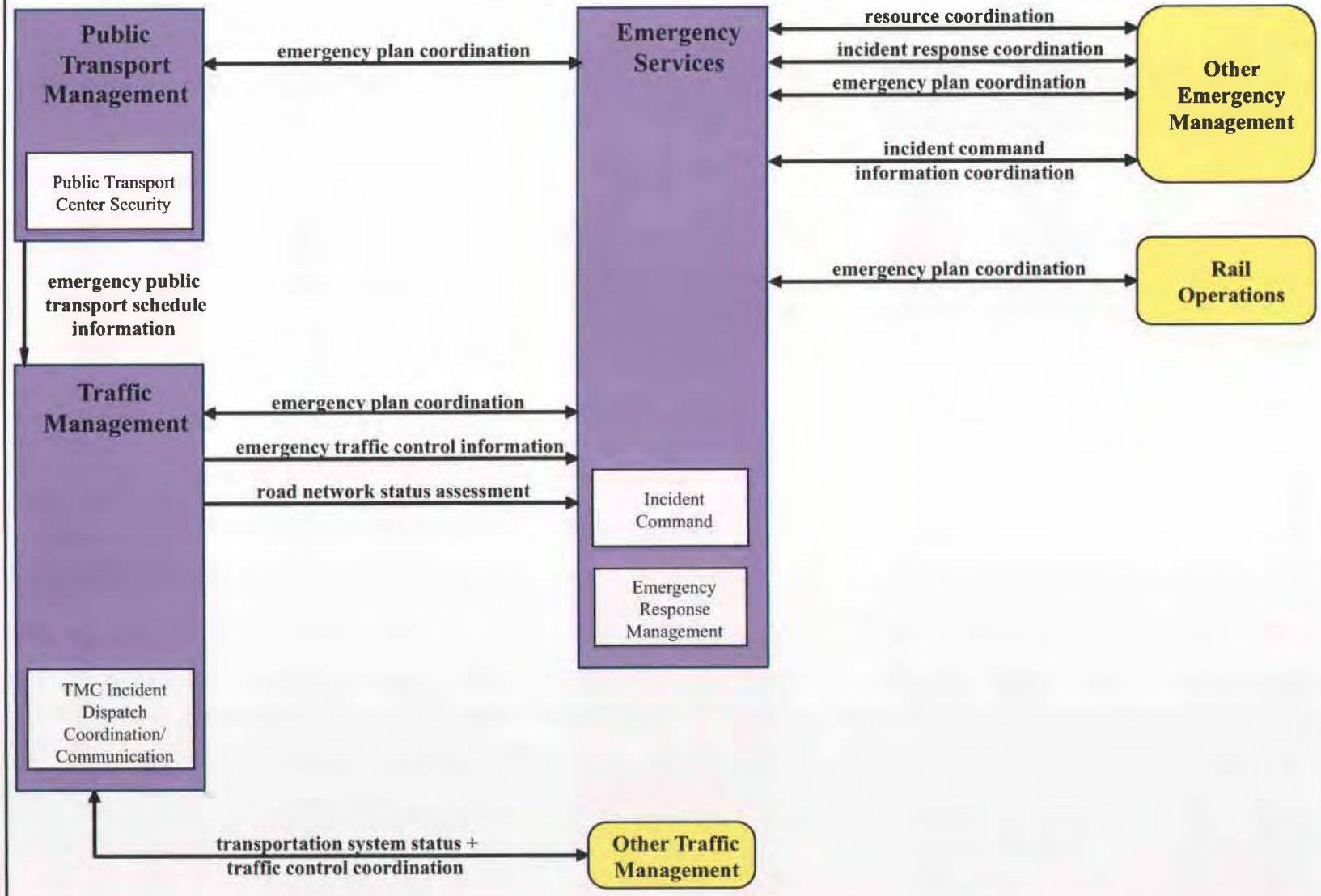
GI – 101 – Disaster and Emergency Data Collection



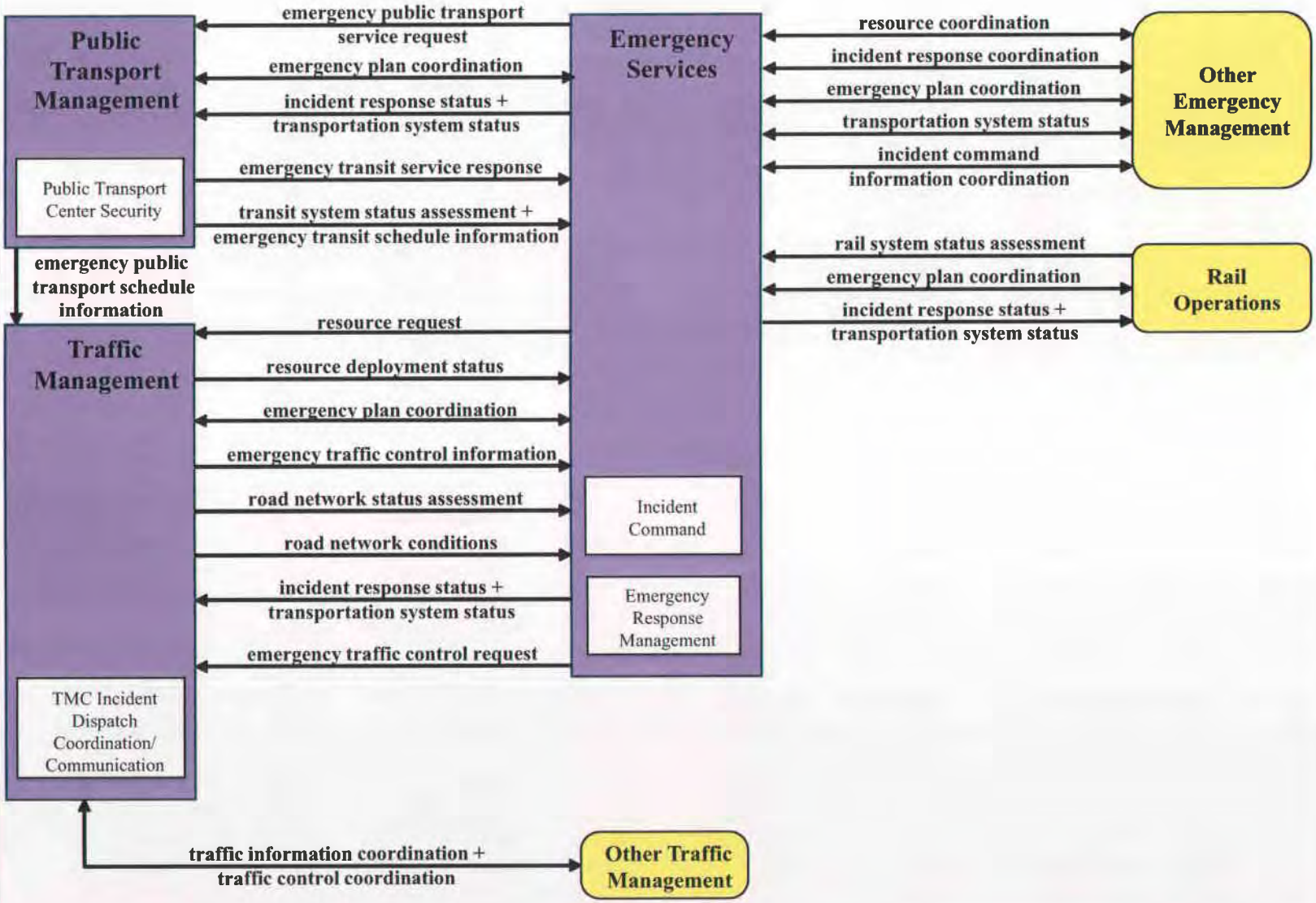
GI - 102 - Disaster Emergency Data Sharing



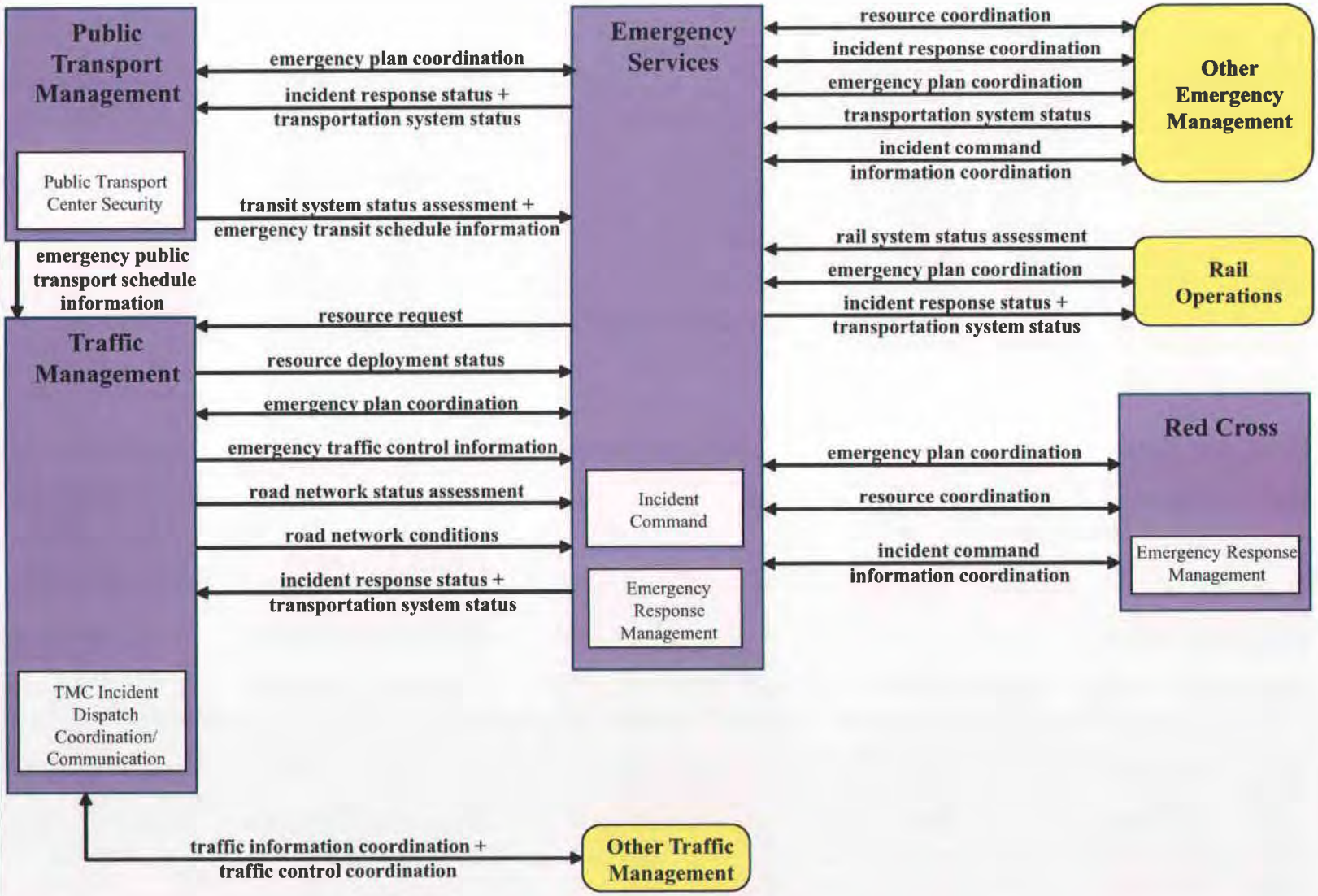
GI - 201 - Disaster Response Planning for Transport Network



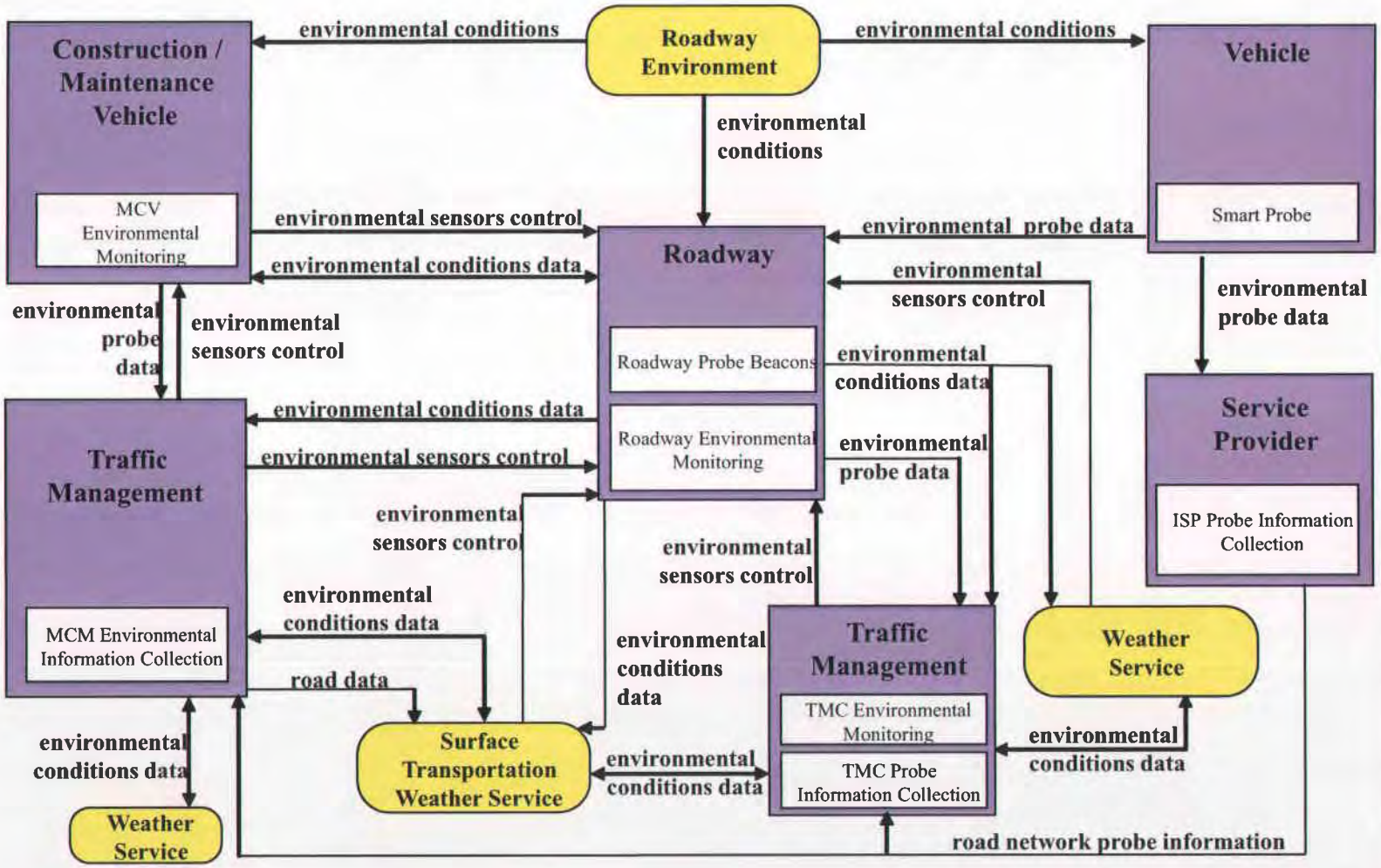
GI – 202 - Disaster Response and Implementation



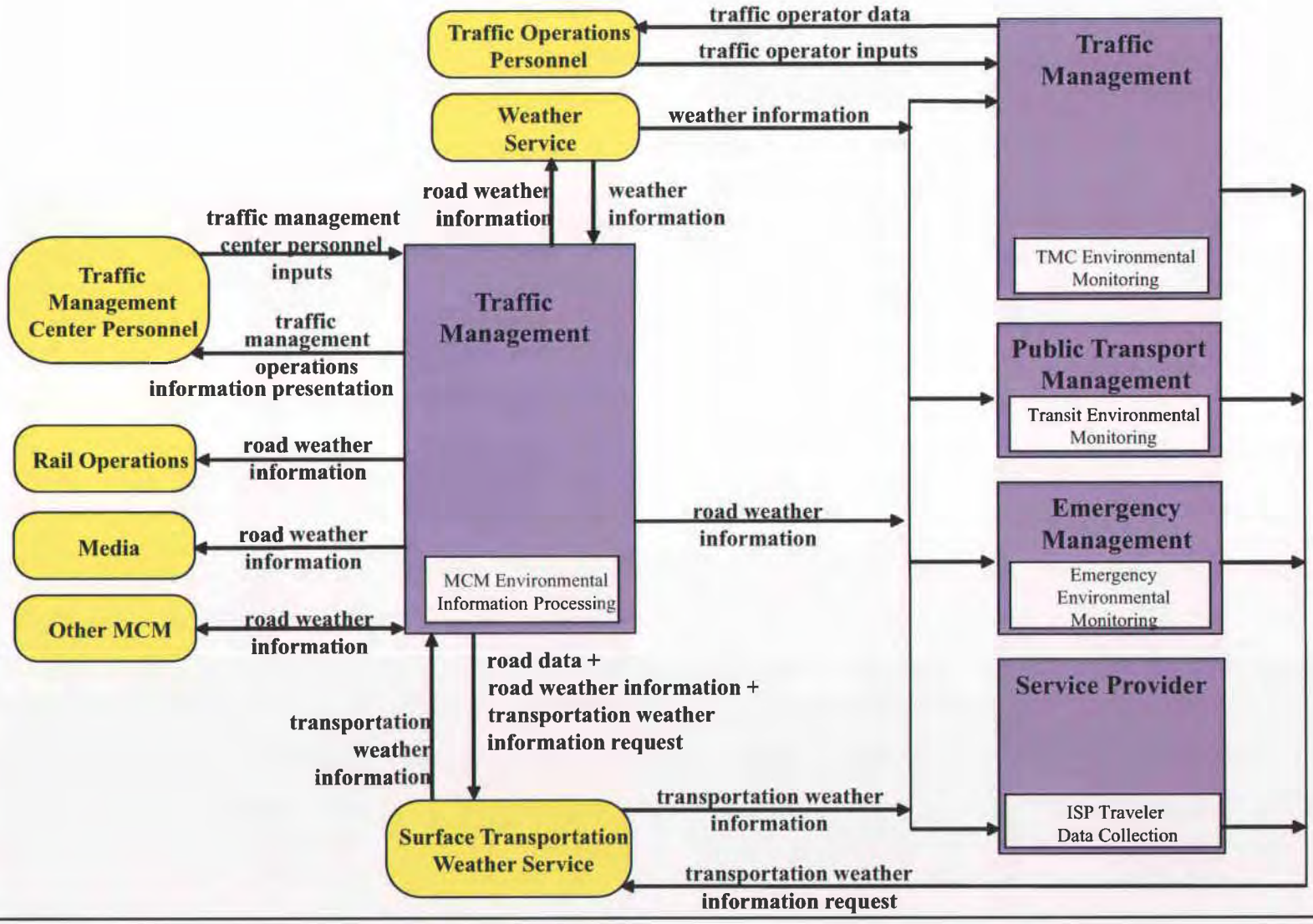
GI – 301 - Disaster Response and Coordination



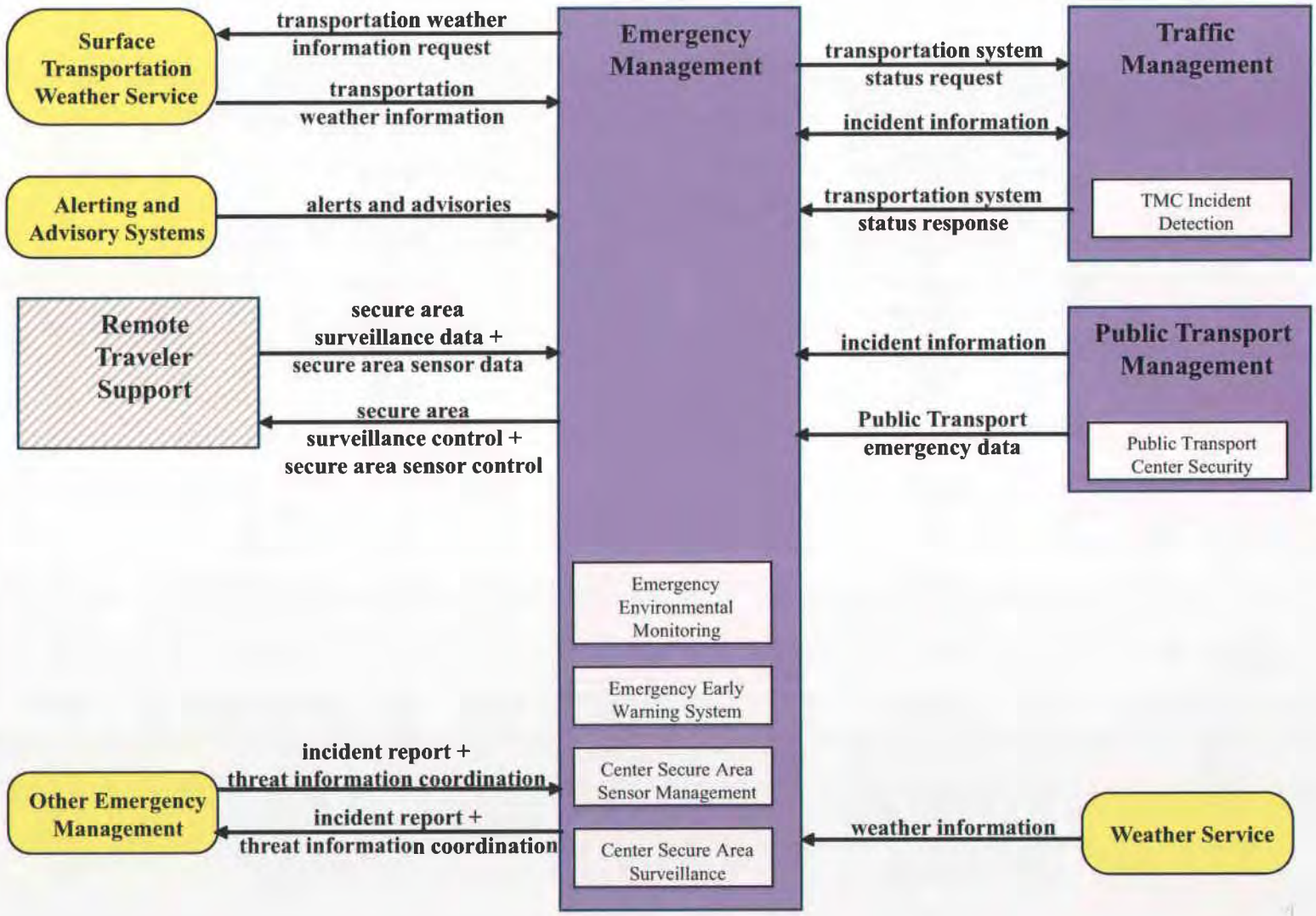
MA – 101 - Road Weather Information Monitoring



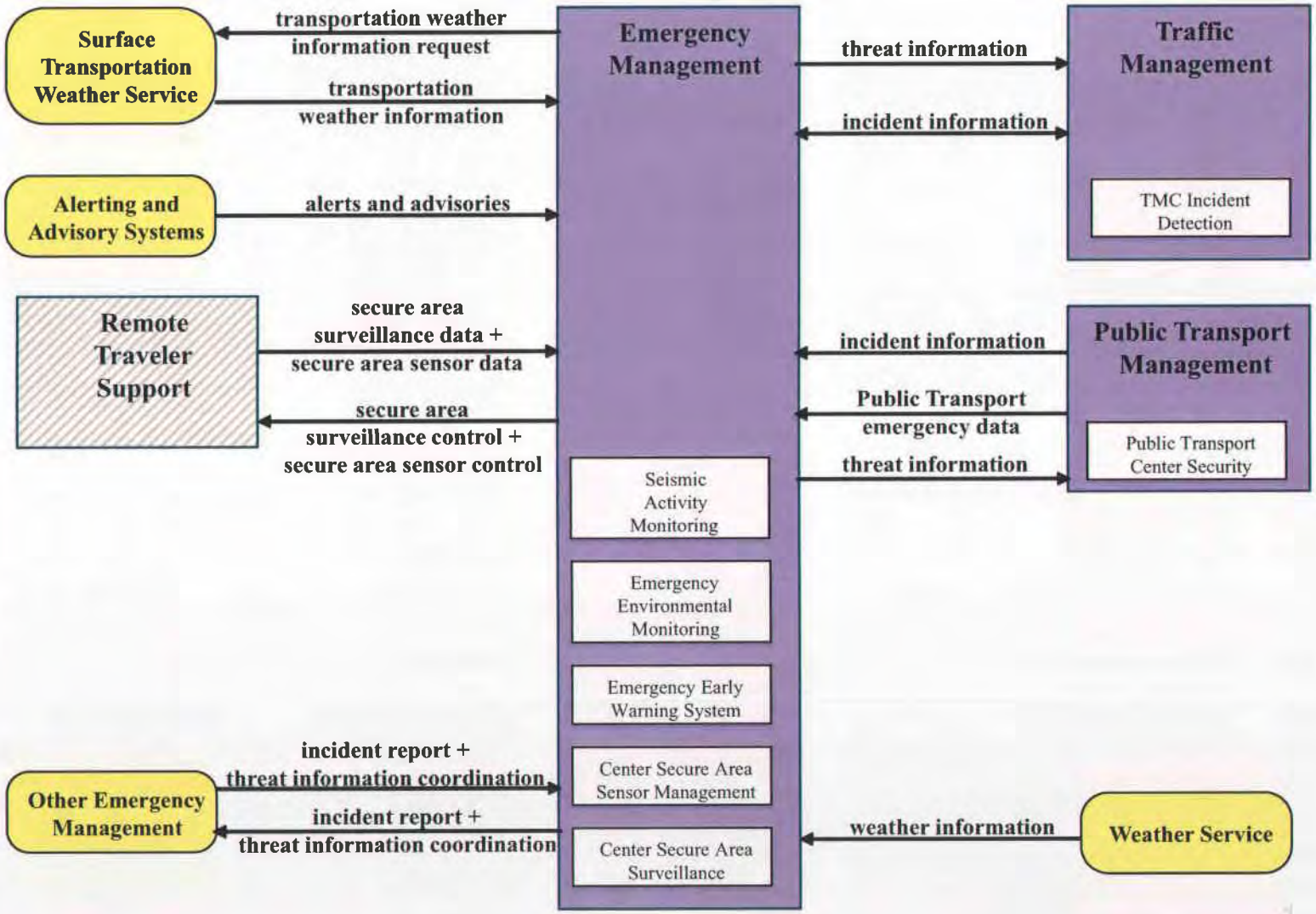
MA -102 – Road Weather Prediction



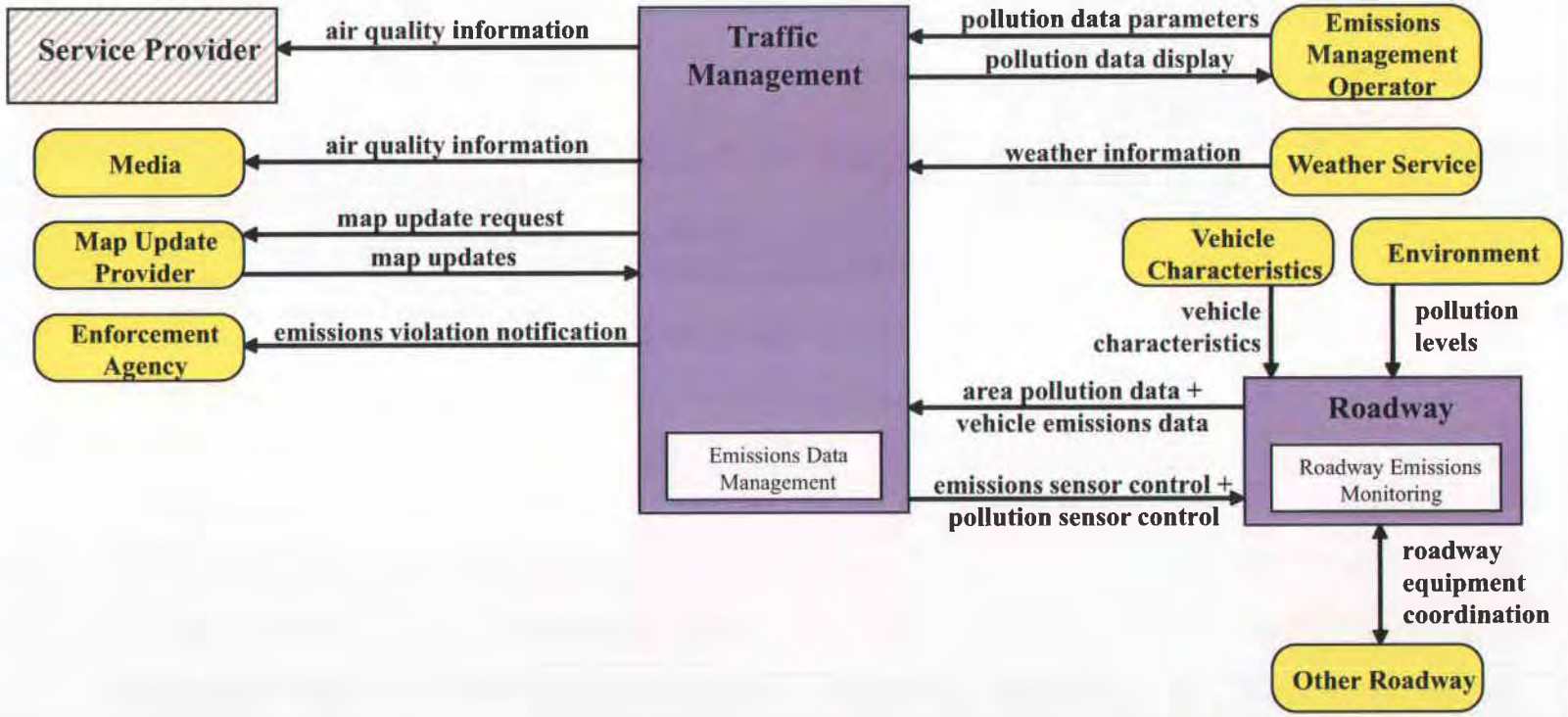
MA – 201 – Water Level / Tidal Monitoring and Prediction



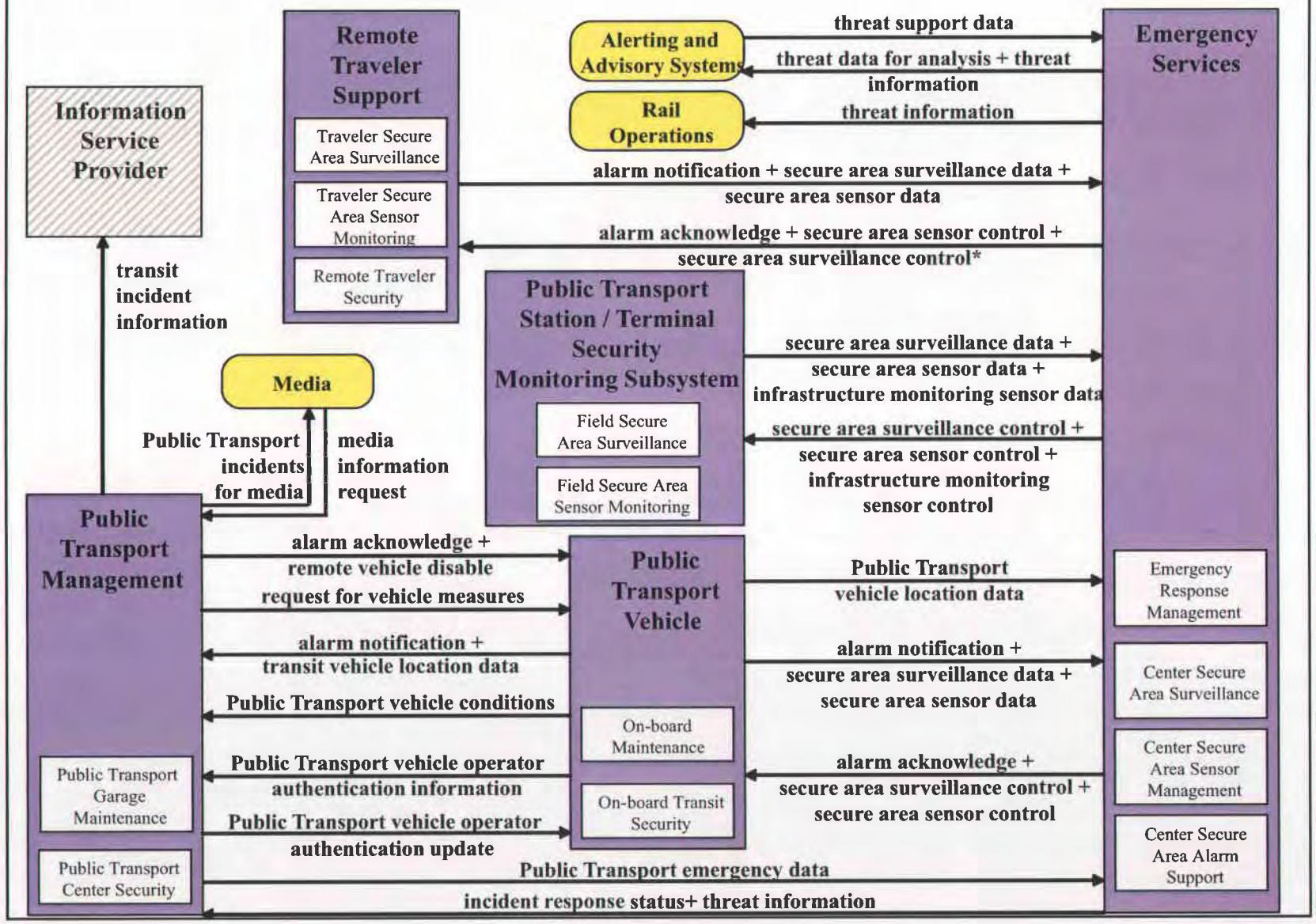
MA – 202 – Seismic Monitoring



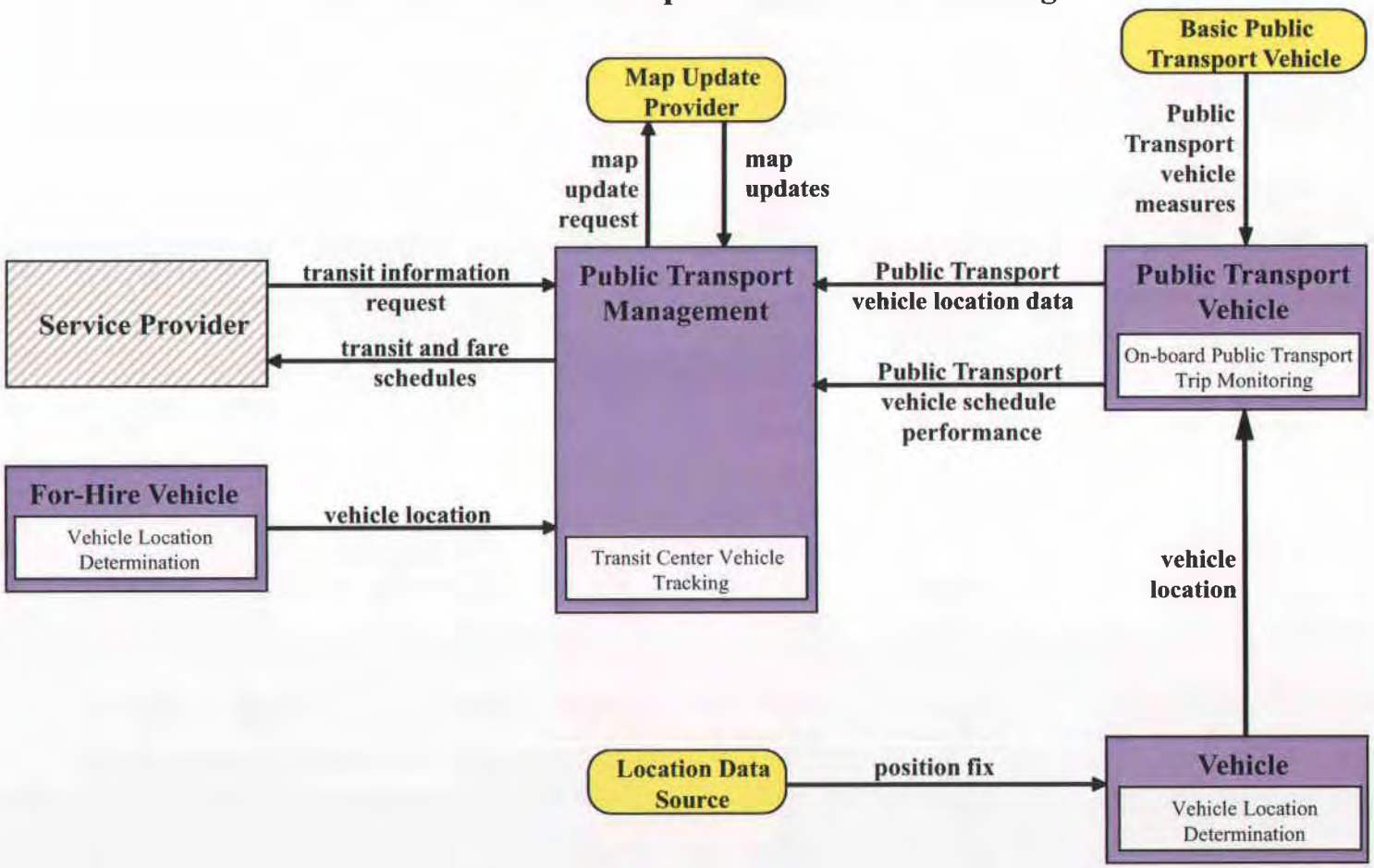
MA – 203 - Pollution Monitoring



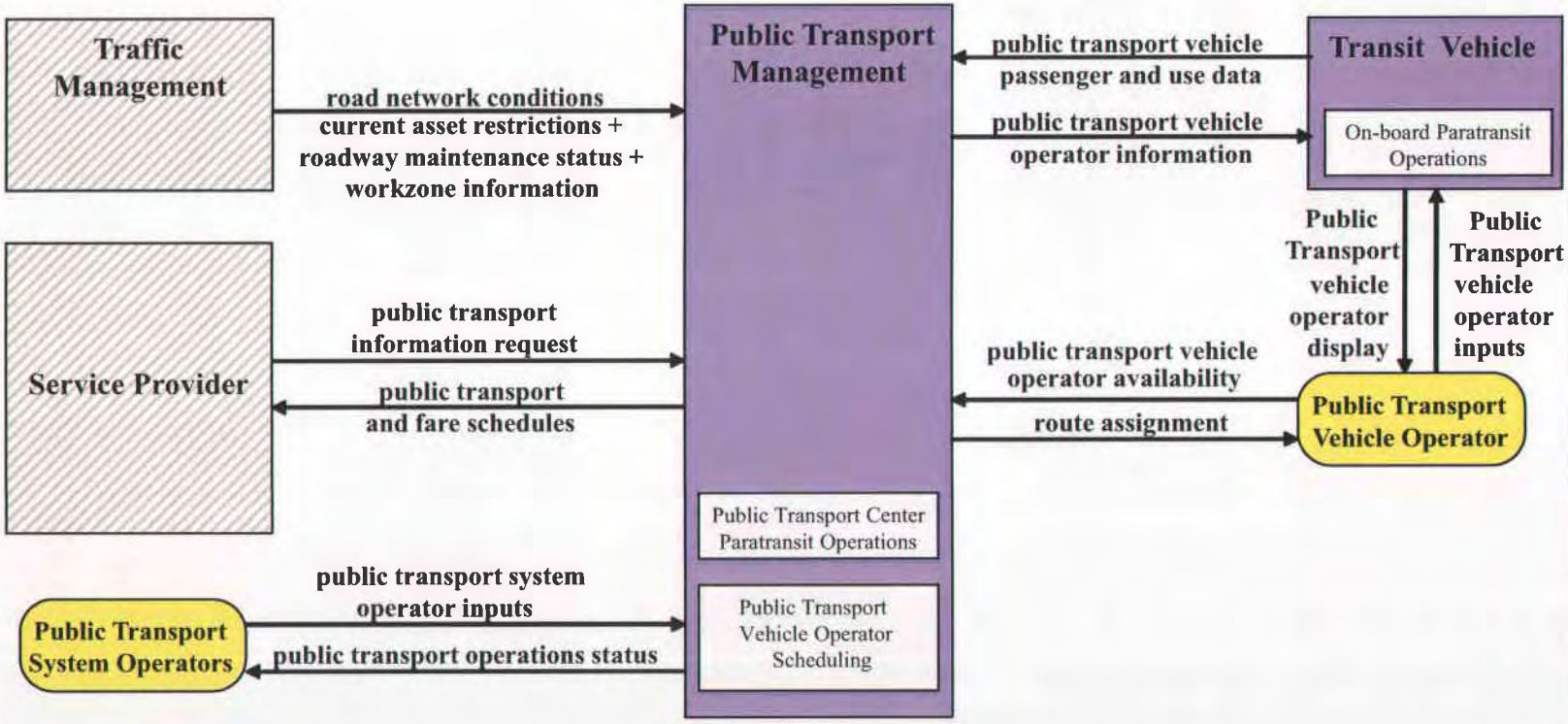
TP – 101 – Public Transport Vehicle Internal Systems Monitoring



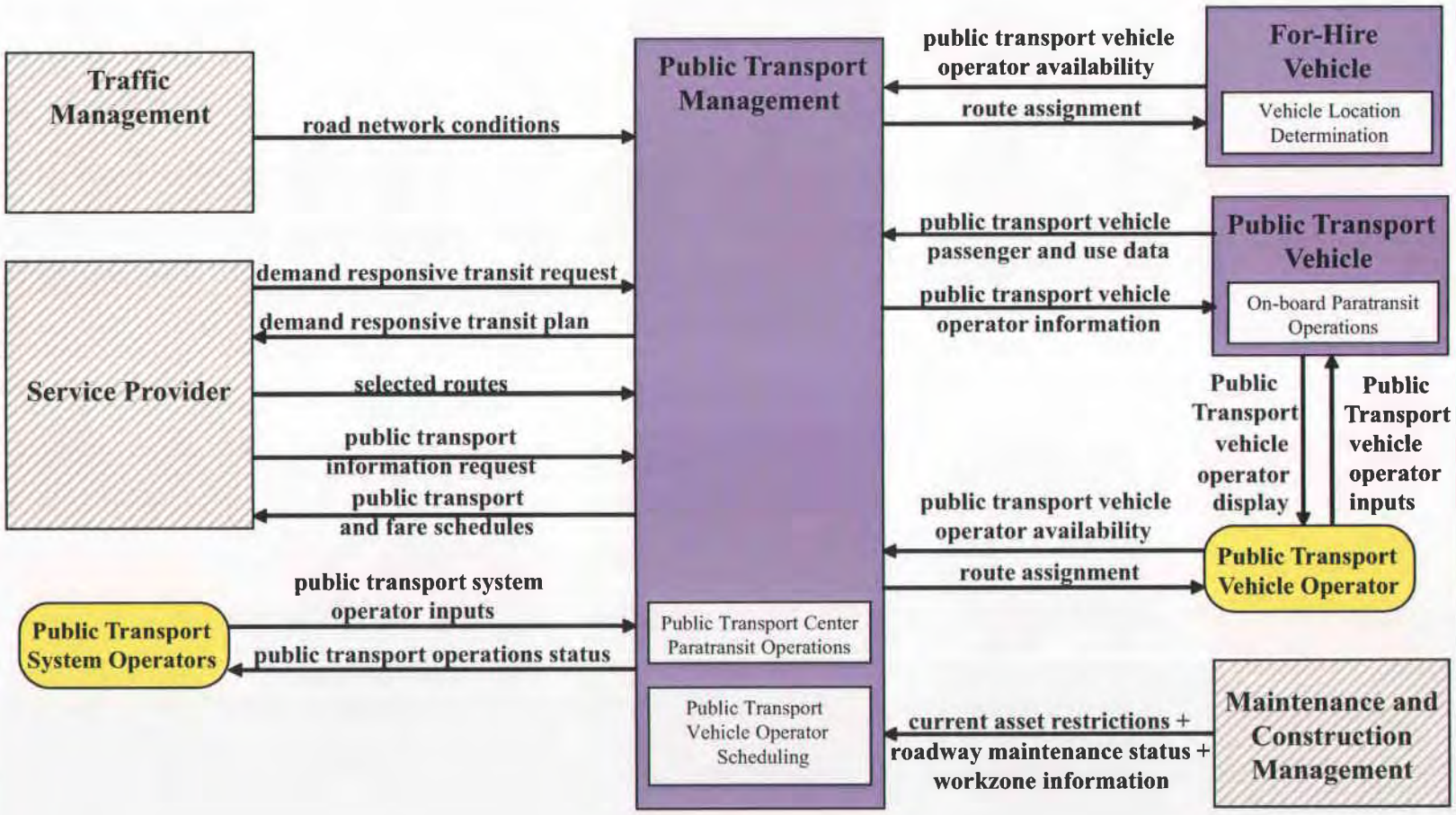
TP – 102 – Public Transport Vehicle Fleet Tracking



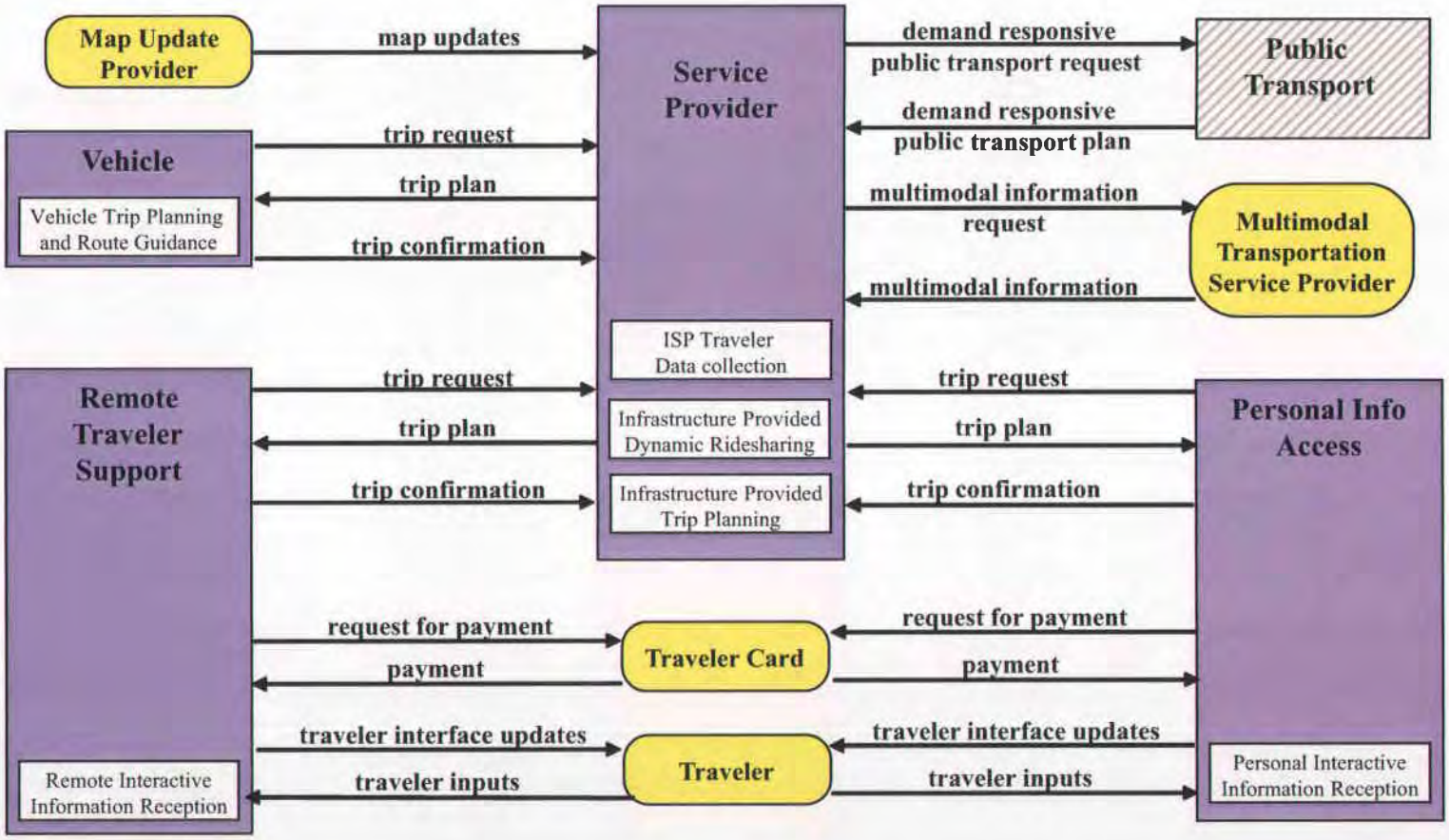
TP – 103 – Public Transport Scheduling Services



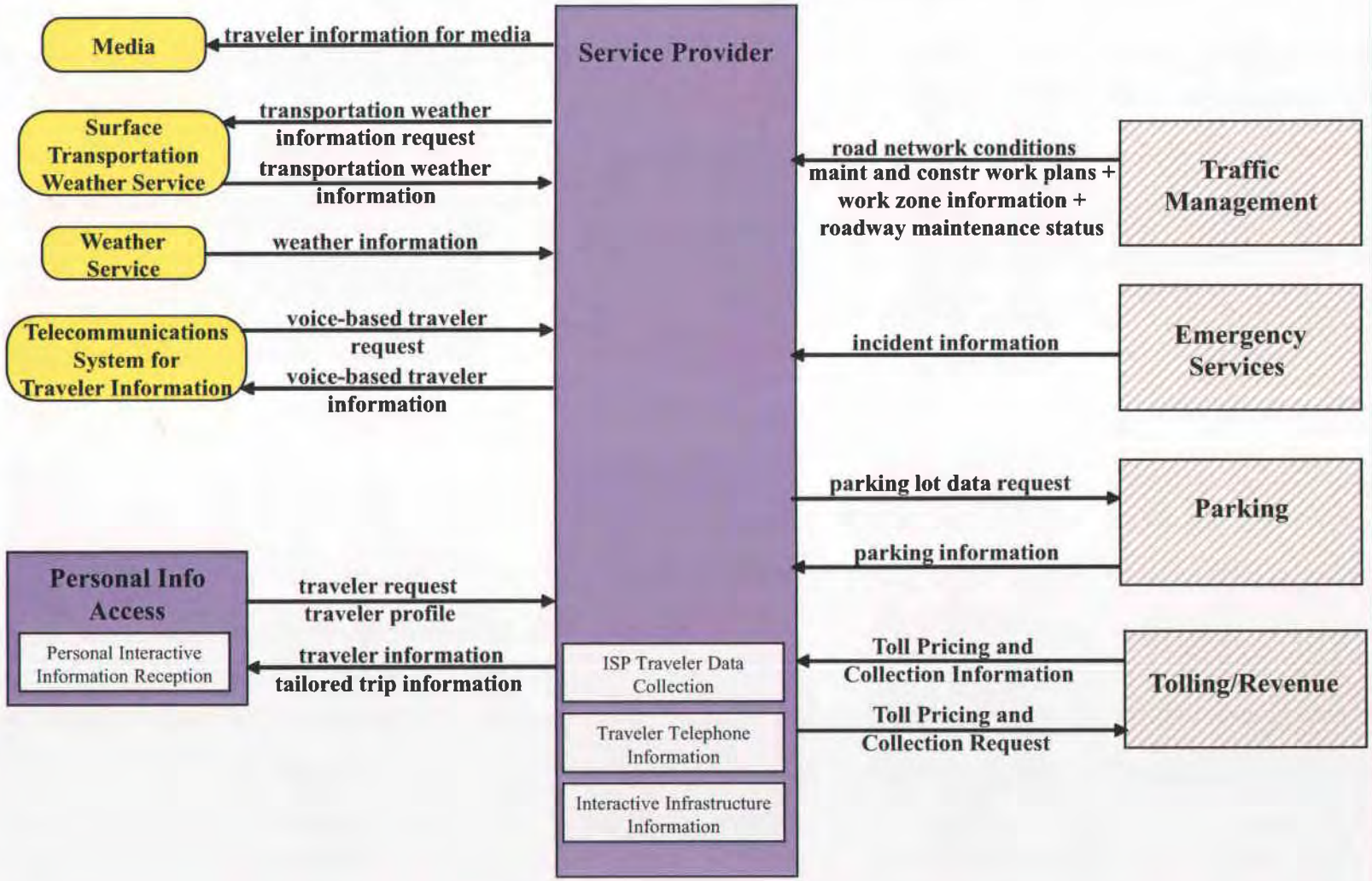
TP – 201 – Paratransit Fleet Dispatch



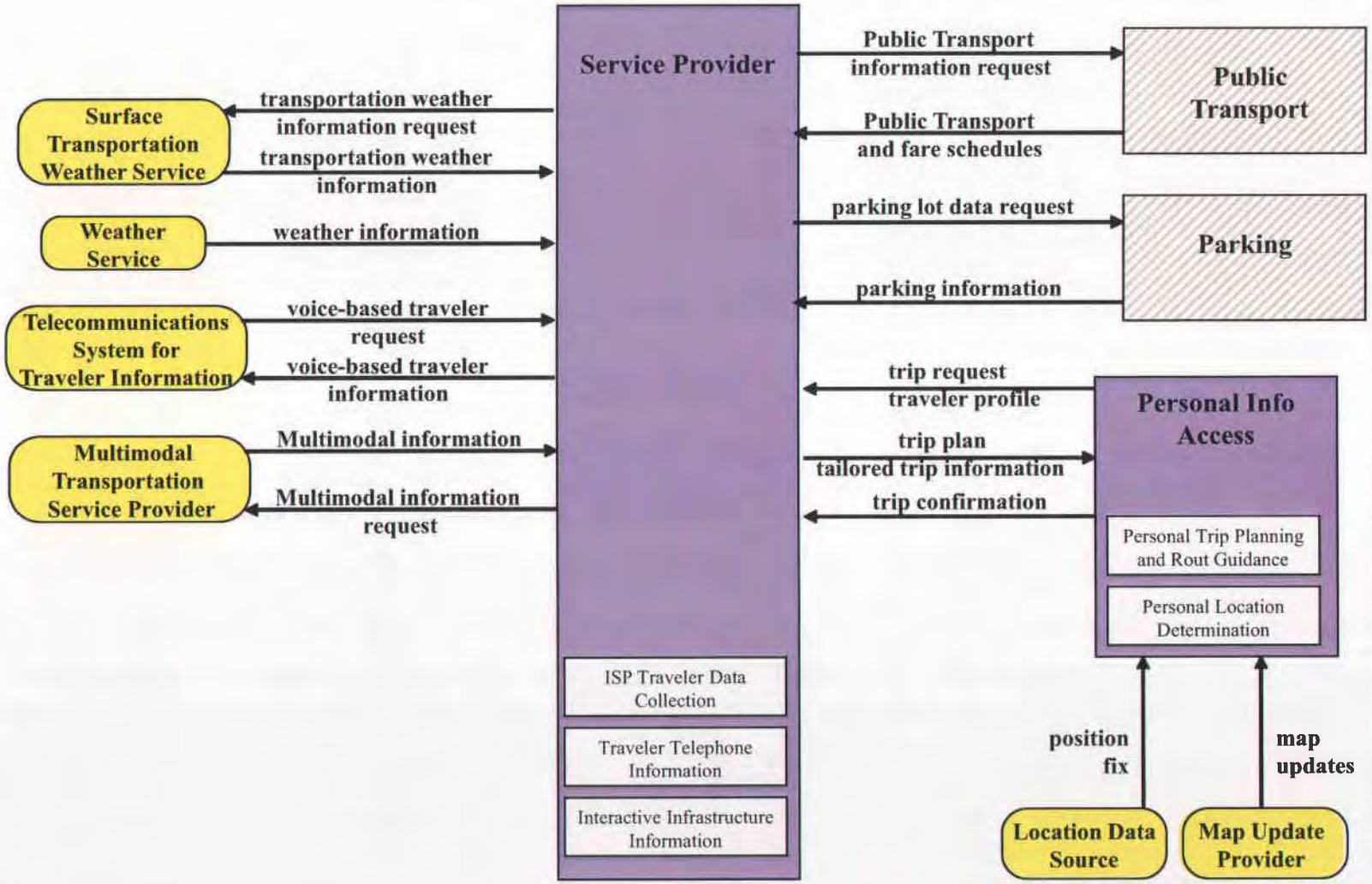
TP – 202 - Dynamic Ridesharing



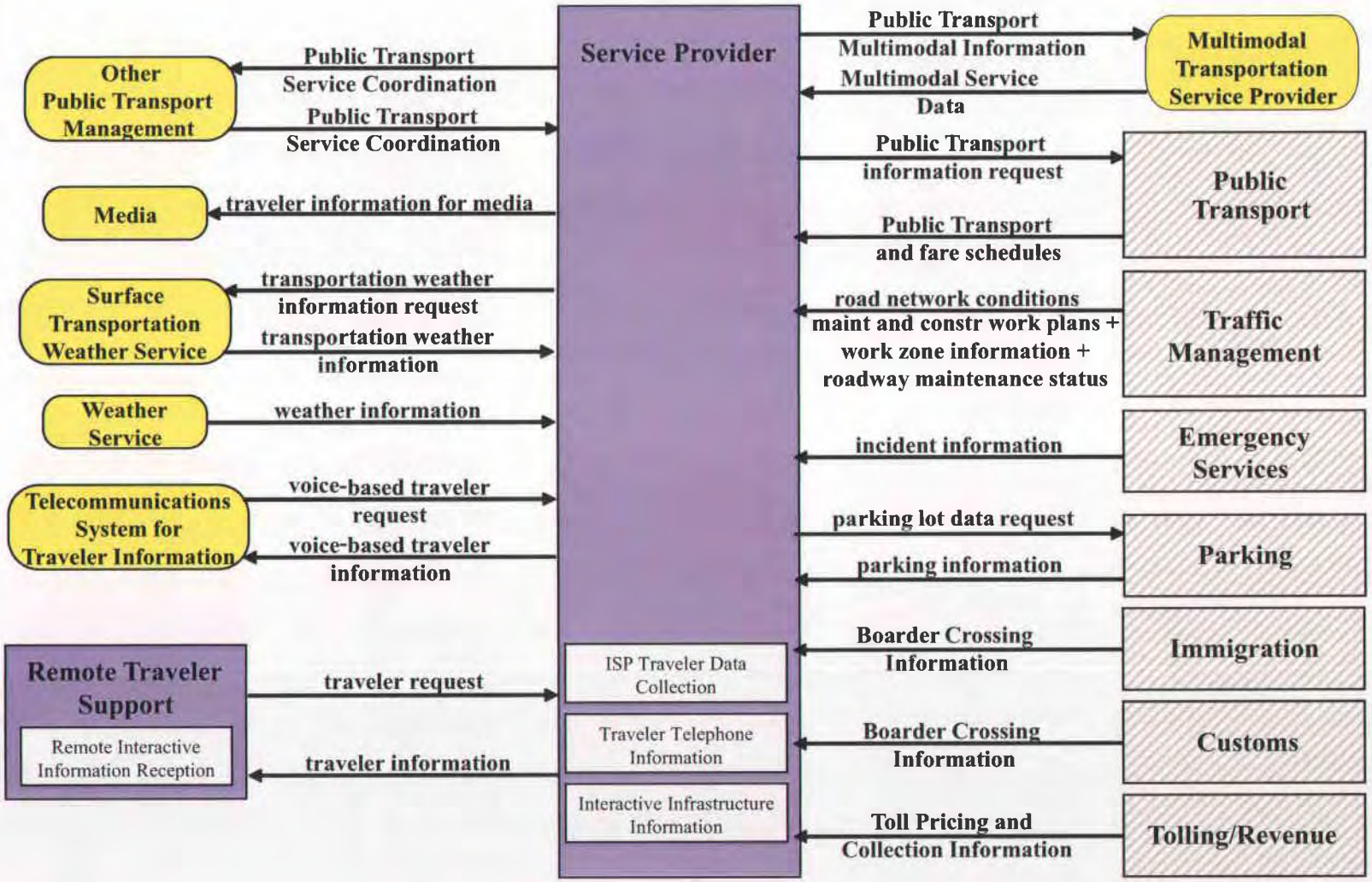
IV – 101 – Pre-Trip Information – Traffic and Roadway



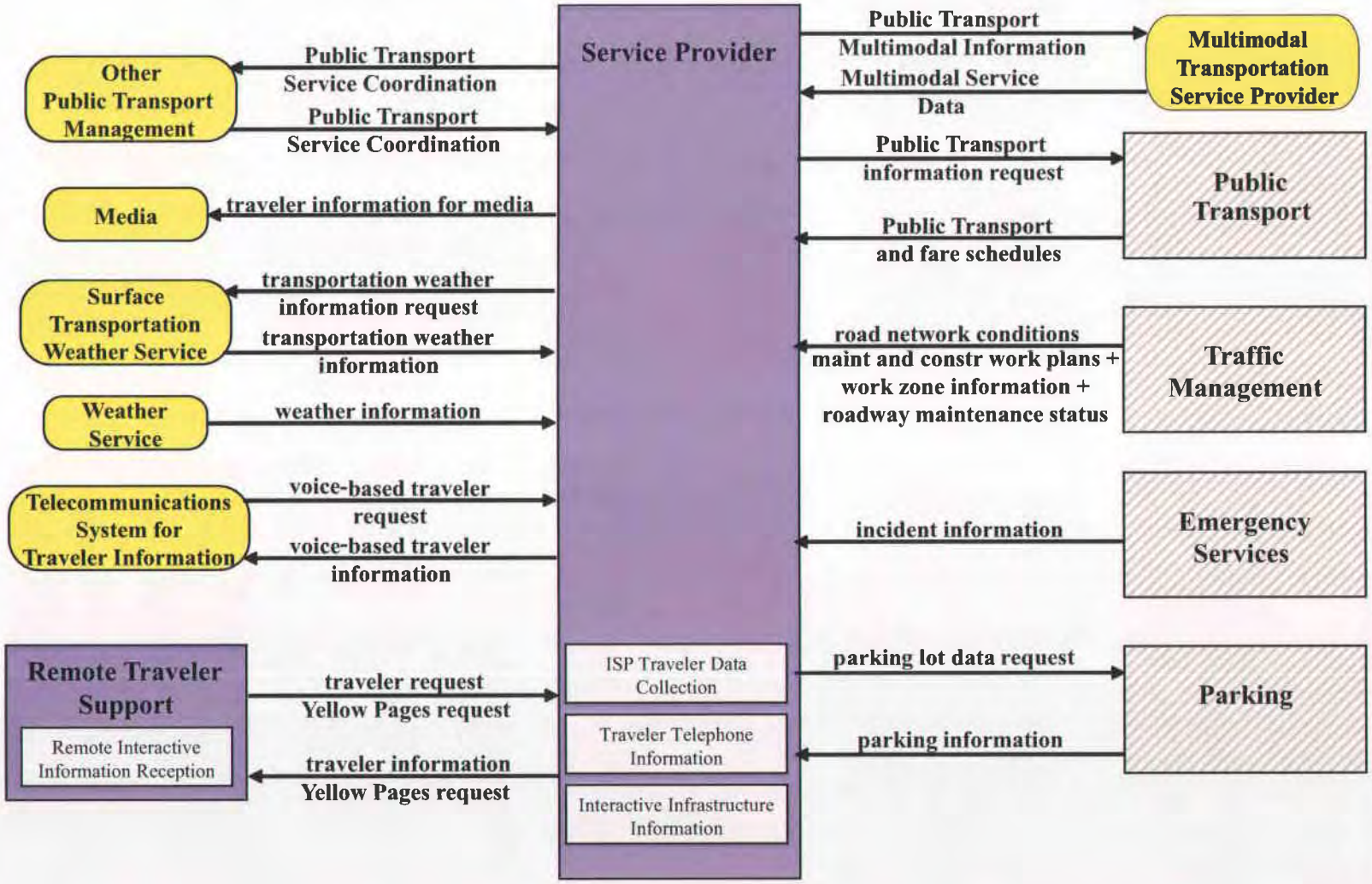
IV – 102 – Pre-Trip Information – Public Transport (Bus and Rail)



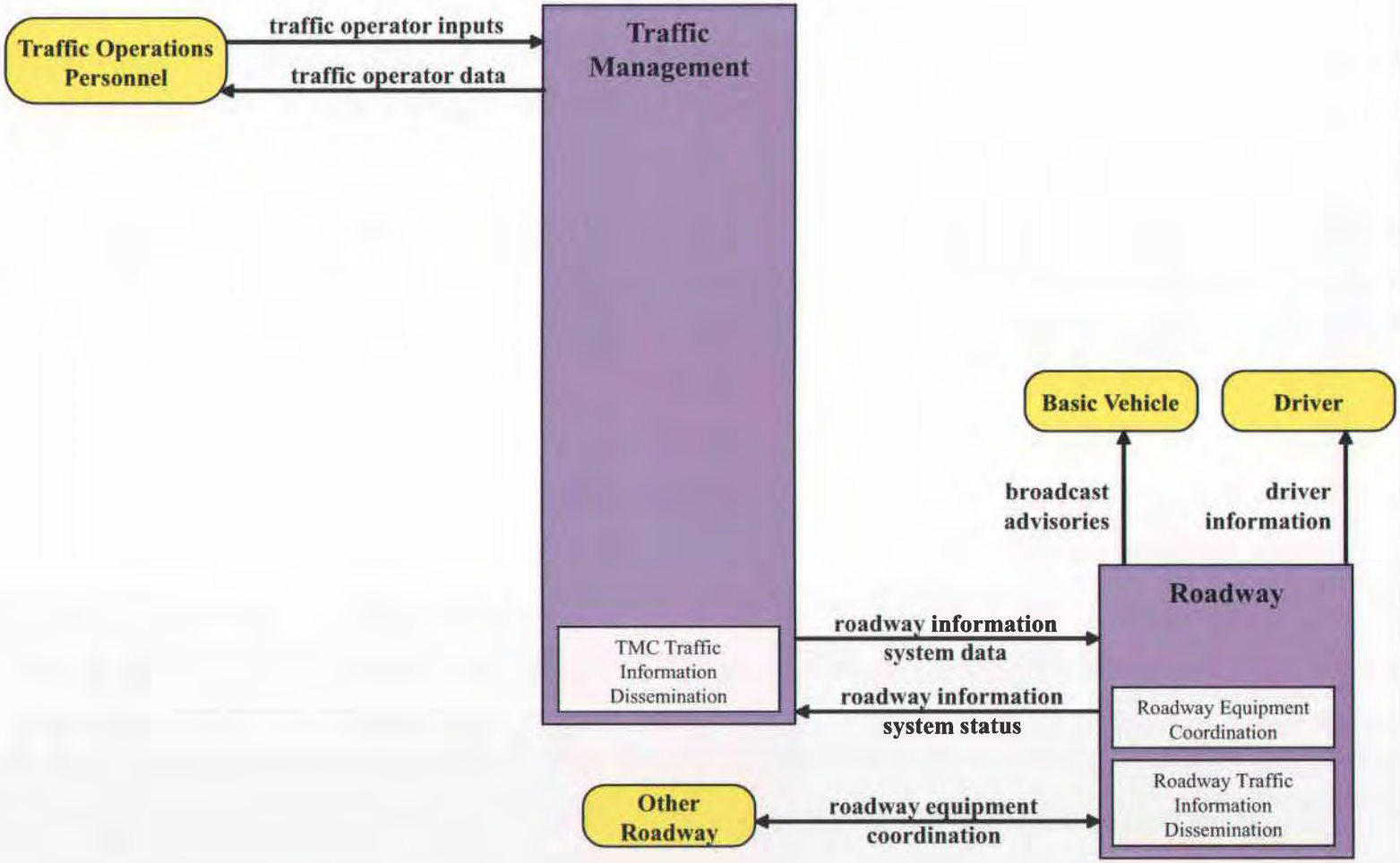
IV – 103 – Pre-Trip Information – Commercial Vehicle



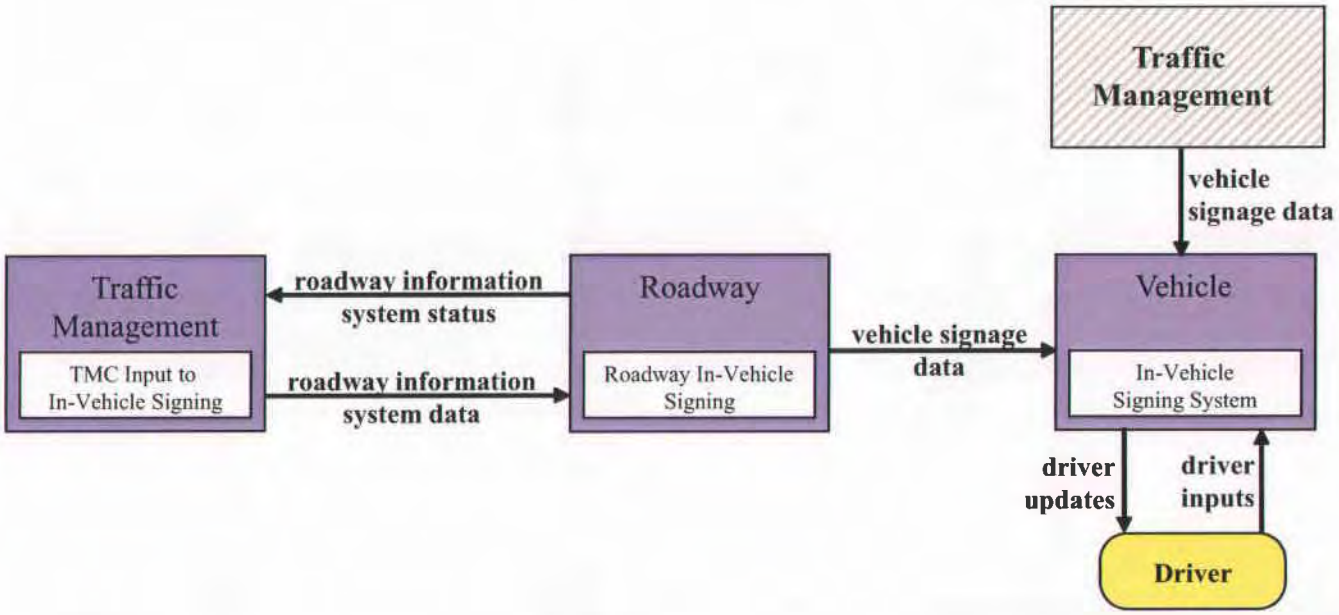
IV – 104 – Pre-Trip Information – Modal Changes and Multimodal Information



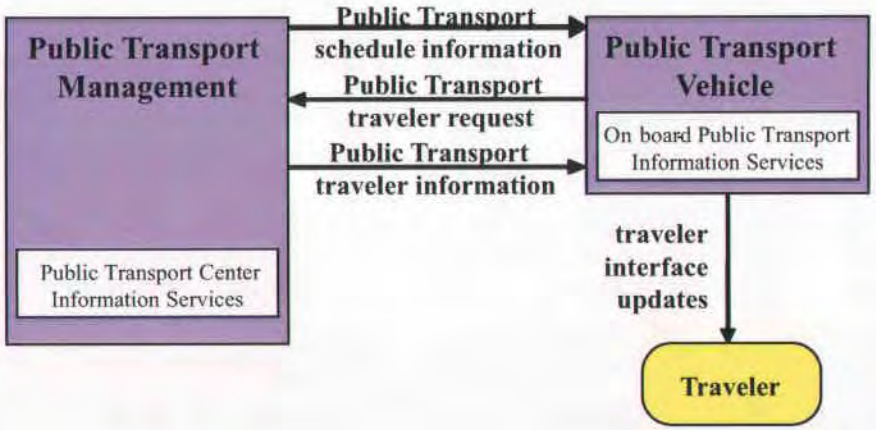
IV – 201 – On-Trip Information - Roadside



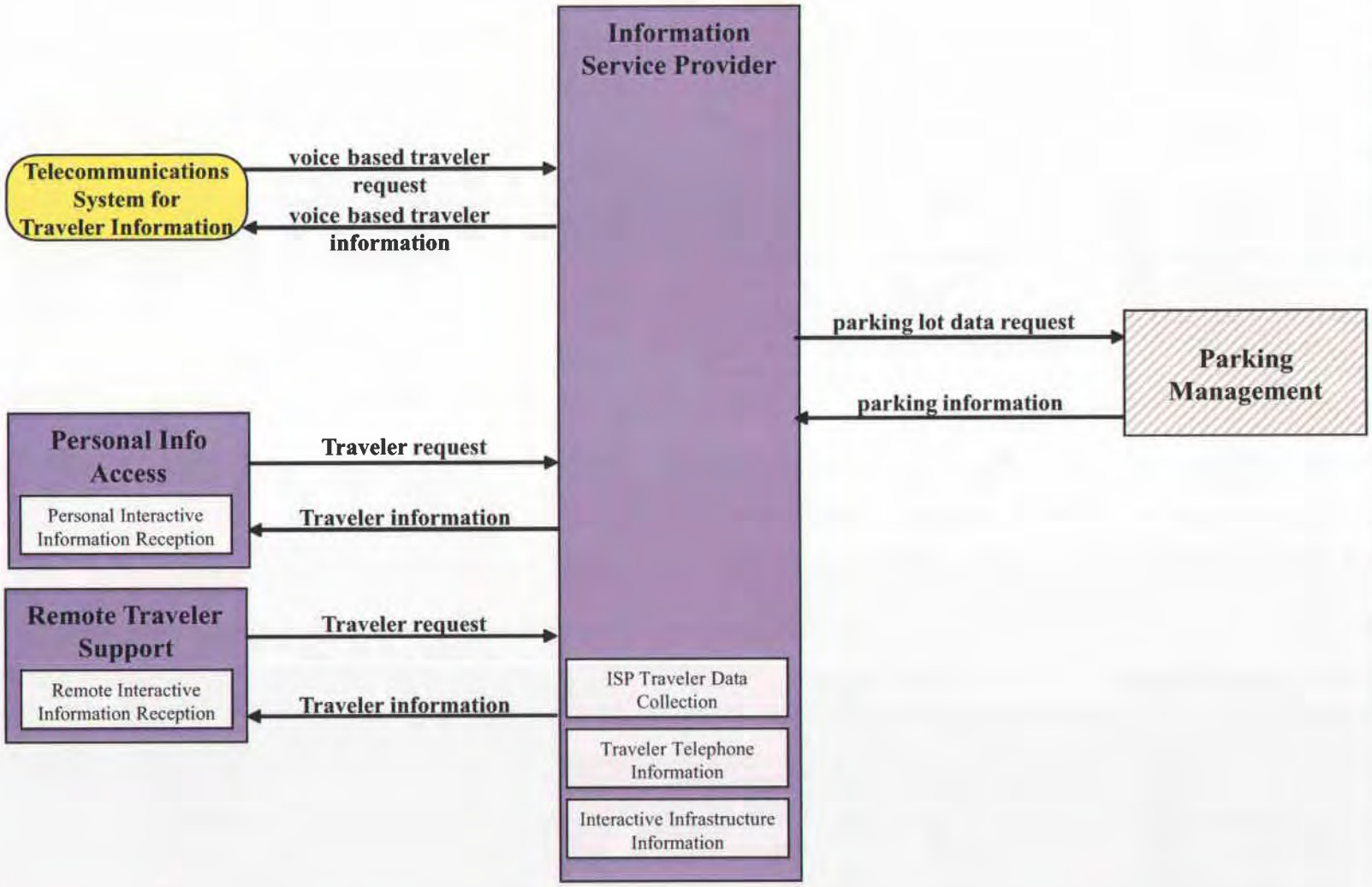
IV – 202 – On-Trip Information - In Vehicle Signing



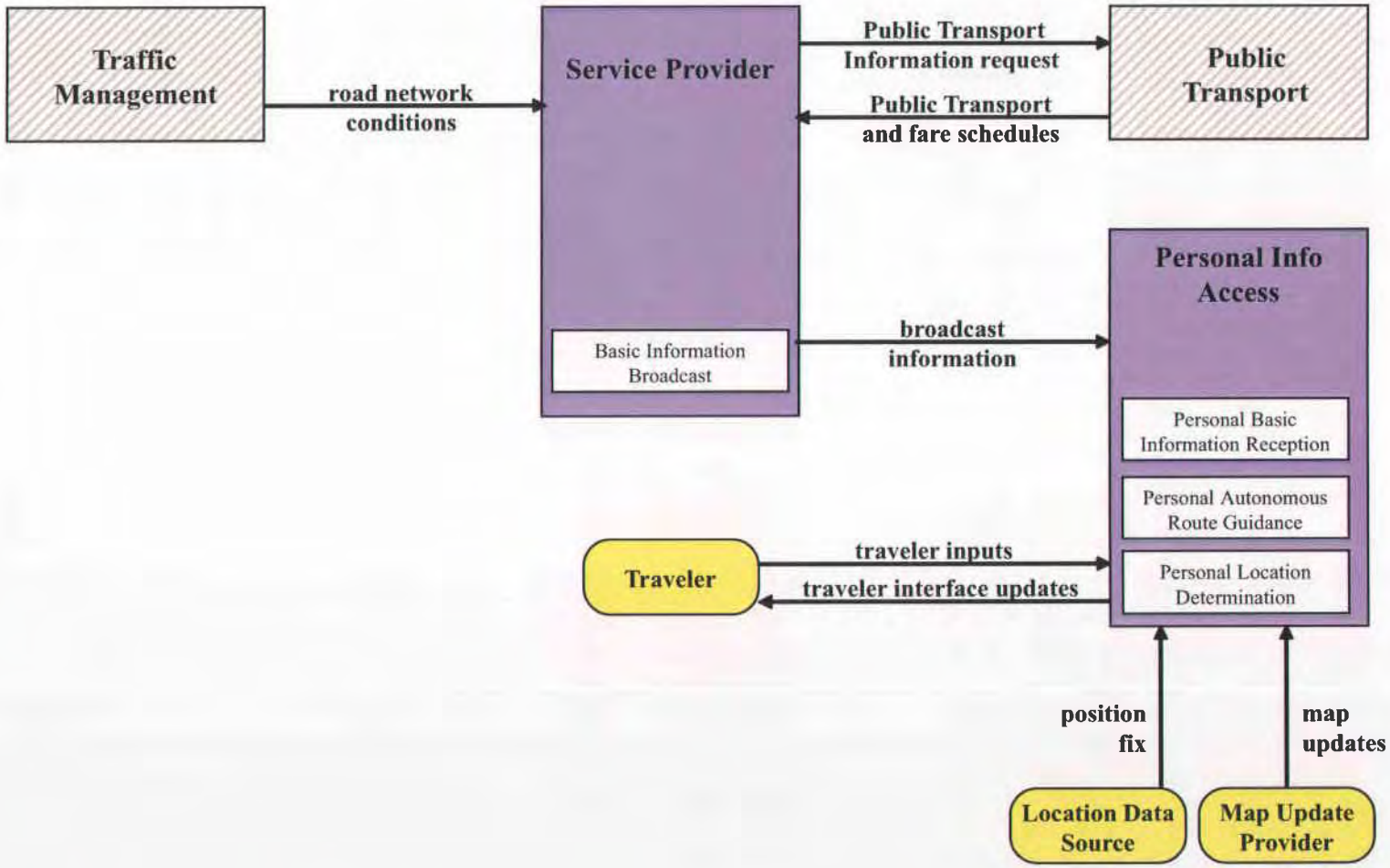
IV – 203 – On-Trip Information – Public Transport Vehicle

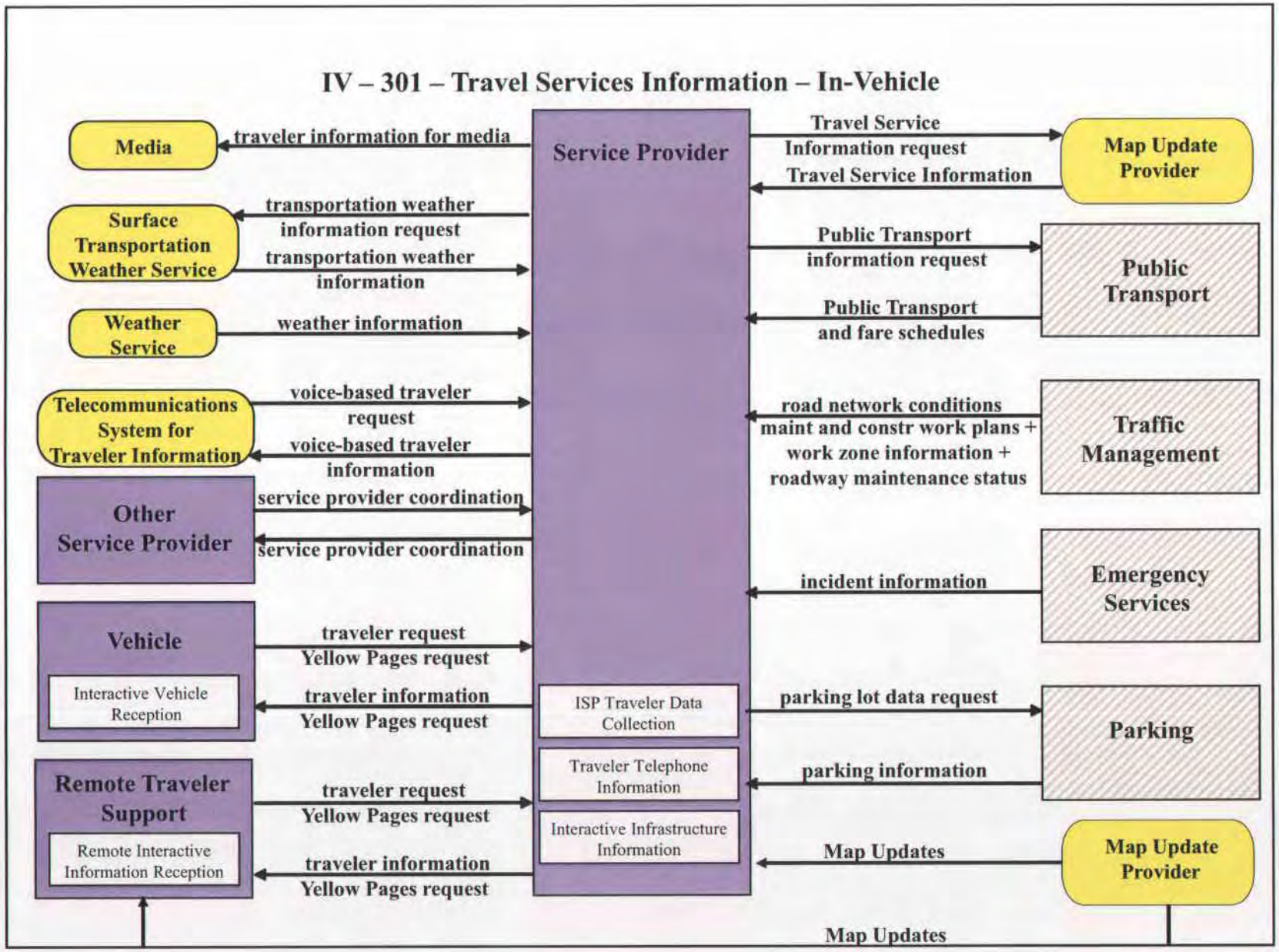


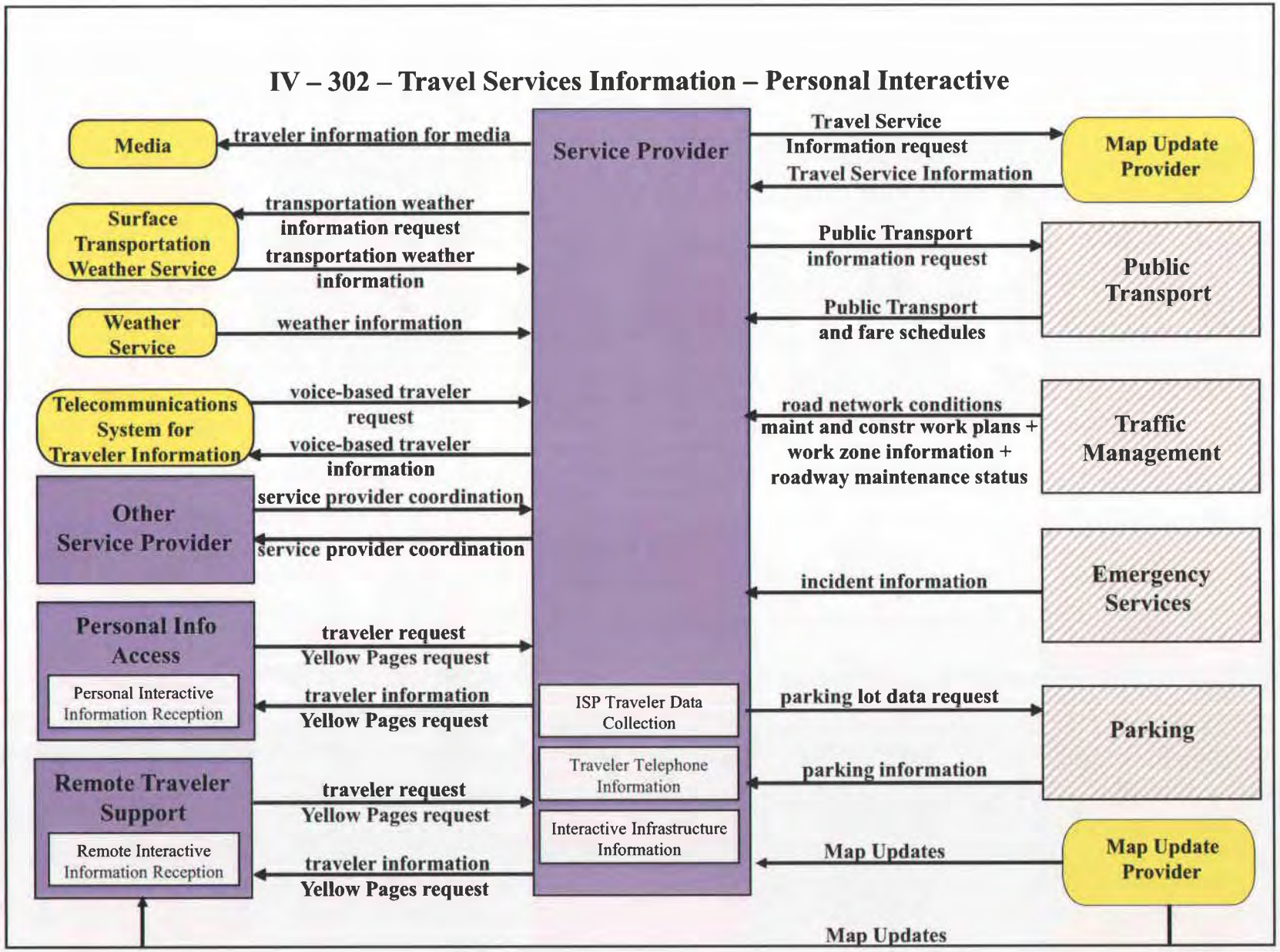
IV – 204 – On-Trip Information – Public Transport Vehicle



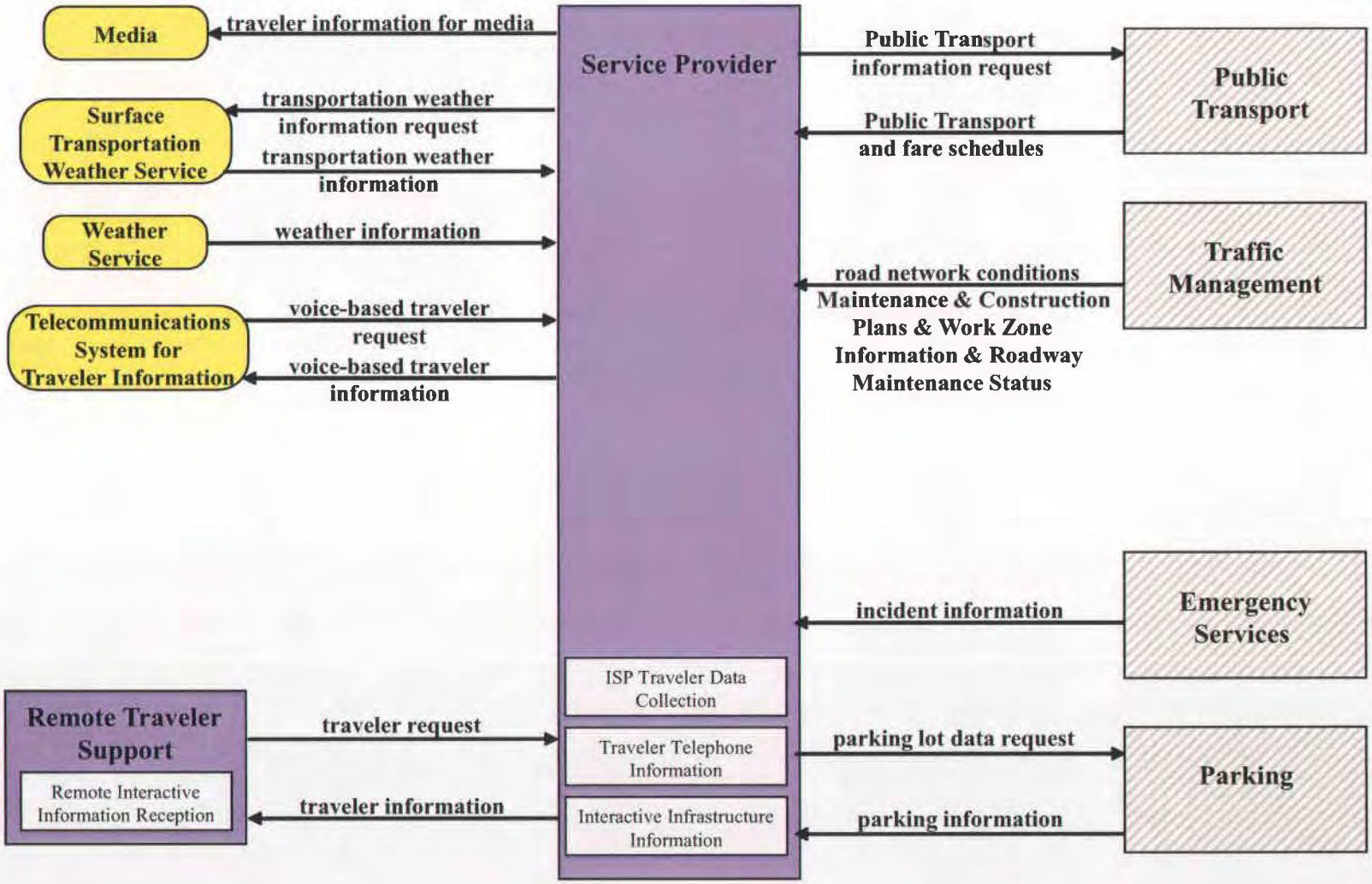
IV -205 – On-Trip Information Through Mobile Devices



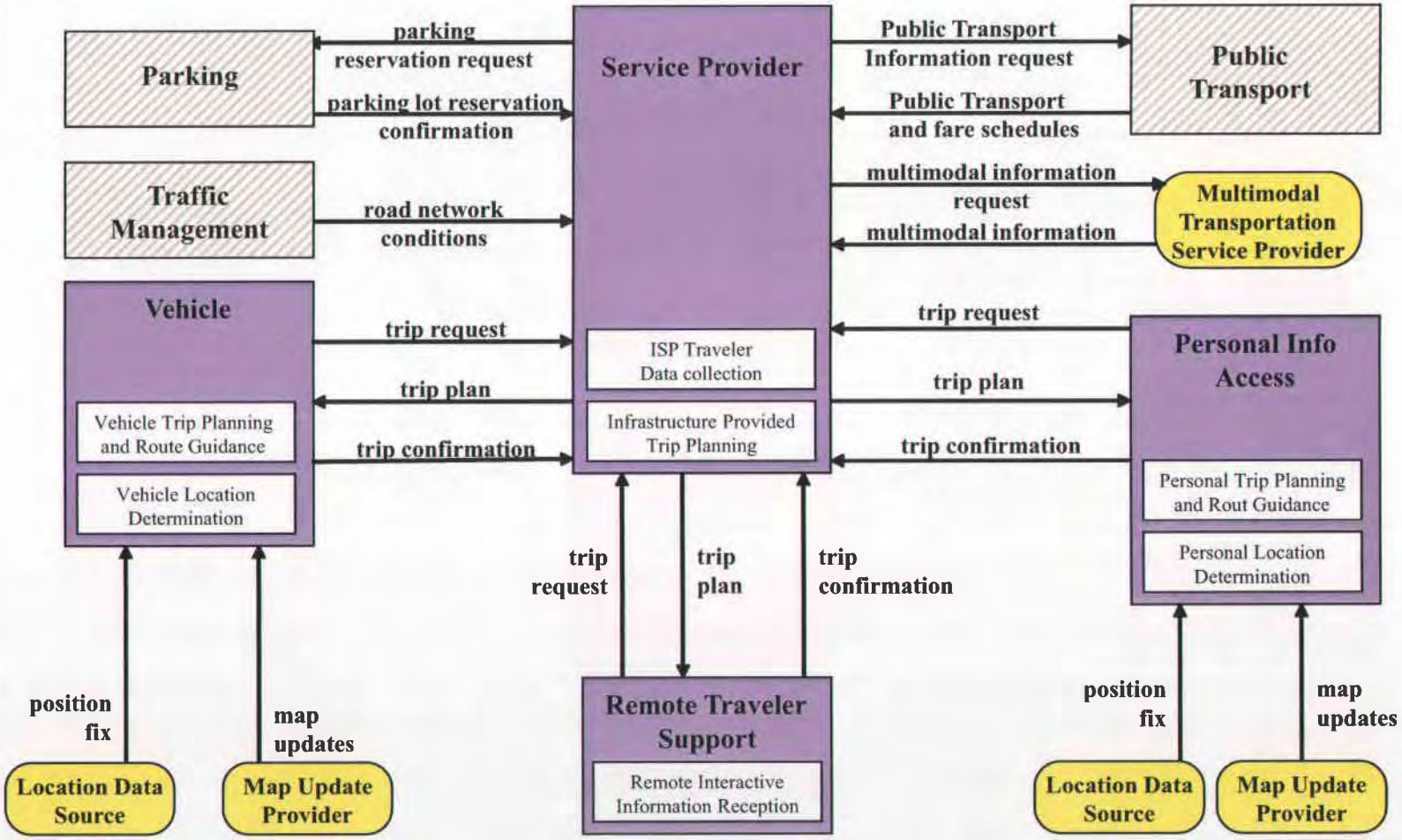

IV – 301 – Travel Services Information – In-Vehicle
Media
traveler information for media
Surface Transportation Weather Service
transportation weather information request
transportation weather information
Weather Service
weather information
Telecommunications System for Traveler Information
voice-based traveler request
voice-based traveler information
Other Service Provider
service provider coordination
service provider coordination
Vehicle
Interactive Vehicle Reception
traveler request Yellow Pages request
traveler information Yellow Pages request
Remote Traveler Support
Remote Interactive Information Reception
traveler request Yellow Pages request
traveler information Yellow Pages request
Service Provider
ISP Traveler Data Collection
Traveler Telephone Information
Interactive Infrastructure Information
Travel Service Information request
Travel Service Information
Map Update Provider
Public Transport information request
Public Transport and fare schedules
Public Transport
road network conditions
maint and constr work plans + work zone information + roadway maintenance status
Traffic Management
incident information
Emergency Services
parking lot data request
parking information
Parking
Map Updates
Map Update Provider
Map Updates


IV – 302 – Travel Services Information – Personal Interactive
Media
traveler information for media
Surface Transportation Weather Service
transportation weather information request
transportation weather information
Weather Service
weather information
Telecommunications System for Traveler Information
voice-based traveler request
voice-based traveler information
Other Service Provider
service provider coordination
service provider coordination
Personal Info Access
Personal Interactive Information Reception
traveler request
Yellow Pages request
traveler information
Yellow Pages request
Remote Traveler Support
Remote Interactive Information Reception
traveler request
Yellow Pages request
traveler information
Yellow Pages request
Service Provider
ISP Traveler Data Collection
Traveler Telephone Information
Interactive Infrastructure Information
Travel Service Information request
Travel Service Information
Map Update Provider
Public Transport information request
Public Transport and fare schedules
Public Transport
road network conditions
maint and constr work plans + work zone information + roadway maintenance status
Traffic Management
incident information
Emergency Services
parking lot data request
parking information
Parking
Map Updates
Map Update Provider
Map Updates

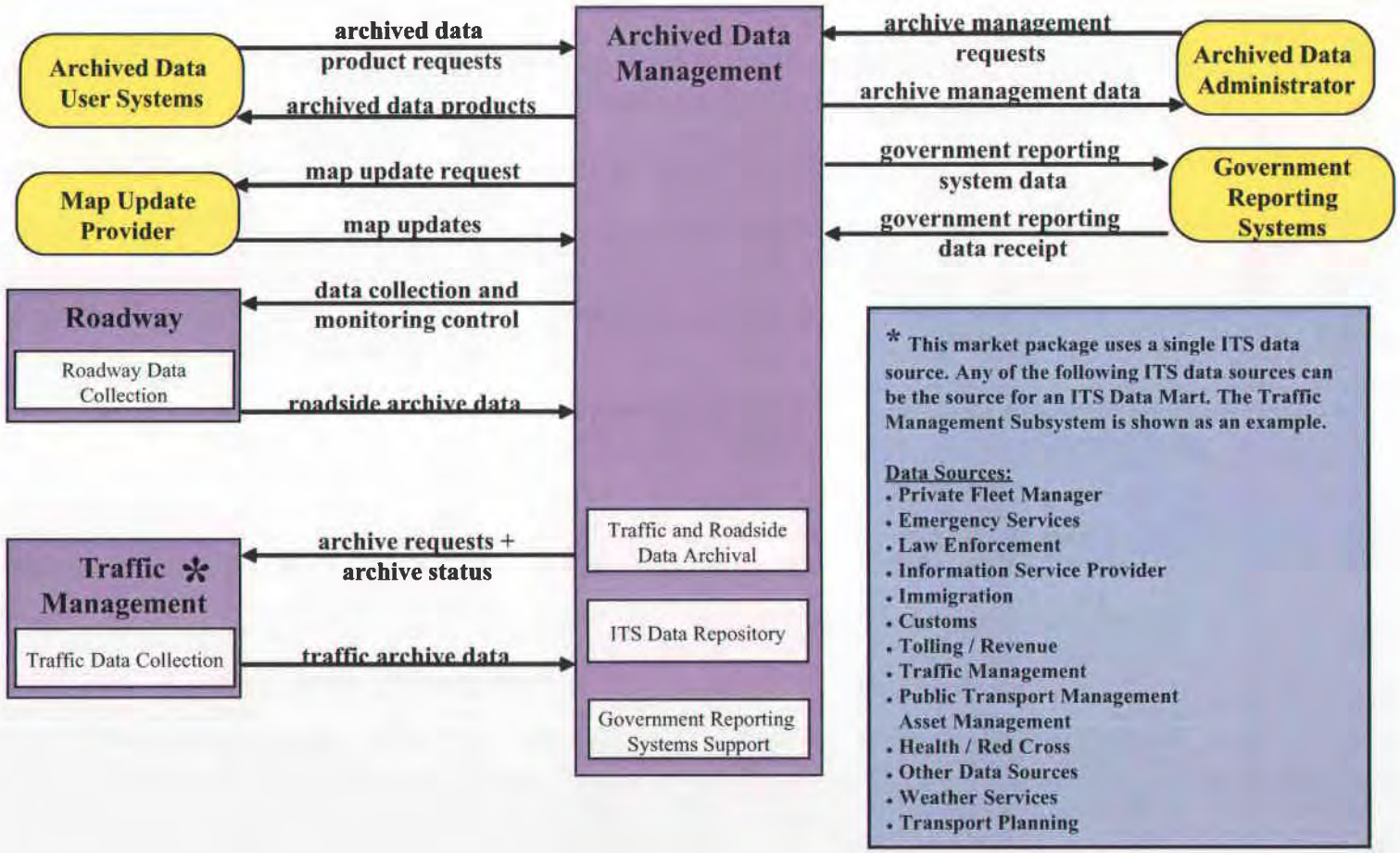
IV – 303 – Travel Services Information – Dedicated Location



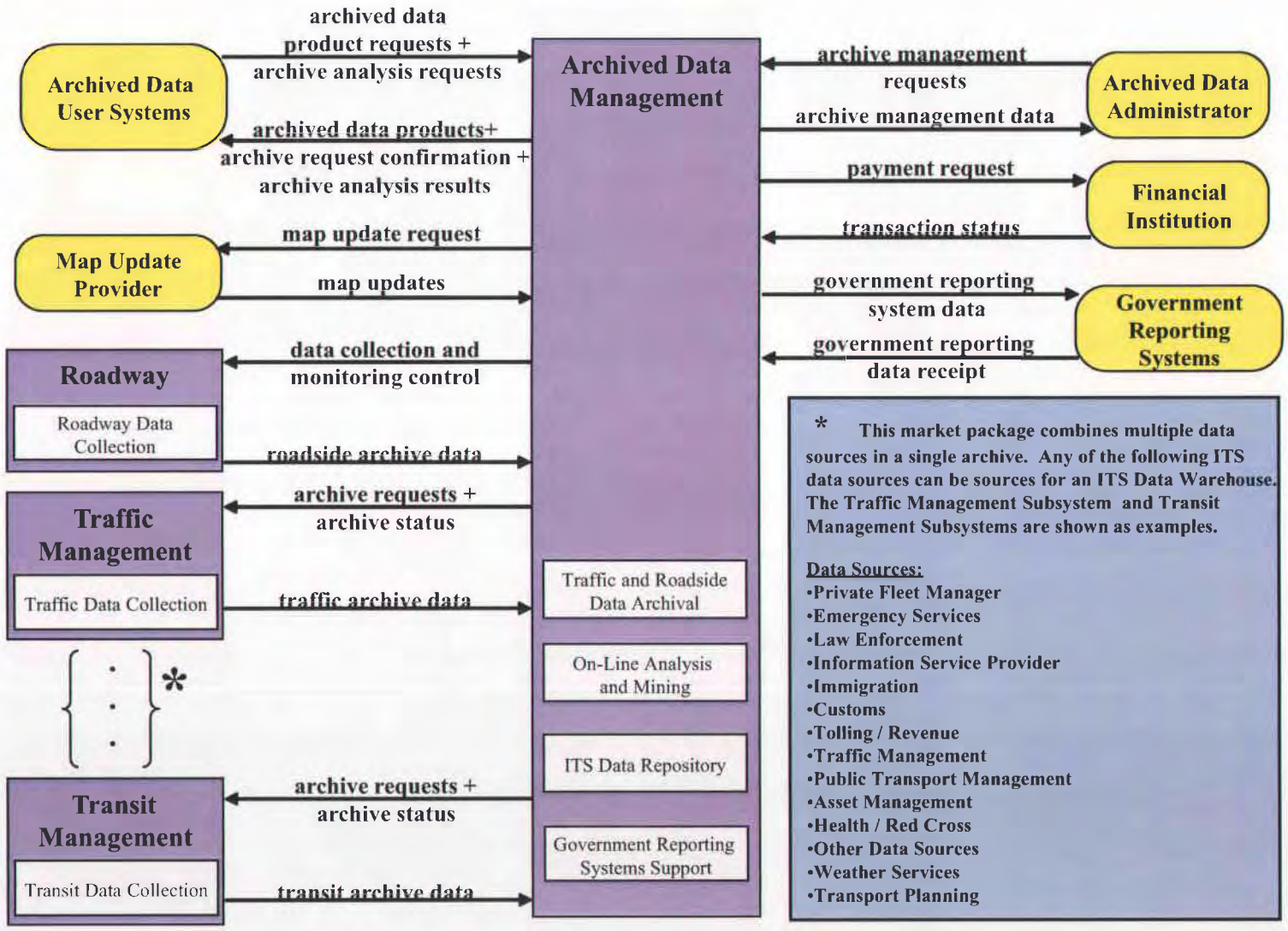
IV – 601 – Individual Trip Planning



IV – 602 - Data Archival



IV – 603 - Data Warehouse



* This market package combines multiple data sources in a single archive. Any of the following ITS data sources can be sources for an ITS Data Warehouse. The Traffic Management Subsystem and Transit Management Subsystems are shown as examples.

Data Sources:
- Private Fleet Manager
- Emergency Services
- Law Enforcement
- Information Service Provider
- Immigration
- Customs
- Tolling / Revenue
- Traffic Management
- Public Transport Management
- Asset Management
- Health / Red Cross
- Other Data Sources
- Weather Services
- Transport Planning

Subsystems																															
National				Int'l		Regional							Roadway						Vehicles								Travelers				
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers	Functional Components	Definition	ITS Services
■																													PT-1 Data File on Traffic and Usage	This equipment package collects and archives traffic, roadway, and environmental information for use in off-line planning, research, and analysis. The equipment package controls and collects information directly from equipment at the roadside, reflecting the deployment of traffic detectors that are used primarily for traffic monitoring and planning purposes rather than for traffic management.	IV-602 Data Archival
■																															IV-603 Data Warehouse
■																													PT-2 System of Data ITS	This equipment package collects data and data catalogs from one or more data sources and stores the data in a focused repository that is suited to a particular set of ITS data users. This equipment package includes capabilities for performing quality checks on the incoming data, error notification, and archive to archive coordination. This equipment package supports a broad range of implementations, ranging from simple data marts that collect a focused set of data and serve a particular user community to large-scale data warehouses that collect, integrate, and summarize transportation data from multiple sources and serve a broad array of users within a region.	IV-602 Data Archival
■																															IV-603 Data Warehouse
■																													PT-3 Support to the System of Emission of Information to Governments	This equipment package selects and formats data residing in an ITS archive to facilitate local, state, and federal government data reporting requirements.	IV-602 Data Archival
■																															IV-603 Data Warehouse
■																													PT-4 Analysis for Use and Extraction of Information	This equipment package provides advanced data analysis, summarization, and mining features that facilitate discovery of information, patterns, and correlations in large data sets. Multidimensional analysis, selective summarization and expansion of data details, and many other advanced analysis services may be offered by various implementations of this equipment package.	IV-603 Data Warehouse
	■																												CS-1 Administration of Taxes and Credentials	This equipment package issues credentials, collects fees and taxes, and supports enforcement of credential requirements. It communicates with the Fleet and Freight Management Subsystems associated with the motor carriers to process credentials applications and collect fuel taxes, weight/distance taxes, and other taxes and fees associated with commercial vehicle operations. The subsystem also receives applications for, and issues special Oversize/Overweight and HAZMAT permits in coordination with other cognizant authorities. This equipment package communicates with similar packages in other jurisdictions to exchange credentials database information. This equipment package also exchanges hazmat route restrictions information, and provides a clearinghouse for this information that can be shared with Map Update Providers, Fleet and Freight Management subsystems and Information Service Providers.	TC-101 Automated Credential Filing
	■																														TC-102 Automated Commercial Vehicle Administration
	■																												CS-3 Exchange of Information CV	This equipment package supports the exchange of safety and credentials data among jurisdiction. The package also supports the exchange of safety and credentials data between systems (for example, an administrative center and the roadside check facilities) within a single jurisdiction. Data are collected from multiple authoritative sources and packaged into snapshots (top-level summary and critical status information) and profiles (detailed and historical data). Data is made available to fleet operators, enforcement agencies, and other information requestors.	TC-101 Automated Credential Filing
	■																														TC-601 Remote access to commercial vehicle safety data
	■																														TC-102 Automated Commercial Vehicle Administration
	■																														TC-103 Automated Border Crossing
	■																												CS-4 Administration of Commercial Vehicle Security	This equipment package provides commercial vehicle safety criteria to roadside check facilities, collects and reviews safety data from the field and distributes safety information to other centers, carriers, and enforcement agencies. It supports the collection and review of carrier safety data and supports determination of the carrier safety rating.	TC-103 Automated Border Crossing
	■																														TC-601 Remote access to commercial vehicle safety data
	■																												CS-5 International Administration of Commercial Vehicles	This equipment package generates and processes the entry documentation necessary to obtain release of vehicle, cargo, and driver across an international border, report the results of the crossing event, and handle duty fee processing. It includes the systems used by customs and immigration, carriers, and service providers (e.g., brokers) to generate, process, and store entry documentation.	TC-103 Automated Border Crossing
		■																											CI-1 Administration of Tolls	This equipment package provides administration and management of an electronic toll collection system. It provides the back office functions that support enrollment, pricing, payment reconciliation with financial institutions and violation notification to enforcement agencies. It also supports dynamic pricing to support demand management. Secure communications with the financial infrastructure and distributed toll plazas support electronic payments and other ancillary requirements such as lost/stolen tag identification and management.	PE-102 Electronic Toll Collection
		■																													PE-105 Electronic distance-based road user fee payment services
		■																													GOT-201 Variable Road Pricing
			■																										CR-1 Emergency Response Management	This equipment package provides the strategic emergency response capabilities and broad inter-agency interfaces that are implemented for extraordinary incidents and disasters that require response from outside the local community. It provides the functional capabilities and interfaces commonly associated with Emergency Operations Centers. This equipment package develops and stores emergency response plans and manages overall coordinated response to emergencies. It tracks the availability of resources and assists in the appropriate allocation of these resources for a particular emergency response. This equipment package provides coordination between multiple allied agencies before and during emergencies to implement emergency response plans and track progress through the incident.	GI-301 Disaster Response Coordination

Subsystems																													Functional Components	Definition	ITS Services
National				Int'l		Regional							Roadway						Vehicles								Travelers				
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
				■																									IMM-1 Identification of Commercial Vehicle Driver	This on-board equipment package monitors the identity of the commercial vehicle driver and compares it with the planned drivers for the commercial vehicle. Any change in driver is sent to the Fleet and Freight Management Subsystem. Notification of any unexpected drivers will also be sent to the Fleet and Freight Management Subsystem which, in turn, may send a disable vehicle command back to this equipment package to cause the vehicle to stop. On receipt of a disable vehicle message from the Fleet and Freight Management Subsystem or on detection of an unauthorized driver, the equipment package will safety disable the CV.	TC-103 Automated Border Crossing
				■																									IMM-2 International Guest Passage	This equipment package checks compliance with import/export and immigration regulations to manage release of commercial vehicle, cargo, and driver across an international border. It includes the equipment at international border crossings operated by government agencies such as customs and immigration.	TC-401 Intermodal Center Facility Management
					■																								A-1 International Guest Passage	This equipment package checks compliance with import/export and immigration regulations to manage release of commercial vehicle, cargo, and driver across an international border. It includes the equipment at international border crossings operated by government agencies such as customs and immigration.	TC-401 Intermodal Center Facility Management
						■																							PS-1 Interactive Information of the Infrastructure	This equipment package collects, processes, stores, and disseminates personalized traveler information including traffic and road conditions, transit information, maintenance and construction information, multimodal information, event information, and weather information. Tailored information is provided based on the traveler's request in this interactive equipment package. The interactive service offered by this equipment package is available to the Vehicle, Remote Traveler Support, and Personal Information Access subsystems.	PE-102 Electronic Toll Collection
						■																									PE-105 Electronic distance-based road user fee payment services
						■																									GOT-201 Variable Road Pricing
						■																									IV-101 Pre-Trip Information - Traffic and Roadway
						■																									IV-102 Pre-Trip Information - Public Transport
						■																									IV-302 Travel Services Information - Personal Interactive
						■																									IV-303 Travel Services Information - Dedicated Location
						■																							PS-2 Planning of Trips Provided by the Infrastructure	This equipment package collects traveler-related data from other centers, consolidates, verifies, and refines the collected data, and makes this data available in a consistent format to applications that deliver traveler information. A broad range of traveler-related data is collected including traffic and road conditions, transit data, emergency information and advisories, weather data, special event information, traveler services, parking, multimodal data, and toll/pricing data. This equipment package also shares data with other information service providers.	GOT-201 Variable Road Pricing
						■																									PE-102 Electronic Toll Collection
						■																									PE-105 Electronic distance-based road user fee payment services
						■																									TP-202 Dynamic Ridesharing
						■																									IV-101 Pre-Trip Information - Traffic and Roadway
						■																									IV-102 Pre-Trip Information - Public Transport
						■																									IV-302 Travel Services Information - Personal Interactive
						■																									IV-303 Travel Services Information - Dedicated Location
						■																									TP-202 Dynamic Ridesharing
						■																							PS-3 Sharing of Information	This equipment package collects and aggregates vehicle probe data and processes it to calculate route travel times. It also collects, aggregates, and processes environmental probe data from equipped vehicles. Calculated route travel times and environmental conditions information are distributed to other centers and other equipment packages that use the information to support traveler information services..	MA-101 Road Weather Information Monitoring
						■																							PS-4 Planning of Trips Provided by the Infrastructure	This equipment package provides pre-trip and en-route trip planning services for travelers. It receives origin, destination, constraints, and preferences and returns trip plan(s) that meet the supplied criteria. Trip plans may be based on current traffic and road conditions, transit schedule information, and other real-time traveler information. Candidate trip plans are multimodal and may include vehicle, transit, and alternate mode segments (e.g., rail, ferry, bicycle routes, and walkways) based on traveler preferences. This equipment package also confirms the trip plan for the traveler and supports reservations and advanced payment for portions of the trip. The trip plan includes specific routing information and instructions for each segment of the trip and may also include information and reservations for additional services (e.g., parking) along the route.	TP-202 Dynamic Ridesharing
						■																								This equipment package services voice-based traveler requests for information that supports traveler telephone	IV-101 Pre-Trip Information - Traffic and Roadway

Subsystems: National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
						■																							PS-5 Telephone Information for Travelers	This equipment package services voice-based traveler requests for information that supports traveler telephone information systems like 511. The equipment package takes requests for traveler information, which could be voice-formatted traveler requests, dual-tone multifrequency (DTMF)-based requests, or a simple traveler information request, and returns the requested traveler information in the proper format. In addition to servicing requests for traveler information, this equipment package also collects and forwards alerts and advisories to traveler telephone information systems.	IV-102 Pre-Trip Information - Public Transport
						■																									IV-302 Travel Services Information - Personal Interactive
						■																									IV-303 Travel Services Information - Dedicated Location
						■																							PS-6 Basic Information Dissemination	This equipment package collects, processes, stores, and disseminates traveler information including traffic and road conditions, incident information, maintenance and construction information, event information, transit information, parking information, and weather information. The same information is broadcast to all equipped traveler interface systems and vehicles.	IV-205 On-Trip Information through mobile devices
							■																						RC-1 Collection of Tolls	This equipment package provides toll plazas the capability to identify properly equipped vehicles, collect electronic tolls, and provide a positive indication to the driver that a toll was collected. Violators are identified and images are collected. Toll transactions are stored and reported to the Toll Administration Subsystem.	PE-102 Electronic Toll Collection
							■																								PE-105 Electronic distance-based road user fee payment services
								■																					TP-1 Public Transport Management	This equipment package collects and stores driver identification records including driver issued PINS and/or individual driver biometric measurements. The equipment package can also manage the storage of driver PINs and/or biometric measurements for authorized drivers on individual public transport vehicles. Based on information reported by the public transport vehicle, the equipment package will determine if the driver is authorized, and notify the public transport Manager when an unauthorized driver is detected. The public transport Manager may override the disable vehicle action. When an unauthorized driver is detected and the system is not overridden, then the equipment package will issue a message to the public transport vehicle to safely disable the vehicle. If an unauthorized driver is detected, then the equipment package will send to the Emergency Management Subsystem that includes: incident location, current location of the public transport vehicle, Vehicle ID, Driver ID.	SP-101 Silent Alarm
								■																					TP-2 Demand Responsive and Shared Public Transport	This equipment package monitors transit vehicle operator or traveler activated alarms received from on-board a transit vehicle. It supports transit vehicle operator authentication and provides the capability to remotely disable a transit vehicle. This equipment package also includes the capability to alert operators and police to potential incidents identified by these security features.	SP-102 Mayday Alert for Public Transport
								■																							SP-102 Mayday Alert for Public Transport
								■																							SP-102 Mayday Alert for Public Transport
								■																							GI-301 Disaster Response Coordination
								■																							MA-201 Water Level / Tidal Monitoring and Prediction
								■																							SP-104 Public Transport Surveillance
								■																							SP-104 Public Transport Surveillance
								■																							SP-104 Public Transport Surveillance
								■																							GI-201 Disaster Response Planning for Transport Network
								■																							TP-101 Public Transport Vehicle Internal Systems Monitoring
								■																					TP-3 Management of Tariffs and Load of the Public Transportation.	This equipment package manages fare collection and passenger load management at the transit center. It provides the back office functions that support transit fare collection, supporting payment reconciliation with links to financial institutions and enforcement agencies for fare violations. It collects data required to determine accurate rider ship levels, establish fares, and distribute fare information. This equipment package supports two-way data communication between the transit vehicle and center to support collection of fare and passenger loading information.	PE-101a Electronic Transit Fare Payment (Light Rail). PE-101b Electronic Transit Fare Payment (bus concessions)
								■																							PE-202 Integration of Regional Multi-modal Payment Systems
								■																					TP-4 Maintenance of Factories of the Public Transport	This equipment package provides advanced maintenance functions for the transit property. It collects operational and maintenance data from transit vehicles, manages vehicle service histories, and monitors operators and vehicles. It collects vehicle mileage data and uses it to automatically generate preventative maintenance schedules for each vehicle by utilizing vehicle tracking data from a prerequisite vehicle tracking equipment package. In addition, it provides information to proper service personnel to support maintenance activities and records and verifies that maintenance work was performed.	TP-101 Public Transport Vehicle Internal Systems Monitoring

Subsystems: National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
								■																					TP-5 Tracking of PublicTransit Vehicles of Digitally	This equipment package monitors transit vehicle location. The location information is collected via a data communication link between the transit vehicles and the transit center. The location information is presented to the transit operator on a digitized map of the transit service area. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. The real-time schedule information is provided to Information Service Providers and the Transit Center Information Services equipment package, which furnish the information to travelers.	TP-102 Public Transport Vehicle Fleet Tracking
								■																					TP-6 Managing Demand Responsive Transit /Paratransit Services	This equipment package manages demand responsive transit services, including paratransit services. It supports planning and scheduling of these services, allowing paratransit and other demand response transit services to plan efficient routes and better estimate arrival times. This equipment package also supports automated dispatch of paratransit vehicles. Customer service operator systems are updated with the most current schedule information.	TP-201 Paratransit Fleet Dispatch
								■																					TP-7 Programming of the Operator of Vehicles of Public Transport	This equipment package automates and supports the assignment of transit vehicles and operators to enhance the daily operation of a transit service. It provides the capability to assign operators to routes or service areas in a fair manner while minimizing labor and overtime services, considering operator preferences and qualifications, and automatically tracking and validating the number of work hours performed by each individual operator. This operator scheduling function is often performed at a Transit Garage facility.	TP-201 Paratransit Fleet Dispatch
								■																					TP-8 Information Services of the Power Station	This equipment package collects the latest available information for a transit service and makes it available to transit customers and to Information Service Providers for further distribution. Customers are provided information at transit stops and other public transportation areas before they embark and on-board the transit vehicle once they are enroute. Information provided can include the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents, weather conditions, yellow pages, and special events. In addition to general service information, tailored information (e.g., itineraries) are provided to individual transit users.	IV-203 On-Trip Information - Public Transport Vehicle
								■																					TP-9 Storing Public Transport Data	This equipment package collects and stores transit information that is collected in the course of transit operations performed by the Transit Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.	IV-603 Data Warehouse
									■																				SE-1 Transport Related Emergency Notification and Personal Security	This equipment package provides the strategic emergency response capabilities and broad inter-agency interfaces that are implemented for extraordinary incidents and disasters that require response from outside the local community. It provides the functional capabilities and interfaces commonly associated with Emergency Operations Centers. This equipment package develops and stores emergency response plans and manages overall coordinated response to emergencies. It tracks the availability of resources and assists in the appropriate allocation of these resources for a particular emergency response. This equipment package provides coordination between multiple allied agencies before and during emergencies to implement emergency response plans and track progress through the incident.	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application
									■																						SP-102 Mayday Alert for Public Transport
									■																						SP-104 Public Transport Surveillance
									■																						GOT-403 Incident and Event Coordination
									■																						GI-201 Disaster Response Planning for Transport Network
									■																						TP-101 Public Transport Vehicle Internal Systems Monitoring
									■																						GI-301 Disaster Response Coordination
									■																				SE-2 Emergency Vehicle Management	This equipment package monitors surveillance inputs from secure areas in the transportation system. The surveillance may be of secure areas frequented by travelers (i.e., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities, on-board a transit vehicle, etc.) or around transportation infrastructure such as bridges, tunnels and transit railways or guideways. It provides both video and audio surveillance information to emergency personnel and automatically alerts emergency personnel of potential incidents.	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application
									■																						SP-102 Mayday Alert for Public Transport
									■																						SP-104 Public Transport Surveillance
									■																						SE-101 Automated Mayday Dispatch
									■																						TP-101 Public Transport Vehicle Internal Systems Monitoring
									■																						MA-201 Water Level / Tidal Monitoring and Prediction
									■																				SE-3 Hazardous Materials & Incident	This equipment package manages sensors that monitor secure areas in the transportation system, processes the collected data, performs threat analysis in which data is correlated with other sensor, surveillance, and advisory inputs, and then disseminates resultant threat information to emergency personnel and other agencies. In response to identified threats, the operator may request activation of barrier and safeguard systems to preclude an incident, control access during and after an incident or mitigate impact of an incident. The sensors may be in	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application
									■																						SP-102 Mayday Alert for Public Transport

Subsystems																														
National				Int'l		Regional							Roadway						Vehicles									Travelers	
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers	

Functional Components	Definition	ITS Services
SE-3 Hazardous Materials & Incident Notification	... secure areas frequented by travelers (i.e., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities, on-board a transit vehicle, etc.) or around transportation infrastructure such as bridges, tunnels and transit railways or guideways. The types of sensors include acoustic, threat (e.g. chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors), infrastructure condition and integrity, motion and object sensors.	SP-104 Public Transport Surveillance
		TP-101 Public Transport Vehicle Internal Systems Monitoring
		MA-201 Water Level / Tidal Monitoring and Prediction
SE-4 Alarm Support	This equipment package receives traveler or transit vehicle operator alarm messages, notifies the system operator, and provides acknowledgement of alarm receipt back to the originator of the alarm. The alarms received can be generated by silent or audible alarm systems and may originate from public areas (e.g. transit stops, park and ride lots, transit stations, rest areas) or transit vehicles. The nature of the emergency may be determined based on the information in the alarm message as well as other inputs.	TP-101 Public Transport Vehicle Internal Systems Monitoring
		SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application
		SP-102 Mayday Alert for Public Transport
		SP-104 Public Transport Surveillance
		SE-101 Automated Mayday Dispatch
SE-5 Security of the Center ofTransit	This equipment package monitors transit vehicle operator or traveler activated alarms received from on-board a transit vehicle. It supports transit vehicle operator authentication and provides the capability to remotely disable a transit vehicle. This equipment package also includes the capability to alert operators and police to potential incidents identified by these security features.	SP-101 Silent Alarm
SE-6 Security of the Commercial Vehicle and Load	This equipment package provides for the security of the commercial vehicle and the freight that it carries by detecting breaches such as seals or locks being broken into by unauthorized personnel and/or any other unauthorized tampering. In addition, this equipment package monitors the commercial vehicle driver and compares it with the planned driver for the vehicle. In a similar manner, the driver and vehicle that have been assigned to move freight are monitored and compared with the planned assignment for that freight. In all cases, any deviations to the planned assignments and any breach or tamper events are reported to the Emergency Management Subsystem.	SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring
SE-7 Support to the Mayday Distress Signal	This equipment package receives Mayday messages from vehicles or personal handheld devices, determines an appropriate response, and either uses internal resources or contacts a local agency to provide that response. The nature of the emergency is determined based on the information in the mayday message as well as other inputs. This package effectively serves as an interface between automated mobile mayday systems and the local public safety answering point for messages which require a public safety response.	SE-101 Automated Mayday Dispatch
		SE-301 Hazmat Vehicle Tracking
		SE-302 Automated Hazmat Mayday
		GOT-404 Hazardous Materials Monitoring and Management
SE-8 Tracking of TransportVehicles	This equipment package monitors transit vehicle location. The location information is collected via a data communication link between the transit vehicles and the transit center. The location information is presented to the transit operator on a digitized map of the transit service area. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. The real-time schedule information is provided to Information Service Providers and the Transit Center Information Services equipment package, which furnish the information to travelers.	SP-201 Non-motorized vehicle and pedestrian monitoring systems
SE-9 Answer to Emergency Vehicles	This equipment package supports routing of emergency vehicles and enlists support from the Traffic Management Subsystem to facilitate travel along these routes. Routes may be determined by this equipment package based on real-time traffic information and road conditions or routes may be provided by the Traffic Management Subsystem on request. Vehicles are tracked and routes are based on current vehicle location. This equipment package may coordinate with the Traffic Management Subsystem to provide preemption or otherwise adapt the traffic control strategy along the selected route.	SE-202 Emergency Vehicle - Traffic Management Coordination
		GOT-104 Preferential Treatment for Traffic Control
SE-10 Commercial Vehicle Emergency Response	This equipment package identifies and initiates a response to commercial vehicle and freight equipment related emergencies. These emergencies may include incidents involving hazardous materials as well as the detection of non-permitted transport of security sensitive hazmat. The equipment package identifies the location of the vehicle, the nature of the incident, the route information, and information concerning the freight itself. The information supports the determination of the response and identifies the responding agencies to notify. As part of the response, this equipment package can request Fleet and Freight Management to disable a specific vehicle in their fleet.	SE-301 Hazmat Vehicle Tracking
		SE-302 Automated Hazmat Mayday
		GOT-404 Hazardous Materials Monitoring and Management
SE-10 Management of the Service of Patrolling	This equipment package supports dispatch and communication with roadway service patrol vehicles that monitor roads to aid motorists, offering rapid response to minor incidents.	GOT-401 Incident On-Site Motorist Assist
	The equipment package provides tactical decision support, resource coordination, and communications integration for Incident Commands that are established by first responders at or near the incident scene to support local management of an incident. The equipment package supports communications with public safety, emergency ...	GOT-403 Incident and Event Coordination

National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
									■																				SE-11 Command of Incidents	management of an incident. The equipment package supports communications with public safety, emergency management, transportation, and other allied response agency centers, tracks and maintains resource information, action plans, and the incident command organization itself. Information is shared with agency centers including resource deployment status, hazardous material information, traffic, road, and weather conditions, evacuation advice, and other information that enables emergency or maintenance personnel in the field to implement an effective, safe incident response. This equipment package supports the functions and interfaces commonly supported by a mobile command center.	GI-201 Disaster Response Planning for Transport Network
									■																						GI-301 Disaster Response Coordination
									■																				SE-12 Monitoring Road Conditions for Emergency Vehicle Operaion	This equipment package collects current and forecast road conditions and surface weather information from a variety of sources, including both weather service providers and vehicle probes. The collected environmental information is monitored and presented to the operator and used to more effectively manage incidents.	MA-201 Water Level / Tidal Monitoring and Prediction
									■																				SE-13 System of Early Alert for Emergencies	This equipment package monitors alerting and advisory systems, information collected by ITS surveillance and sensors, and reports from other agencies and uses this information to identify potential, imminent, or in-progress major incidents or disasters. Notification is provided to other equipment packages that provide the emergency response, including public notification using ITS traveler information systems, where appropriate.	MA-201 Water Level / Tidal Monitoring and Prediction
										■																			GFC-1 Administration of the Fleet	This equipment package provides vehicle tracking, dispatch, and reporting capabilities to fleet management center personnel. It gathers current road conditions and traffic information, prepares vehicle routes, and provides a fleet interface for toll collection. It also provides route plan information for network performance evaluation. As part of the tracking function, this equipment package monitors commercial vehicle location, compares it against the known route and notifies the Emergency Management Subsystem and Fleet-Freight Manager of any deviations, including HAZMAT route restriction violations.	TC-101 Automated Credential Filing
										■																					TC-102 Automated Commercial Vehicle Administration
										■																			GFC-2 Management and Information of Credentials and Taxes of the Fleet	This equipment package provides the capability to purchase credentials, file taxes and trip reports electronically, and perform electronic enrollment in expedited border crossing programs. It tracks and manages credentials and provides electronic interfaces to appropriate state and federal commercial vehicle administration centers.	TC-101 Automated Credential Filing
										■																					TC-102 Automated Commercial Vehicle Administration
										■																			GFP-1 Management of the Driver Identification Reports	This equipment package collects and stores driver identification records including driver issued PINS and/or individual driver biometric measurements. The equipment package can also manage the storage of driver PINs and/or biometric measurements for authorized drivers on individual commercial vehicles. Based on information reported by the commercial vehicle, the equipment package will determine if the driver is authorized, and notify the Commercial Vehicle Manager when an unauthorized driver is detected. The Commercial Vehicle Manager may override the disable vehicle action. When an unauthorized driver is detected and the system is not overridden, then the equipment package will issue a message to the commercial vehicle to safely disable the vehicle. If an unauthorized driver is detected, then the equipment package will send to the Emergency Management Subsystem that includes: incident location, current location of the CV, Vehicle ID, Carrier ID, Driver ID, CV Credentials information, and cargo manifest (if known).	SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring
										■																			GFP-2 Management of HAZMAT Fleet	This equipment package manages hazardous materials shipments. In the event of an incident, it notifies the Emergency Management Subsystem, providing information on the nature of the cargo and the vehicle equipment.	SV-301 Longitudinal Collision Avoidance
										■																					SE-302 Automated Hazmat Mayday
										■																					GOT-404 Hazardous Materials Monitoring and Management
										■																			GFP-3 Interchange of Commercial Vehicle Information	This equipment package supports the exchange of safety and credentials data among jurisdiction. The package also supports the exchange of safety and credentials data between systems (for example, an administrative center and the roadside check facilities) within a single jurisdiction. Data are collected from multiple authoritative sources and packaged into snapshots (top-level summary and critical status information) and profiles (detailed and historical data). Data is made available to fleet operators, enforcement agencies, and other information requestors.	SE-303 Hazmat Preclearance
										■																			GFP-4 Administration of the Safety of Commercial Vehicles	This equipment package provides commercial vehicle safety criteria to roadside check facilities, collects and reviews safety data from the field and distributes safety information to other centers, carriers, and enforcement agencies. It supports the collection and review of carrier safety data and supports determination of the carrier safety rating.	SE-303 Hazmat Preclearance
										■																			GFP-5 Administration and Management of Freight Loads	This equipment package manages the movement of freight from source to destination via links to the freight equipment, intermodal freight shippers, and depots. It interfaces to intermodal freight shippers to setup and schedule transportation and coordinates with intermodal freight depots to coordinate the shipment. The equipment package monitors the status of the freight and freight equipment (container, trailer, or chassis) and monitors freight location and compares it against the planned route.	TC-103 Automated Border Crossing
										■																					TC-203 Freight Container Tracking
										■																					TC-501 Dangerous Goods movement data sharing
										■																			GFP-6 Central Tracking of Vehicles	This equipment package provides the capabilities to support fleet management with automatic vehicle location and automated mileage and fuel reporting and auditing. In addition, this equipment is used to monitor the planned route and notify the Fleet and Freight Management Subsystem of any deviations.	TC-201 Commercial Vehicle Fleet Tracking

Subsystems: National (Transportation Planning, Security Fulfillment, Tolls and Income, Salubrity/the Red Cross); Int'l (Immigration, Customs); Regional (Service Supplier, Toll Collection, Public Transportation, Emergency Services, Manager of Private Fleet, Public Order, Traffic Manager); Roadway (Calzada, Parking, Payment in Route, Commercial Inspection/Load, Terminal station/(Transp. Pub.), Intermodal Terminal); Vehicles (Vehicle, Of Aquiler (taxi), Public Transportation, Commercial, Intermodal Container, Emergency, Construction/Maintenance, Public Order (police)); Travelers (Personal Information Access, Remote Support for Travellers)

Subsystem marked	Functional Components	Definition	ITS Services
Regional – Manager of Private Fleet	GFP-1 Fleet Dispatch	This equipment package provides vehicle tracking, dispatch, and reporting capabilities to fleet management center personnel. It gathers current road conditions and traffic information, prepares vehicle routes, and provides a fleet interface for toll collection. It also provides route plan information for network performance evaluation. As part of the tracking function, this equipment package monitors commercial vehicle location, compares it against the known route and notifies the Emergency Management Subsystem and Fleet-Freight Manager of any deviations, including HAZMAT route restriction violations.	TC-202 Commercial Vehicle Fleet Dispatching
Regional – Manager of Private Fleet	GFP-6 Security of Commercial Vehicles and Freight	This equipment package provides for the security of the commercial vehicle and the freight that it carries by detecting breaches such as seals or locks being broken into by unauthorized personnel and/or any other unauthorized tampering. In addition, this equipment package monitors the commercial vehicle driver and compares it with the planned driver for the vehicle. In a similar manner, the driver and vehicle that have been assigned to move freight are monitored and compared with the planned assignment for that freight. In all cases, any deviations to the planned assignments and any breach or tamper events are reported to the Emergency Management Subsystem.	TC-203 Freight Container Tracking TC-501 Dangerous Goods movement data sharing TC-701 Commercial Vehicle Internal Systems Monitoring
Regional – Manager of Private Fleet	GFP-9 Administration of the Fleet	This equipment package provides vehicle tracking, dispatch, and reporting capabilities to fleet management center personnel. It gathers current road conditions and traffic information, prepares vehicle routes, and provides a fleet interface for toll collection. It also provides route plan information for network performance evaluation. As part of the tracking function, this equipment package monitors commercial vehicle location, compares it against the known route and notifies the Emergency Management Subsystem and Fleet-Freight Manager of any deviations, including HAZMAT route restriction violations.	TC-203 Freight Container Tracking TC-301 Vehicle and container arrival information exchange TC-401 Intermodal Center Facility Management TC-402 Intermodal Vehicle and Container Control TC-501 Dangerous Goods movement data sharing TC-502 Dangerous Goods movement data registry TC-503 Dangerous Goods movement fleet coordination TC-601 Remote access to commercial vehicle safety data PE-102 Electronic Toll Collection PE-105 Electronic distance-based road user fee payment services GOT-201 Variable Road Pricing
Regional – Manager of Private Fleet	GFP-10 Management of the Maintenance of Fleets	This equipment package tracks and monitors diagnostic results, vehicle mileage, inspection records, and repair and service records collected from a commercial vehicle fleet equipped with on-board monitoring equipment. The data is used to develop preventative maintenance and repair schedules and repair and service records are maintained.	TC-701 Commercial Vehicle Internal Systems Monitoring
Regional – Public Order	OP-1 Surveillance of Secure Areas	This equipment package includes video and audio surveillance equipment that monitors conditions of secure areas including facilities (e.g. transit yards) and transportation infrastructure (e.g. as bridges, tunnels, interchanges, and transit railways or guideways). It provides the surveillance information to the Emergency Management Subsystem for possible threat detection. The equipment package also provides local processing of the video or audio information, providing processed or analyzed results to the Emergency Management Subsystem. This equipment package provides the same functions as the Traveler Secure Area Surveillance equipment package.	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application SP-102 Mayday Alert for Public Transport SP-104 Public Transport Surveillance
Regional – Public Order	OP-2 Monitoring of Secure Road Areas with Sensors	This equipment package includes sensors that monitor conditions of secure areas including facilities (e.g. transit yards) and transportation infrastructure (e.g. bridges, tunnels, interchanges, and transit railways or guideways). A range of acoustic, environmental threat (e.g. chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors), infrastructure condition and integrity and motion and object sensors are included.	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application SP-102 Mayday Alert for Public Transport SP-104 Public Transport Surveillance

Functional Components	Definition	ITS Services
GT-1 Security of the Power Station	This equipment package collects and stores driver identification records including driver issued PINS and/or individual driver biometric measurements. The equipment package can also manage the storage of driver PINs and/or biometric measurements for authorized drivers on individual commercial vehicles. Based on information reported by the commercial vehicle, the equipment package will determine if the driver is authorized, and notify the Commercial Vehicle Manager when an unauthorized driver is detected. The Commercial Vehicle Manager may override the disable vehicle action. When an unauthorized driver is detected and the system is not overridden, then the equipment package will issue a message to the commercial vehicle to safely disable the vehicle. If an unauthorized driver is detected, then the equipment package will send to the Emergency Management Subsystem that includes: incident location, current location of the CV, Vehicle ID, Carrier ID, Driver ID, CV Credentials information, and cargo manifest (if known).	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application
GT-2 Tracking of Vehicles	This equipment package tracks the location of maintenance and construction vehicles and other equipment. Vehicle location and associated information is presented to the operator.	SP-202 Systems to Monitor Public Sector Fleet Vehicles
GT-3 Storing of Data on Traffic Monitoring	This equipment package remotely monitors and controls traffic sensors and surveillance (e.g., CCTV) equipment, and collects, processes and stores the collected traffic data. The collected information is provided to traffic operations personnel and made available to other centers.	SP-401 Intelligent Intersection GOT-101 Traffic Monitoring GOT-102 Surface Street Control GOT-103 Freeway Control GOT-203 High-Occupancy lane management
GT-4 Control of Traffic Lights	This equipment package provides the capability for traffic managers to monitor and manage the traffic flow at signalized intersections. This capability includes analyzing and reducing the collected data from traffic surveillance equipment and developing and implementing control plans for signalized intersections. Control plans may be developed and implemented that coordinate signals at many intersections under the domain of a single traffic management subsystem and are responsive to traffic conditions and adapt to support incidents, preemption and priority requests, pedestrian crossing calls, etc.	SP-401 Intelligent Intersection GOT-102 Surface Street Control GOT-104 Preferential Treatment for Traffic Control SE-202 Emergency Vehicle - Traffic Management Coordination GOT-107 Coordination of Surface Street and Freeway Control
GT-5 Maintenance of Traffic	This equipment package monitors the operational status of field equipment and detects failures. It presents field equipment status to Traffic Operations Personnel and reports failures to the Maintenance and Construction Management Subsystem. The equipment package tracks the repair or replacement of the failed equipment. The entire range of ITS field equipment may be monitored by this equipment package including sensors (traffic, infrastructure, environmental, security, speed, etc.) and devices (highway advisory radio, dynamic message signs, automated roadway treatment systems, barrier and safeguard systems, cameras, traffic signals and override equipment, ramp meters, beacons, security surveillance equipment, etc.).	SP-401 Intelligent Intersection GOT-101 Traffic Monitoring GOT-102 Surface Street Control GOT-103 Freeway Control
GT-6 Coordination/communication for the Office to the Incident	This equipment package formulates and manages an incident response that takes into account the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.	SE-202 Emergency Vehicle - Traffic Management Coordination GOT-104 Preferential Treatment for Traffic Control
GT-7 Filed Data Management	This equipment package collects and stores traffic information that is collected in the course of traffic operations performed by the Traffic Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.	GOT-101 Traffic Monitoring IV-602 Data Archival IV-603 Data Warehouse
GT-8 Dissemination of Information on Freeway Traffic	This equipment package disseminates traffic and road conditions, closure and detour information, incident information, driver advisories, and other traffic-related data to other centers, the media, and driver information systems. It monitors and controls driver information system field equipment including dynamic message signs and highway advisory radio, managing dissemination of driver information through these systems.	GOT-103 Freeway Control GOT-106 Traffic Information Dissemination
GT-9 Management of Freeways	This equipment package provides center monitoring and control of freeway traffic control systems including ramp control, interchange control, and mainline lane control systems. Approaches covered include ramp metering, interchange connector metering, overhead lane control signals, freeway mainline metering, and variable speed control systems.	GOT-103 Freeway Control
GT-10 Management of Reversible Lanes	This equipment package remotely monitors and controls reversible lanes. It provides an interface to reversible lane field equipment (traffic sensors, surveillance equipment, lane control signals, physical lane access controls, etc.) and to traffic operations personnel to support central monitoring and control of these facilities.	GOT-105 Reversible Lane Management

Subsystems	National				Int'l		Regional							Roadway						Vehicles								Travelers	
Functional Components	Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers
GT-1 Security of the Power Station																													
GT-2 Tracking of Vehicles																													
GT-3 Storing of Data on Traffic Monitoring																													
GT-4 Control of Traffic Lights																													
GT-5 Maintenance of Traffic																													
GT-6 Coordination/communication for the Office to the Incident																													
GT-7 Filed Data Management																													
GT-8 Dissemination of Information on Freeway Traffic																													
GT-9 Management of Freeways																													
GT-10 Management of Reversible Lanes																													

Subsystems: National				Int'l		Regional							Roadway						Vehicles								Travelers				
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers	**Functional Components**	**Definition**	**ITS Services**
																													GT-11 Control of Regional Traffic	This equipment package supports coordination between traffic management centers in order to share traffic information between centers as well as control of traffic management field equipment. This coordination supports wide area optimization and regional coordination that spans jurisdictional boundaries; for example, coordinated signal control in a metropolitan area or coordination between freeway operations and arterial signal control within a corridor.	GOT-107 Coordination of Surface Street and Freeway Control
																													GT-12 Management of Highways	This equipment package provides center monitoring and control of freeway traffic control systems including ramp control, interchange control, and mainline lane control systems. Approaches covered include ramp metering, interchange connector metering, overhead lane control signals, freeway mainline metering, and variable speed control systems.	GOT-107 Coordination of Surface Street and Freeway Control
																													GT-13 Management of Traffic in Road Intersections - Railroad	This equipment package monitors and controls highway-rail intersection (HRI) equipment. Various levels of roadside equipment may be interfaced to this equipment package including standard speed active warning systems and high speed systems which provide additional information on approaching trains and detect and report obstructions in the HRI. This equipment package remotely monitors and reports the status of the HRI equipment and sends control plan updates to the HRI equipment.	GOT-108 Intermodal Highway Junction Management
																													GT-14 Management of Traffic in Road Intersections - Railroad	This equipment package provides the capability to gather information on regional toll, parking, and transit usage and request changes to pricing and other mechanisms to manage overall transportation demand.	GOT-109 Parking Management
																															GOT-201 Variable Road Pricing
																													GT-15 Management of Traffic in Work Zones	This equipment package coordinates work plans with maintenance systems so that work zones are established that have minimum traffic impact. Traffic control strategies are implemented to further mitigate traffic impacts associated with work zones that are established, providing work zone information on driver information systems such as dynamic message signs.	GOT-110 Work Zone Traffic Management
																															GOT-301 Roadway Construction and Maintenance Management
																													GT-16 Management of Construction and Maintenance in Work Zones	This equipment package remotely monitors and supports work zone activities, controlling traffic through dynamic message signs (DMS), Highway Advisory Radio (HAR), gates and barriers, and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds, and delays, and closures are provided to the motorist prior to the work zones. This equipment package provides control of field equipment in all maintenance areas, including fixed and portable field equipment supporting both stationary and mobile work zones.	GOT-110 Work Zone Traffic Management
																															GOT-301 Roadway Construction and Maintenance Management
																													GT-1 Evaluation of the Performance of the Traffic Network	This equipment package predicts travel demand patterns to support traffic flow optimization, demand management, and incident management. This equipment package collects traffic data from sensors and surveillance equipment as well as input from other traffic management centers, emissions management, transit operations, and event promoters. It collects route planning information from information service providers and integrates and uses this information to predict future traffic conditions. The planned control strategies can be passed back to the Information Service Provider so that the intended strategies can be reflected in future route planning.	GOT-201 Variable Road Pricing
																													GT-18 HOV Lane Managment	This equipment package provides center monitoring and control of HOV lanes. It coordinates freeway ramp meters and connector signals with HOV lane usage signals to provide preferential treatment to HOV lanes. In advanced implementations, it automatically detects HOV violators.	GOT-203 High-Occupancy lane management
																													GT-19 Monitoring of Pavement	This equipment package assimilates current and forecast road conditions and surface weather information using a combination of weather service provider information, information collected by other centers such as the Maintenance and Construction Management Subsystem, and data collected from environmental sensors deployed on and about the roadway. The collected environmental information is monitored and presented to the operator. This information can be used to issue general traveler advisories and support location specific warnings to drivers. Other equipment packages process the collected information and provide decision support.	GOT-303 Pavement Management
																															MA-101 Road Weather Information Monitoring
																													GT-20 CGT -Storing Vehicle Probe Data	This equipment package collects, assimilates, and disseminates vehicle probe data collected from roadside beacons and centers controlling transit vehicles, emergency vehicles, toll collection points, and route-guided vehicles. It estimates traffic and road conditions based on the aggregated probe data and disseminates this information to other centers.	GOT-303 Pavement Management
																															MA-101 Road Weather Information Monitoring
																													GT-21 Storing of Environmental Information	This equipment package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. In addition to fixed sensor stations at the roadside, this equipment package also collects environmental information from sensor systems located on Maintenance and Construction Vehicles. It also collects current and forecast environmental conditions information that is made available by other systems.	GOT-303 Pavement Management
																															MA-101 Road Weather Information Monitoring
																													GT-22 Management of Safety in Work Zones	This equipment package remotely monitors work zone safety systems that detect vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone.	GOT-305 Automated Road Management
																													GT-23 Dissemination of Traffic	This equipment package disseminates traffic and road conditions, closure and detour information, incident information, driver advisories, and other traffic-related data to other centers, the media, and driver information	GOT-402 Incident On-Site Traffic Management

Subsystems

National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
												■																	Information	systems. It monitors and controls driver information system field equipment including dynamic message signs and highway advisory radio, managing dissemination of driver information through these systems.	MA-201 Water Level / Tidal Monitoring and Prediction
												■																	GT-24 Coordination/Communication of Office of Incidents	This equipment package formulates and manages an incident response that takes into account the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.	GOT-403 Incident and Event Coordination
												■																			GI-201 Disaster Response Planning for Transport Network
												■																			GI-301 Disaster Response Coordination
												■																	GT-25 Detection of Incidents	This equipment package identifies and reports incidents to Traffic Operations Personnel. It remotely monitors and controls traffic sensor and surveillance systems that support incident detection and verification. It analyzes and reduces the collected sensor and surveillance data, external alerting and advisory and incident reporting systems, anticipated demand information from intermodal freight depots, special event information, and identifies and reports incidents and hazardous conditions	GOT-403 Incident and Event Coordination
												■																			MA-201 Water Level / Tidal Monitoring and Prediction
												■																	GT-26 Management of the Data on Emissions	This equipment package collects and stores air quality and vehicle emissions information by remotely monitoring and controlling area wide and point sensors. General air quality measures are distributed as general traveler information and also may be used for in demand management programs. Collected roadside emissions are analyzed and used to detect, identify, and notify concerned parties regarding vehicles that exceed emissions standards.	MA-203 Pollution Monitoring
													■																C-1 Basic Monitoring of the Road	This equipment package monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.	SP-401 Intelligent Intersection
													■																		GOT-101 Traffic Monitoring
													■																		GOT-102 Surface Street Control
													■																		GOT-103 Freeway Control
													■																C-2 Coordination of the Field Equipment	This equipment package supports direct communications between field equipment. It includes field elements that control and send data to other field elements. This includes coordination between remote sensors and field devices (e.g., Dynamic Message Signs) and coordination between the field devices themselves (e.g., direc coordination between traffic controllers that are controlling adjacent intersections.).	SP-401 Intelligent Intersection
													■																		GOT-101 Traffic Monitoring
													■																		GOT-305 Automated Road Management
													■																		GOT-102 Surface Street Control
													■																		GOT-105 Reversible Lane Management
													■																		GOT-304 Bridge Management
													■																		GOT-402 Incident On-Site Traffic Management
													■																		GOT-106 Traffic Information Dissemination
													■																		GOT-403 Incident and Event Coordination
													■																C-3 Control of Traffic Lights	This equipment package includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, signal heads, detectors, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. This equipment package represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians.	SP-401 Intelligent Intersection
													■																		GOT-103 Freeway Control
													■																		GOT-102 Surface Street Control
													■																C-4 Traffic Light Signal Priority	This equipment package includes the field elements that receive signal priority and/or signal preemption requests from vehicles approaching a signalized intersection and controls traffic signals accordingly. Depending on the type of request and implementation, this equipment package may override (preempt) current signal timing or delay	SV-202 Automated Low-Speed Maneuvering

	Subsystems																													
	National				Int'l		Regional							Roadway						Vehicles								Travelers	
Functional Components	Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers
C-4 Traffic Light Signal Priority																														
C-5 Dissemination of Traffic on Roads																														
C-6 Road Control of Freeways																														
C-7 Reversible Lane Monitoring and Control																														
C-8 Control of Railway Traffic Lights																														
C-9 Railway Crossing Standards																														
C-10 Control of the Traffic in Zones of Road Work																														
C-11 Coordination of the Equipment on the Road																														
C-12 Control of HOV Lanes																														
C-13 Control of Traffic on Freeways and Ramps																														
C-14 Monitoring Traffic and Road Conditions With Short Range Communications Device																														
C-15 Monitoring Pavement Conditions																														

Functional Components	Definition	ITS Services
C-4 Traffic Light Signal Priority	phase transition. In signal priority systems, the request for priority may or may not be granted, based on the overall traffic situation at the intersection.	GOT-104 Preferential Treatment for Traffic Control
C-5 Dissemination of Traffic on Roads	This equipment package includes field elements that provides information to drivers, including dynamic message signs and highway advisory radio.	GOT-103 Freeway Control GOT-106 Traffic Information Dissemination GOT-304 Bridge Management
C-6 Road Control of Freeways	This equipment package includes the field equipment used to control traffic on freeways including ramp meters, interchange connector meters, mainline meters, and lane control signals.	GOT-103 Freeway Control
C-7 Reversible Lane Monitoring and Control	This equipment package includes field elements that monitor and control reversible lane facilities. It includes the traffic sensors, surveillance equipment, lane control signals, physical lane access controls, and other field elements that manage traffic on these facilities. It provides current reversible lane facility status information and accepts requests and control commands from the controlling center.	GOT-105 Reversible Lane Management
C-8 Control of Railway Traffic Lights	This equipment package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Either passive (e.g., the crossbuck sign) or active warning systems (e.g., flashing lights and gates) are supported depending on the specific requirements for each intersection. These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification of an approaching train by interfaced wayside equipment. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported through interfaces to the wayside interface equipment and the traffic management subsystem.	GOT-108 Intermodal Highway Junction Management
C-9 Railway Crossing Standards	This equipment package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Either passive (e.g., the crossbuck sign) or active warning systems (e.g., flashing lights and gates) are supported depending on the specific requirements for each intersection. These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification of an approaching train by interfaced wayside equipment. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported through interfaces to the wayside interface equipment and the traffic management subsystem.	GOT-108 Intermodal Highway Junction Management
C-10 Control of the Traffic in Zones of Road Work	This equipment package controls traffic in areas of the roadway where maintenance and construction activities are underway, monitoring and controlling traffic using field equipment such as CCTV cameras, dynamic messages signs, and gates/barriers. Work zone speeds and delays are provided to the motorist prior to the work zones.	GOT-110 Work Zone Traffic Management GOT-301 Roadway Construction and Maintenance Management
C-11 Coordination of the Equipment on the Road	This equipment package supports direct communications between field equipment. It includes field elements that control and send data to other field elements. This includes coordination between remote sensors and field devices (e.g., Dynamic Message Signs) and coordination between the field devices themselves (e.g., direct coordination between traffic controllers that are controlling adjacent intersections.)	GOT-203 High-Occupancy lane management IV-201 On-Trip Information - Roadside
C-12 Control of HOV Lanes	This equipment package monitors and controls high occupancy vehicle (HOV) and high occupancy toll (HOT) lanes. It includes traffic sensors that monitor HOV lane usage and display equipment such as lane control signals that provide lane status to drivers.	GOT-203 High-Occupancy lane management
C-13 Control of Traffic on Freeways and Ramps	This equipment package includes the field equipment used to control traffic on freeways including ramp meters.	GOT-203 High-Occupancy lane management
C-14 Monitoring Traffic and Road Conditions With Short Range Communications Device	This equipment package monitors traffic and road conditions by collecting information from passing vehicles that are equipped with a transponder or other short range communications device. The probe data collected by this equipment package may include link travel times, average speeds, road conditions, and any other data that can be measured and communicated by passing vehicles. This equipment package consists of field equipment that communicates with passing vehicles using short range communications, collects the information provided by the vehicles, and forwards this information back to the Traffic Management Subsystem.	GOT-303 Pavement Management MA-101 Road Weather Information Monitoring
C-15 Monitoring Pavement Conditions	This equipment package monitors the condition of pavement and includes sensors that monitor the infrastructure and the communications necessary to report this data to a center or vehicle-based maintenance system.	GOT-303 Pavement Management

Functional Components	National				Int'l		Regional							Roadway						Vehicles								Travelers	
	Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers
C-16 Automated Road Treatment														■															
C-17 Security in Zones of Road Work														■															
C-18 Dissemination of Information of Traffic on the Road														■															
C-19 Monitoring the Road Atmosphere														■															
C-20 Monitoring the Road Environment, Emissions and Air Quality														■															
C-21 Storing the Collected Road Data														■															
GE-1 Parking Management															■														
GE-2 Electronic Parking Payment															■														
PV-1 Collection of Toll Plaza Payments																■													
IVC-1 Electronic Registry of Citations and Accidents																	■												
IVC-2 Electronic Monitoring of Commercial Vehicles																	■												
IVC-3 International Border Crossing																	■												

Functional Components	Definition	ITS Services
C-16 Automated Road Treatment	This equipment package automatically treats a roadway section based on environmental or atmospheric conditions or under center control. Treatments include fog dispersion, anti-icing chemicals, etc	GOT-304 Bridge Management
C-17 Security in Zones of Road Work	This equipment package includes field elements that detect vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone.	GOT-305 Automated Road Management
C-18 Dissemination of Information of Traffic on the Road	This equipment package includes field elements that detect vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone.	GOT-402 Incident On-Site Traffic Management IV-201 On-Trip Information - Roadside
C-19 Monitoring the Road Atmosphere	This equipment package measures environmental conditions and communicates the collected information back to a center where it can be monitored and analyzed. A broad array of general weather and road surface information may be collected. Weather conditions that may be measured include temperature, wind, humidity, precipitation, and visibility. Surface and sub-surface sensors can measure road surface temperature, moisture, icing, salinity, and other measures.	MA-101 Road Weather Information Monitoring
C-20 Monitoring the Road Environment, Emissions and Air Quality	This equipment package monitors emissions and general air quality and communicates the collected information back to the emissions management subsystem where it can be monitored, analyzed, and used. This equipment package supports point monitoring of individual vehicle emissions as well as general monitoring of standard air quality measures.	MA-203 Pollution Monitoring
C-21 Storing the Collected Road Data	This equipment package collects traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications where data quality and completeness take precedence over real time performance. This equipment package includes the sensors, supporting roadside infrastructure, and communications equipment that collects and transfers information to a center for archival.	IV-602 Data Archival IV-603 Data Warehouse
GE-1 Parking Management	This equipment package detects and classifies vehicles at parking facility entrances, exits, and other designated locations within the facility. Current parking availability is monitored and used to inform drivers through dynamic message signs/displays so that vehicles are efficiently routed to available spaces. Parking facility information, including current parking rates and directions to entrances and available exits, is also provided to drivers. Coordination with traffic management supports local traffic control coordination in and around the parking facility.	PE-103 Electronic Parking Payment GOT-109 Parking Management
GE-2 Electronic Parking Payment	This equipment package supports electronic payment of parking fees using in-vehicle equipment (tags) or contact or proximity cards. It includes the field elements that provide the interface to the in-vehicle or card payment device and the back-office functionality that performs the transaction.	PE-103 Electronic Parking Payment GOT-109 Parking Management
PV-1 Collection of Toll Plaza Payments	This equipment package provides toll plazas the capability to identify properly equipped vehicles, collect electronic tolls, and provide a positive indication to the driver that a toll was collected. Violators are identified and images are collected. Toll transactions are stored and reported to the Toll Administration Subsystem.	GOT-201 Variable Road Pricing
IVC-1 Electronic Registry of Citations and Accidents	The equipment package documents accidents, citations, and violations identified during roadside safety inspections and forwards the information to the Commercial Vehicle Administration Subsystem for processing.	SE-303 Hazmat Preclearance TC-601 Remote access to commercial vehicle safety data TC-701 Commercial Vehicle Internal Systems Monitoring
IVC-2 Electronic Monitoring of Commercial Vehicles	This equipment package provides two-way communication with approaching properly equipped commercial vehicles at mainline speeds, reading tags for automated vehicle identification and credential checking. This equipment package processes the data from the commercial vehicles along with accessed database information to determine whether a pull-in message is needed or to generate random pull-in messages with provisions for facility operators and enforcement officials to have manual override capabilities.	SE-303 Hazmat Preclearance TC-103 Automated Border Crossing TC-601 Remote access to commercial vehicle safety data
IVC-3 International Border Crossing	This equipment package checks compliance with import/export and immigration regulations to manage release of commercial vehicle, cargo, and driver across an international border. It includes the equipment at international border crossings operated by government agencies such as customs and immigration.	TC-103 Automated Border Crossing

Functional Components	Subsystems: National – Transportation Planning	National – Security Fulfillment	National – Tolls and Income	National – Salubrity/the Red Cross	Int'l – Immigration	Int'l – Customs	Regional – Service Supplier	Regional – Toll Collection	Regional – Public Transportation	Regional – Emergency Services	Regional – Manager of Private Fleet	Regional – Public Order	Regional – Traffic Manager	Roadway – Calzada	Roadway – Parking	Roadway – Payment in Route	Roadway – Commercial Inspection/Load	Roadway – Terminal station/(Transp. Pub.)	Roadway – Intermodal Terminal	Vehicles – Vehicle	Vehicles – Of Aquiler (taxi)	Vehicles – Public Transportation	Vehicles – Commercial	Vehicles – Intermodal Container	Vehicles – Emergency	Vehicles – Construction/Maintenance	Vehicles – Public Order (police)	Travelers – Personal Information Access	Travelers – Remote Support for Travellers
IVC-4 Inspection of Security and Protection to Flank of the Route																	■												
IC-5 Remote Electronic Commercial Vehicle Weighting																	■												
ETP-1 Monitoring Facilities and Infrastructures Through Surveillance of a Secure Area																		■											
ETP-2 Monitoring a Secure Area with Sensors																		■											
[illegible]																			■										
[illegible]																			■										
[illegible]																			■										
[illegible]																			■										

Functional Components	Definition	ITS Services
IVC-4 Inspection of Security and Protection to Flank of the Route	This equipment package supports the roadside safety inspection process. It reads on-board safety data at mainline speeds to rapidly screen the vehicle and driver and accesses historical safety data after identifying vehicles at mainline speeds or while stopped at the roadside. The capabilities to process safety data and issue pul in messages or provide warnings to the driver, carrier, and enforcement agencies are also provided. It includes hand held devices to rapidly inspect the vehicle and driver. Results of screening and summary safety inspection data are stored and maintained. Since a vehicle may cross jurisdictional boundaries during a trip, this equipment package supports the concept of a last clearance event record carried on the vehicle tag. The last clearance event record reflects the results of the roadside verification action. For example, if the vehicle is pulled over in State A and undergoes credential, weight, and safety checks, the results of the clearance process are written to the vehicle s tag. If the vehicle continues the trip and passes a roadside station in State B, the State B station has access to the results of the previous pull-in because it can read the last clearance event record written by the State A roadside station.	TC-601 Remote access to commercial vehicle safety data TC-701 Commercial Vehicle Internal Systems Monitoring
IC-5 Remote Electronic Commercial Vehicle Weighting	This equipment package measures commercial vehicle weight at high speeds. It includes both portable and permanent installations and can be used to augment electronic credentials checking or it can be a stand alone package with display.	TC-301 Vehicle and container arrival information exchange TC-401 Intermodal Center Facility Management
ETP-1 Monitoring Facilities and Infrastructures Through Surveillance of a Secure Area	This equipment package includes video and audio surveillance equipment that monitors conditions of secure areas including facilities (e.g. transit yards) and transportation infrastructure (e.g. as bridges, tunnels, interchanges, and transit railways or guideways). It provides the surveillance information to the Emergency Management Subsystem for possible threat detection. The equipment package also provides local processing of the video or audio information, providing processed or analyzed results to the Emergency Management Subsystem. This equipment package provides the same functions as the Traveler Secure Area Surveillance equipment package.	TP-101 Public Transport Vehicle Internal Systems Monitoring
ETP-2 Monitoring a Secure Area with Sensors	This equipment package includes sensors that monitor conditions of secure areas including facilities (e.g. transit yards) and transportation infrastructure (e.g. bridges, tunnels, interchanges, and transit railways or guideways). A range of acoustic, environmental threat (e.g. chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors), infrastructure condition and integrity and motion and object sensors are included.	TP-101 Public Transport Vehicle Internal Systems Monitoring
[illegible]	This equipment package manages the movement of freight from source to destination via links to the freight equipment, intermodal freight shippers, and depots. It interfaces to intermodal freight shippers to setup and schedule transportation and coordinates with intermodal freight depots to coordinate the shipment. The equipment package monitors the status of the freight and freight equipment (container, trailer, or chassis) and monitors freight location and compares it against the planned route.	TC-301 Vehicle and container arrival information exchange
[illegible]	This equipment package checks compliance with import/export and immigration regulations to manage release of commercial vehicle, cargo, and driver across an international border. It includes the equipment at international border crossings operated by government agencies such as customs and immigration.	TC-301 Vehicle and container arrival information exchange TC-401 Intermodal Center Facility Management
[illegible]	This equipment package collects and stores driver identification records including driver issued PINS and/or individual driver biometric measurements. The equipment package can also manage the storage of driver PINs and/or biometric measurements for authorized drivers on individual commercial vehicles. Based on information reported by the commercial vehicle, the equipment package will determine if the driver is authorized, and notify the Commercial Vehicle Manager when an unauthorized driver is detected. The Commercial Vehicle Manager may override the disable vehicle action. When an unauthorized driver is detected and the system is not overridden, then the equipment package will issue a message to the commercial vehicle to safely disable the vehicle. If an unauthorized driver is detected, then the equipment package will send to the Emergency Management Subsystem that includes: incident location, current location of the CV, Vehicle ID, Carrier ID, Driver ID, CV Credentials information, and cargo manifest (if known).	TC-401 Intermodal Center Facility Management
[illegible]	This equipment package provides for the security of the commercial vehicle and the freight that it carries by detecting breaches such as seals or locks being broken into by unauthorized personnel and/or any other unauthorized tampering. In addition, this equipment package monitors the commercial vehicle driver and compares it with the planned driver for the vehicle. In a similar manner, the driver and vehicle that have been assigned to move freight are monitored and compared with the planned assignment for that freight. In all cases, any deviations to the planned assignments and any breach or tamper events are reported to the Emergency Management Subsystem.	TC-401 Intermodal Center Facility Management

Subsystems																													Functional Components	Definition	ITS Services
National				Int'l		Regional							Roadway						Vehicles								Travelers				
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travelers			
																													V-1 Identification Commercial Vehicle/Driver	This on-board equipment package monitors the identity of the commercial vehicle driver and compares it with the planned drivers for the commercial vehicle. Any change in driver is sent to the Fleet and Freight Management Subsystem. Notification of any unexpected drivers will also be sent to the Fleet and Freight Management Subsystem which, in turn, may send a disable vehicle command back to this equipment package to cause the vehicle to stop. On receipt of a disable vehicle message from the Fleet and Freight Management Subsystem or on detection of an unauthorized driver, the equipment package will safety disable the CV.	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application
																													V-2 On-board Commercial Vehicle Security	This on-board equipment package collects and processes vehicle and driver safety and security information and provides safety and security information to the Fleet and Freight Management Subsystem. This equipment package also supplies this information to the roadside facilities both at mainline speeds and while stopped for inspections. The capability to alert the commercial vehicle driver whenever there is a critical safety or security problem or potential emergency is also provided. The package also supports on-board driver safety log maintenance and checking.	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application
																													V-3 Determining the Location of a Vehicle	This equipment package determines current location of the vehicle using GPS or similar location referencing capability and provides this information to other equipment packages that use the location information to provide various ITS services.	SE-201 Emergency Vehicle Fleet Tracking
																															SE-202 Emergency Vehicle - Traffic Management Coordination
																															SE-301 Hazmat Vehicle Tracking
																															SE-302 Automated Hazmat Mayday
																															SP-202 Systems to Monitor Public Sector Fleet Vehicles
																															SE-101 Automated Mayday Dispatch
																															TC-201 Commercial Vehicle Fleet Tracking
																															TC-202 Commercial Vehicle Fleet Dispatching
																															TC-502 Dangerous Goods movement data registry
																															TC-503 Dangerous Goods movement fleet coordination
																															GOT-104 Preferential Treatment for Traffic Control
																															GOT-404 Hazardous Materials Monitoring and Management
																															TP-102 Public Transport Vehicle Fleet Tracking
																													V-4 Detection of Emergencies	This equipment package provides the capability for drivers or collision detection sensors to report an emergency and summon assistance. This equipment package includes the on-board collision detection sensors, a mechanism for the driver to summon assistance, and two-way communications with a service provider.	SE-101 Automated Mayday Dispatch
																															SE-301 Hazmat Vehicle Tracking
																															SE-302 Automated Hazmat Mayday
																															GOT-404 Hazardous Materials Monitoring and Management
																													V-5 Lateral Control of a Vehicle	This equipment package provides lateral control of a vehicle to allow "hands off" driving, automating the steering control function. It includes on-board systems that detect lanes and obstacles or vehicles to the sides of the vehicle. This sensor information is processed on board the vehicle, and appropriate steering control actions are maintained using steering actuators.	SV-202 Automated Low-Speed Maneuvering
																													V-6 Longitudinal Control of a Vehicle	This equipment package provides longitudinal control of a vehicle to allow "feet off" driving, automating the function of speed control, acceleration, and braking to maintain safe following distances. It includes on-board systems that detect obstacles or vehicles in the longitudinal path of the vehicle. This sensor information is processed on board the vehicle, and appropriate control actions (acceleration, braking, or maintaining speed) are initiated using accelerator and/or brake actuators.	SV-203 Precision Docking for Public Transport Vehicles
																													V-7 Longitudinal System of Alert of the Vehicle	This equipment package monitors areas in front of and behind the vehicle and provides warnings to the driver so the driver can take action to recover and maintain safe control of the vehicle. It includes on-board sensors that detect objects in front of or behind the vehicle and the driver information system that provides the warning.	SV-301 Longitudinal Collision Avoidance

Subsystems: National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
																			X										V-8 Lateral System of Alert of the Vehicle	This equipment package monitors areas to the sides of a vehicle and provides warnings to a driver so the driver can take action to recover and maintain safe control of the vehicle. It includes on-board sensors that detect lanes and obstacles or vehicles to the sides of the vehicle and the driver information system that provides the warning.	SV-302 Lateral Collision Avoidance
																			X										V-9 System of Monitoring Security of Vehicle	This equipment package monitors critical components of the vehicle and warns the driver of potential dangers. These capabilities are provided by on-board sensors to monitor the vehicle condition and performance, including steering, braking, acceleration, emissions, fuel economy, engine performance, etc. Problems with any of these systems are identified and reported to the driver. Warnings are provided in the event of a serious condition (e.g., likely failure or damage).	SV-401 Vehicle Internal Systems Monitoring
																			X										V-10 Systems of Monitoring the Driver	This equipment package monitors the driver's condition and warns the driver of potential dangers. This equipment package includes driver sensors to assess the suitability of the driver (e.g., fitness and alertness) to assume manual control of the vehicle.	TC-702 Commercial Vehicle Driver Alertness Monitoring
																			X											This equipment package monitors the driver's condition and warns the driver of potential dangers. This equipment package includes driver sensors to assess the suitability of the driver (e.g., fitness and alertness) to assume manual control of the vehicle.	PE-102 Electronic Toll Collection
																			X										V-12 Interphase Parking Vehicles	This equipment package includes the on-board systems that pay for tolls and parking electronically. It includes in-vehicle equipment that communicates with the toll/parking plaza (e.g., a tag) and an optional interface to a traveler card to allow use of a common payment medium for all transportation services.	PE-103 Electronic Parking Payment
																			X												PE-105 Electronic distance-based road user fee payment services
																			X												GOT-109 Parking Management
																			X												GOT-201 Variable Road Pricing
																			X										V-13 Interactive Reception of Vehicles	This equipment package provides drivers with personalized traveler information including traffic and road conditions, transit information, maintenance and construction information, multimodal information, event information, and weather information. The provided information is tailored based on driver requests. Both one-time requests for information and on-going information streams based on a submitted traveler profile and preferences are supported.	GOT-402 Incident On-Site Traffic Management
																			X										V-14 Intelligent Sounding	This equipment package includes the vehicle sensors and communications systems that sense and send road conditions and surface weather information as the vehicle travels. The same vehicle equipment that improves stability and provides driver information in adverse conditions is a potential source for this information.	MA-101 Road Weather Information Monitoring
																			X										V-15 Consultant's Office to Plan Trips in Vehicles and Routes	This equipment package includes the in-vehicle system that coordinates with a traveler information center to provide a personalized trip plan to the driver. The trip plan is calculated by the Information Service Provider based on preferences and constraints supplied by the driver and provided to the driver for confirmation. Reservations and advanced payment may also be processed by this equipment package to confirm the trip plan. Coordination with the Information Service Provider may continue during the trip so that the route plan can be modified to account for new information. Many equipment configurations are possible including in-vehicle systems that provide a basic trip plan to the driver as well as more sophisticated systems that can provide turn by turn guidance to the driver along the route.	TP-202 Dynamic Ridesharing
																				X									VDA-1 Determination of the Location of the Vehicle	This equipment package determines current location of the vehicle using GPS or similar location referencing capability and provides this information to other equipment packages that use the location information to provide various ITS services.	TP-102 Public Transport Vehicle Fleet Tracking
																				X											SP-201 Non-motorized vehicle and pedestrian monitoring systems
																					X								VTP-1 Authenticaion of the Commercial Vehicle Driver	This on-board equipment package monitors the identity of the commercial vehicle driver and compares it with the planned drivers for the commercial vehicle. Any change in driver is sent to the Fleet and Freight Management Subsystem. Notification of any unexpected drivers will also be sent to the Fleet and Freight Management Subsystem which, in turn, may send a disable vehicle command back to this equipment package to cause the vehicle to stop. On receipt of a disable vehicle message from the Fleet and Freight Management Subsystem or on detection of an unauthorized driver, the equipment package will safety disable the CV.	SP-101 Silent Alarm
																					X										SP-101 Silent Alarm
																					X										SP-101 Silent Alarm
																					X								VTP-2 On-board Security and Safety Monitoring	This equipment package provides security and safety functions on-board the transit vehicle. It includes surveillance and sensor systems that monitor the on-board environment, silent alarms that can be activated by transit user or vehicle operator, operator authentication, and a remote vehicle disable function. The surveillance equipment includes video (e.g. CCTV cameras), audio systems and/or event recorder systems. The sensor	SP-102 Mayday Alert for Public Transport
																					X										SP-102 Mayday Alert for Public Transport
																					X										SP-102 Mayday Alert for Public Transport
																					X										SP-102 Mayday Alert for Public Transport
																					X										SP-104 Public Transport Surveillance

Subsystems: National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
																					■									equipment includes threat sensors (e.g. chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g. metal detectors).	SP-104 Public Transport Surveillance
																					■										SP-104 Public Transport Surveillance
																					■										SP-104 Public Transport Surveillance
																					■										TP-101 Public Transport Vehicle Internal Systems Monitoring
																					■								VTP-4 On-board Public Transportation Fare Collection Monitoring	This on-board equipment package supports fare collection using a standard fare card or other non-monetary fare medium, detects payment violations, and counts passengers as they embark and disembark from the vehicle. It collects data required to determine accurate ridership levels and implement variable and flexible fare structures. Collected passenger and fare data are made available to the center.	PE-101a Electronic Transit Fare Payment (Light Rail). PE-101b Electronic Transit Fare Payment (bus concessions)
																					■										PE-202 Integration of Regional Multi-modal Payment Systems
																					■								VTP-5 On-board Transit Vehicle Maintenance Data Collectiona	This on-board equipment package collects and processes transit vehicle maintenance data including mileage and vehicle operating conditions. This maintenance information is provided to the management center and used to schedule future vehicle maintenance and repair.	TP-101 Public Transport Vehicle Internal Systems Monitoring
																					■								VTP-6 Monitoring of Public Transportain Vehicle Trips	This on-board equipment package tracks vehicle location, monitors fuel usage, collects operational status (doors opened/closed, running times, etc.) and sends the collected, timestamped data to the Transit Management Subsystem.	TP-102 Public Transport Vehicle Fleet Tracking
																					■								VTP-7 Management of Operations of On Board Paratransit /Flexible-route Dispatch	This on-board equipment package forwards paratransit and flexible-route dispatch requests to the operator and forwards acknowledgements to the center. It coordinates with, and assists the operator in managing multi-stop runs associated with demand responsive transit services including paratransit.	TP-201 Paratransit Fleet Dispatch
																					■								VTP-8 On-board Public Transit Travel Information Services	This equipment package furnishes en-route transit users with real-time travel-related information on-board a transit vehicle. Current information that can be provided to transit users includes transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents, weather conditions, non-motorized transportation services, and special events are provided. In addition to tailored information for individual transit users, this equipment package also supports general annunciation and/or display of general schedule information, imminent arrival information, and other information of general interest to transit users.	IV-203 On-Trip Information - Public Transport Vehicle
																						■							SVC-1 Electronic Data On-board Vehicle	This on-board equipment package exchanges information with roadside facilities, providing information such as driver, vehicle, and carrier identification to roadside facilities that can be used to support electronic screening. Pass/pull-in messages are received and presented to the commercial vehicle driver and screening events are recorded. Additional information, including trip records (e.g., border clearance information), safety inspection records, cargo information, and driver status information may also be collected, stored, and made available to the roadside facility by this equipment package.	TC-103 Automated Border Crossing
																						■							VC-1 Authentication of the Commercial Vehicle Driver	This on-board equipment package monitors the identity of the commercial vehicle driver and compares it with the planned drivers for the commercial vehicle. Any change in driver is sent to the Fleet and Freight Management Subsystem. Notification of any unexpected drivers will also be sent to the Fleet and Freight Management Subsystem which, in turn, may send a disable vehicle command back to this equipment package to cause the vehicle to stop. On receipt of a disable vehicle message from the Fleet and Freight Management Subsystem or on detection of an unauthorized driver, the equipment package will safety disable the CV.	SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring
																						■									TC-203 Freight Container Tracking
																						■							VC-2 Monitoring the Commercial Vehicle and Cargo	This on-board equipment package monitors the location and status of the commercial vehicle and its cargo. It sends the collected data to appropriate centers and roadside facilities, including emergency management in the case of HAZMAT incidents. Depending on the nature of the cargo, this equipment package may include sensors that measure temperature, pressure, load leveling, acceleration, and other attributes of the cargo.	SE-301 Hazmat Vehicle Tracking
																						■									TC-501 Dangerous Goods movement data sharing
																						■									SE-302 Automated Hazmat Mayday
																						■									TC-203 Freight Container Tracking
																						■									GOT-404 Hazardous Materials Monitoring and Management
																						■							VC-4 Electronic Data On-board	This on-board equipment package exchanges information with roadside facilities, providing information such as driver, vehicle, and carrier identification to roadside facilities that can be used to support electronic screening. Pass/pull-in messages are received and presented to the commercial vehicle driver and screening events are	SE-303 Hazmat Preclearance

Subsystems: National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
																						■							Commercial Vehicles	recorded. Additional information, including trip records (e.g., border clearance information), safety inspection records, cargo information, and driver status information may also be collected, stored, and made available to the roadside facility by this equipment package.	TC-601 Remote access to commercial vehicle safety data
																						■							VC-5 Monitoring of Commercial Trips On board the Vehicle	This equipment package provides the capabilities to support fleet management with automatic vehicle location and automated mileage and fuel reporting and auditing. In addition, this equipment is used to monitor the planned route and notify the Fleet and Freight Management Subsystem of any deviations.	TC-201 Commercial Vehicle Fleet Tracking
																						■									TC-202 Commercial Vehicle Fleet Dispatching
																						■									TC-501 Dangerous Goods movement data sharing
																						■									TC-502 Dangerous Goods movement data registry
																						■									TC-503 Dangerous Goods movement fleet coordination
																						■									TC-203 Freight Container Tracking
																						■							VC-6 On-board Security for Commercial Vehicle and Driver	This on-board equipment package collects and processes vehicle and driver safety and security information and provides safety and security information to the Fleet and Freight Management Subsystem. This equipment package also supplies this information to the roadside facilities both at mainline speeds and while stopped for inspections. The capability to alert the commercial vehicle driver whenever there is a critical safety or security problem or potential emergency is also provided. The package also supports on-board driver safety log maintenance and checking.	TC-501 Dangerous Goods movement data sharing
																						■									TC-701 Commercial Vehicle Internal Systems Monitoring
																							■						CIM-1 On-Board Electronic Screening Information	This on-board equipment package exchanges information with roadside facilities, providing information such as driver, vehicle, and carrier identification to roadside facilities that can be used to support electronic screening. Pass/pull-in messages are received and presented to the commercial vehicle driver and screening events are recorded. Additional information, including trip records (e.g., border clearance information), safety inspection records, cargo information, and driver status information may also be collected, stored, and made available to the roadside facility by this equipment package.	TC-401 Intermodal Center Facility Management
																							■								TC-402 Intermodal Vehicle and Container Control
																								■					VE-1 Monitoring and Managing a Fleet Route and Reporting	This equipment package provides the capabilities to support fleet management with automatic vehicle location and automated mileage and fuel reporting and auditing. In addition, this equipment is used to monitor the planned route and notify the Emergency Management Subsystem of any deviations.	SE-201 Emergency Vehicle Fleet Tracking
																								■					VE-2 Support for the Routing of an Emergency Vehicle	This on-board equipment package supports dispatch, routing, and tracking of an emergency vehicle. Dispatch and routing information are received and presented to the driver and vehicle location and status are tracked and provided back to the dispatcher. This equipment package supports traffic signal preemption via short range communication directly with signal control equipment. It also supports communications with care facilities, sharing patient status and care facility status between the en route emergency vehicle and the care facility.	SE-202 Emergency Vehicle - Traffic Management Coordination
																								■							GOT-104 Preferential Treatment for Traffic Control
																								■							GOT-401 Incident On-Site Motorist Assist
																								■					VE-2 Communication On-board for the Management of Incidents	This on-board equipment package provides communications support to first responders. Information about the incident, information on dispatched resources, and ancillary information such as road and weather conditions are provided to emergency personnel. Emergency personnel transmit information about the incident such as identification of vehicles and people involved, the extent of injuries, hazardous material, resources on site, site management strategies in effect, and current clearance status.	GOT-401 Incident On-Site Motorist Assist
																								■							GOT-403 Incident and Event Coordination
																									■				VMC-1 Tracking of Vehicles	This on-board equipment package tracks vehicle location and reports the position and timestamp information to a dispatch center	SP-202 Systems to Monitor Public Sector Fleet Vehicles
																									■				VMC-2 Control of a Barrier System	This on-board equipment package provides local control of automatic or remotely controlled gates and other barrier systems from a maintenance and construction vehicle. Using this equipment package, maintenance and construction field personnel (e.g., snow plow operators) can open and close gates and other barrier systems without leaving the vehicle, using dedicated short range communications to control the barriers.	GOT-110 Work Zone Traffic Management
																									■						GOT-301 Roadway Construction and Maintenance Management
																									■				VMC-3 Support to the Local Management of a Work Zone	This on-board equipment package provides communications and support for local management of a work zone. It supports communications between field personnel and the managing center to keep the center appraised of current work zone status. It controls vehicle-mounted driver information systems (e.g., dynamic message signs) and uses short range communications to monitor and control other fixed or portable driver information systems in the work zone.	GOT-110 Work Zone Traffic Management
																									■						GOT-301 Roadway Construction and Maintenance Management
																									■				VMC-4 Monitoring the Pavement for the Maintenance/Construction Vehicle	This on-board equipment package collects current road and surface weather conditions from sensors on-board the maintenance and construction vehicle or by querying fixed sensors on or near the roadway. Environmental information including road surface temperature, air temperature, and wind speed is measured and spatially located and time stamped, and reported back to a center.	GOT-303 Pavement Management
																									■						MA-101 Road Weather Information Monitoring

Subsystems: National				Int'l		Regional							Roadway						Vehicles								Travelers		Functional Components	Definition	ITS Services
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
																									■				VMC-5 Monitoring the Security of the Maintenance/Construction Vehicle	This equipment package detects vehicle intrusions in the vicinity of the vehicle and warns crew workers and drivers of imminent encroachment. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone. This equipment package can be used for stationary work zones or in mobile applications where a safe zone is maintained around the moving vehicle.	GOT-305 Automated Road Management
																										■			OPV-1 On-Board Emergency Vehicle Support	This on-board equipment package supports dispatch, routing, and tracking of an emergency vehicle. Dispatch and routing information are received and presented to the driver and vehicle location and status are tracked and provided back to the dispatcher. This equipment package supports traffic signal preemption via short range communication directly with signal control equipment. It also supports communications with care facilities, sharing patient status and care facility status between the en route emergency vehicle and the care facility.	SN-101a Vehicle hazmat and explosives monitoring at the border. SN-101b Vehicle hazmat and explosives monitoring mobile application SE-201 Emergency Vehicle Fleet Tracking SE-202 Emergency Vehicle - Traffic Management Coordination GOT-401 Incident On-Site Motorist Assist
																										■			OPV-2 Determination of Vehicle Location Electronically	This equipment package determines current location of the vehicle using GPS or similar location referencing capability and provides this information to other equipment packages that use the location information to provide various ITS services.	SE-201 Emergency Vehicle Fleet Tracking
																										■			OPV-3 On-board Communications Support	This on-board equipment package provides communications support to first responders. Information about the incident, information on dispatched resources, and ancillary information such as road and weather conditions are provided to emergency personnel. Emergency personnel transmit information about the incident such as identification of vehicles and people involved, the extent of injuries, hazardous material, resources on site, site management strategies in effect, and current clearance status.	GOT-401 Incident On-Site Motorist Assist
																											■		AIP-1 Distress Signal for Travelers	This equipment package provides the capability for travelers to report an emergency or activate a panic button to summon assistance. The personal mayday capability is provided by a portable device such as a personal digital assistant (PDA).	SE-101 Automated Mayday Dispatch
																											■		AIP-2 Determination of the Location Information	This equipment package determines current location information and provides this information to other equipment packages that use the location information to provide guidance and emergency notification services. The equipment package includes location referencing technology such as a GPS receiver that is embedded in the user's personal computer or other portable device.	SE-101 Automated Mayday Dispatch IV-205 On-Trip Information through mobile devices IV-102 Pre-Trip Information - Public Transport
																											■		AIP-3 Provide Information by Interactive Personnel	This equipment package provides traffic information, road conditions, transit information, yellow pages (traveler services) information, special event information, and other traveler information that is specifically tailored based on the traveler's request and/or previously submitted traveler profile information. The interactive traveler information capability is provided by personal devices including personal computers and personal portable devices such as personal digital assistants (PDAs).	GOT-402 Incident On-Site Traffic Management IV-101 Pre-Trip Information - Traffic and Roadway TP-202 Dynamic Ridesharing IV-302 Travel Services Information - Personal Interactive
																											■		AIP-5 Trip Planner for Traveler	This equipment package provides a personalized trip plan to the traveler. The trip plan is calculated by the Information Service Provider based on preferences and constraints supplied by the traveler and provided to the traveler for confirmation. Reservations and advanced payment may also be processed by this equipment package to confirm the trip plan. Coordination with the Information Service Provider may continue during the trip so that the route plan can be modified to account for new information. Many equipment configurations are possible including systems that provide a basic trip plan to the traveler as well as more sophisticated systems that can provide transition by transition guidance to the traveler along a multi-modal route. Devices represented by this equipment package include desktop computers at home, work, or at major trip generation sites, plus personal portable devices such as PDAs and pagers.	IV-102 Pre-Trip Information - Public Transport
																											■		AIP-6 Basic Traveler Information Broadcasts	This equipment package receives formatted traffic advisories, road conditions, transit information, broadcast alerts, and other general traveler information broadcasts and presents the information to the traveler. The traveler information broadcasts are received by personal devices including personal computers and personal portable devices such as personal digital assistants (PDAs) and pagers.	IV-205 On-Trip Information through mobile devices

Subsystems																													Functional Components	Definition	ITS Services
National				Int'l		Regional							Roadway						Vehicles								Travelers				
Transportation Planning	Security Fulfillment	Tolls and Income	Salubrity/the Red Cross	Immigration	Customs	Service Supplier	Toll Collection	Public Transportation	Emergency Services	Manager of Private Fleet	Public Order	Traffic Manager	Calzada	Parking	Payment in Route	Commercial Inspection/Load	Terminal station/(Transp. Pub.)	Intermodal Terminal	Vehicle	Of Aquiler (taxi)	Public Transportation	Commercial	Intermodal Container	Emergency	Construction/Maintenance	Public Order (police)	Personal Information Access	Remote Support for Travellers			
																											■		AIP-7 Autonomous Route Guidance	This equipment package provides multi-modal route planning and transition by transition route guidance. It provides autonomous route guidance in the absence of real-time information or factors information provided by the infrastructure into its route selection and guidance algorithms if available. The equipment package also includes those truly autonomous systems that are not configured to receive or process any external data. The route guidance capabilities of this equipment package are hosted on personal devices including personal computers and personal portable devices such as PDAs and pagers.	IV-205 On-Trip Information through mobile devices
																												■	ARPV-1 Surveillance of Secure Area	This equipment package manages surveillance equipment that monitors secure areas in the transportation system that are frequented by travelers (i.e., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities, etc). This package collects the images and audio inputs at the secure area and provides the surveillance information to the Emergency Management Subsystem. The equipment package also provides local processing of the video or audio information, providing processed or analyzed results to the Emergency Management Subsystem. This equipment package provides the same functions as the Field Secure Area Surveillance equipment package.	SE-101 Automated Mayday Dispatch
																												■	ARPV-1 Monitoring a Secure Area for Travelers		TP-101 Public Transport Vehicle Internal Systems Monitoring
																												■	ARPV-2 Security of Travelers From a Distance	This equipment package provides the capability to report an emergency or summon assistance from secure areas such as transit stops, transit stations, modal transfer facilities, rest stops and picnic areas, park-and-ride areas, tourism and travel information areas, and emergency pull off areas. This package includes interfaces that support initiation of an alarm and presentation of the returned alarm acknowledgement as well as a broadcast message to advise or warn the traveler.	SE-101 Automated Mayday Dispatch
																												■	ARPV-3 Remote Management of Fare Collection	This on-board equipment package supports fare collection using a standard fare card or other non-monetary fare medium, detects payment violations, and counts passengers as they embark and disembark from the vehicle. It collects data required to determine accurate ridership levels and implement variable and flexible fare structures. Collected passenger and fare data are made available to the center.	PE-101a Electronic Transit Fare Payment (Light Rail). PE-101b Electronic Transit Fare Payment (bus concessions)
																												■	ARPV-4 Remote Management of Traveler Payment	This equipment package provides the capability for the traveler to use a common fare medium for transit fares, tolls, and/or parking lot charges. It accepts a service request and means of payment, verifies eligibility, calculates the amount due, collects payment, and identifies payment problems. This equipment package may be implemented using a traveler card reader in a kiosk that includes a communications interface to the financial infrastructure to support payment collection and reconciliation.	PE-202 Integration of Regional Multi-modal Payment Systems
																												■	ARPV-5 Monitoring Secure Areas for Travelers	This equipment package includes sensors that monitor conditions of secure areas that are frequented by travelers (i.e., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities, etc). The equipment package monitors areas for environmental threats (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors), intrusion and motion, and object detection.	TP-101 Public Transport Vehicle Internal Systems Monitoring
																												■	ARPV-8 Remote Security of Travelers	This equipment package provides the capability to report an emergency or summon assistance from secure areas such as transit stops, transit stations, modal transfer facilities, rest stops and picnic areas, park-and-ride areas, tourism and travel information areas, and emergency pull off areas. This package includes interfaces that support initiation of an alarm and presentation of the returned alarm acknowledgement as well as a broadcast message to advise or warn the traveler.	TP-101 Monitoring of the Internal Systems of the Vehicles of the Public Transport
																												■	ARPV-7 Reception of Interactive Information	This equipment package provides traffic information, road conditions, transit information, yellow pages (traveler services) information, special event information, and other traveler information that is specifically tailored based on the traveler's request and/or previously submitted traveler profile information. The interactive traveler information capability is provided by a public traveler interface, such as a kiosk.	TP-202 Dynamic Ridesharing IV-302 Travel Services Information - Personal Interactive IV-303 Travel Services Information - Dedicated Location

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
SN-101 Vehicle hazmat and explosives monitoring	VACUS system for remote inspection of vehicles. Used at border crossings.	$ 1,580,000	$ 1,580,000	$ 40,000	$ 1,240,000	Total	$ 195,000	$ 31,600,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 45,000	
SN-101 Vehicle hazmat and explosives monitoring	VACUS system for remote inspection of vehicles. Used in mobile applications.	$ 1,260,000	$ 6,300,000	$ -	$ 6,000,000	Total	$ 375,000	$ 6,300,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 225,000	
SN-301 National data collection and sharing	Nationwide vehicle registration database (both commercial and private autos)	$ 246,638	$ 2,592,400	$ 204,000	$ 750,000	Total	$ 883,200	$ 2,592,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 64,000	
SN-301 National data collection and sharing	Nationwide driver registration database	$ 246,638	$ 2,592,400	$ 204,000	$ 750,000	Total	$ 883,200	$ 2,592,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 64,000	
SN-302 National multi-agency cooperation	Establishing a secure and automated network for sharing and privacy	$ 323,225	$ 3,062,400	$ 300,000	$ 724,000	Total	$ 1,039,200	$ 3,062,400
						Staffing	$ 1,000,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 20,000	
SP-101 Silent alarm	Driver initiated silent alarm on public passenger vehciles	$ 126,100	$ 3,106,000	$ 96,000	$ 3,010,000	Total	$ 750,000	$ 46,590,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 750,000	
SP-102 9-1-1/Mayday alert for public transport	Automated messaging to emergency responders if airbags are deployed			Fee based private service				
SP-104 Public transport surveillance	Cameras on vehicles recording information (no real time) - drivers download video when completing shift	$ 90,600	$ 3,334,000	$ 264,000	$ 3,010,000	Total	$ 780,000	$ 50,010,000
						Staffing	$ -	
						Facilities/Utilities	$ 30,000	
						Other M&O	$ 750,000	
SP-202 Systems to monitor public sector fleet vehicles	Mayday systems	$ 90,600	$ 270,000	$ -	$ 210,000	Total	$ 780,000	$ 4,050,000
						Staffing	$ -	
						Facilities/Utilities	$ 30,000	
						Other M&O	$ 750,000	

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
SN-101 Vehicle hazmat and explosives monitoring	VACUS system for remote inspection of vehicles. Used at border crossings.	$ 1,580,000	$ 1,580,000	$ 40,000	$ 1,240,000	Total	$ 195,000	$ 31,600,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 45,000	
SN-101 Vehicle hazmat and explosives monitoring	VACUS system for remote inspection of vehicles. Used in mobile applications.	$ 1,260,000	$ 6,300,000	$ -	$ 6,000,000	Total	$ 375,000	$ 6,300,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 225,000	
SN-301 National data collection and sharing	Nationwide vehicle registration database (both commercial and private autos)	$ 246,638	$ 2,592,400	$ 204,000	$ 750,000	Total	$ 883,200	$ 2,592,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 64,000	
SN-301 National data collection and sharing	Nationwide driver registration database	$ 246,638	$ 2,592,400	$ 204,000	$ 750,000	Total	$ 883,200	$ 2,592,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 64,000	
SN-302 National multi-agency cooperation	Establishing a secure and automated network for sharing and privacy	$ 323,225	$ 3,062,400	$ 300,000	$ 724,000	Total	$ 1,039,200	$ 3,062,400
						Staffing	$ 1,000,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 20,000	
SP-101 Silent alarm	Driver initiated silent alarm on public passenger vehciles	$ 126,100	$ 3,106,000	$ 96,000	$ 3,010,000	Total	$ 750,000	$ 46,590,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 750,000	
SP-102 9-1-1/Mayday alert for public transport	Automated messaging to emergency responders if airbags are deployed			Fee based private service				
SP-104 Public transport surveillance	Cameras on vehicles recording information (no real time) - drivers download video when completing shift	$ 90,600	$ 3,334,000	$ 264,000	$ 3,010,000	Total	$ 780,000	$ 50,010,000
						Staffing	$ -	
						Facilities/Utilities	$ 30,000	
						Other M&O	$ 750,000	
SP-202 Systems to monitor public sector fleet vehicles	Mayday systems	$ 90,600	$ 270,000	$ -	$ 210,000	Total	$ 780,000	$ 4,050,000
						Staffing	$ -	
						Facilities/Utilities	$ 30,000	
						Other M&O	$ 750,000	

APP

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
SP-202 Systems to monitor public sector fleet vehicles	Lane change warning systems	$ 8,000	$ 200,000	$ -	$ 200,000	Total	$ -	$ 3,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
SP-202 Systems to monitor public sector fleet vehicles	Vehicle-based variable speed alerting and limiting systems	$ 8,000	$ 200,000	$ -	$ 200,000	Total	$ -	$ 3,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
SP-401 Intelligent Intersection	Dynamic signing approaching complex intersections to provide safety warnings	$ 320,000	$ 320,000	$ 80,000	$ 240,000	Total	$ 15,000	$ 16,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 15,000	
SE-101 Automated 9-1-1 and Mayday Dispatch	Automated call to 911 if airbags deploy			Fee based private service				
	User initiated Mayday dispatch call			Fee based private service				
SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring	"Lojack " type stolen vehicle location information			Fee based private service				
SE-201 Emergency vehicle fleet tracking	AVL for emergency vehicles	$ 290,563	$ 1,654,000	$ 264,000	$ 610,000	Total	$ 540,000	$ 24,810,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ 240,000	
						Other M&O	$ 150,000	
SE-202 Emergency vehicle – traffic management coordination	Real time travel information in emergency vehicles for better route selection - provided to central system and radioed to vehicles	$ 272,000	$ 272,000	$ 60,000	$ 200,000	Total	$ 12,000	$ 4,080,000
						Staffing	$ -	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 6,000	
SE-301 Hazmat vehicle tracking	AVL for Hazmat vehicles with national real time monitoring of hazmat vehicles and loads	$ 2,560,000	$ 2,560,000	$ 300,000	$ 60,000	Total	$ 1,132,500	$ 2,560,000
						Staffing	$ 1,100,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 32,500	
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Driver initiated mayday notification			Fee based private service				
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated notification when airbags have deployed			Fee based private service				
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated notification when vehicle has detected a rollover			Fee based private service				
SE-303 Hazmat preclearance services	Preclear for hazmat vehicles at border crossings.		$ -		$0	Total	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Staffing	$0	
						Facilities/Utilities	$0	
						Other M&O	$0	
SV-204 Automated Cruise Control	Intelligent cruise control Vehicle platooning on an automated highway			Consumer based COTS system				
SV-301 Longitudinal Collision Avoidance	Intelligent cruise control Vehicle platooning on an automated highway			Consumer based COTS system				
SV-302 Lateral Collision Avoidance	Lane departure warning systems Adjacent vehicle detection systems			Consumer based COTS system				
SV-401 Vehicle Internal Systems Monitoring	Warning systems for all engine components			Consumer based COTS system				
TC-101 Automated Credential Filing	Create a system for automated processing of Commercial vehicle	$ 296,000	$ 920,000	$ 204,000	$ 416,000	Total	$ 235,000	$ 920,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 85,000	
TC-102 Automated Commercial Vehicle Administration	One-stop shopping for all Commercial Vehicle	$ 296,000	$ 920,000	$ 204,000	$ 416,000	Total	$ 235,000	$ 920,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 85,000	
TC-103 Automated Border Crossings	Bypass at border crossings using toll tag technology	$0	$ 1,000,000	$200,000	$500,000	Total	$ 235,000	$20,000,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 85,000	
TC-201 Commercial vehicle fleet tracking	Use of AVL to track locations of fleet and containers			Consumer based COTS system				
TC-202 Commercial vehicle fleet dispatching	Dispatch of carriers based on location of vehicles			Consumer based COTS system				
TC-203 Freight container tracking	Use of AVL to track container location							
	Alerts for cargo shifting/spilling			Consumer based COTS system				
TC-301 Vehicle and container arrival information exchange	Automated information exchange between shippers and carriers			Consumer based COTS system				
	Improved coordination with various modes of transport available to a shipper.			Consumer based COTS system				
TC-302 Customer freight information access (users are customers and shippers)	Customer access to location information in real time.			Consumer based COTS system				
TC-401 Intermodal center facility management	Automated access control	$60,000	$ 458,000	$ 48,000	$ 110,000	Total	$ 177,500	$ 11,450,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 27,500	
TC-402 Intermodal vehicle and container control	AVL to track containers within a facility	$ 620,000	$ 620,000	$ 60,000	$ 60,000	Total	$ 282,500	$ 15,500,000

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Staffing	$ 250,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 32,500	
	System to coordinate shippers and customs within a facility	$ 296,000	$ 616,000	$ 204,000	$ 212,000	Total	$ 134,000	$ 15,400,000
						Staffing	$ 100,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 34,000	
TC-501 Dangerous Goods movement data sharing	Integration of services from all agencies responsible with dangerous goods	$ 323,225	$ 3,062,400	$ 300,000	$ 724,000	Total	$ 1,039,200	$ 3,062,400
						Staffing	$ 1,000,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 20,000	
TC-502 Dangerous Goods movement data registry	Creation of a national Dangerous Goods movement database	$ 230,638	$ 2,080,400	$ 204,000	$ 238,000	Total	$ 859,200	$ 2,080,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 40,000	
TC-503 Dangerous Goods movement fleet coordination	Detection and verification of route deviation	$ 2,560,000	$ 2,560,000	$ 300,000	$ 60,000	Total	$ 1,132,500	$ 2,560,000
						Staffing	$ 1,100,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 32,500	
TC-503 Dangerous Goods movement fleet coordination	Database of authorized drivers	$ 229,700	$ 2,050,400	$ 204,000	$ 208,000	Total	$ 864,200	$ 2,050,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 45,000	
TC-504 Dangerous Goods movement police / safety coordination	Automated sharing of goods information with local law enforcement when there is an incident (enhancement to TC-503)	$ 48,000	$ 48,000	$ 24,000	$ 24,000	Total	$ -	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
TC-601 Remote access to commercial vehicle safety data	Automation of vehicle and container records	$ 231,500	$ 2,054,000	$ 204,000	$ 208,000	Total	$ 866,000	$ 2,054,000
						Staffing	$ 800,000	
						Facilities/Utilities	$ 21,000	
						Other M&O	$ 45,000	
TC-601 Remote access to commercial vehicle safety data	Automate sharing of records with local law enforcement (assuming TC-601 is in place)	$ 48,000	$ 48,000	$ 24,000	$ 24,000	Total	$ -	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
TC-602 Monitoring Vehicle Loads	Virtual Weigh Station	$ 700,000	$ 700,000.00	$ 50,000	$ 650,000	Total	$ 182,500	$ 14,000,000
						Staffing	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Facilities/Utilities	$ -	
						Other M&O	$ 182,500	
TC-701 Commercial vehicle internal systems monitoring	Monitoring of all relevant systems throughout a commercial vehicle			Consumer based COTS system				
TC-702 Commercial vehicle driver alertness monitoring	Automated driver alertness monitoring			Consumer based COTS system				
TC-702 Commercial vehicle driver alertness monitoring	Lane departure warning systems			Consumer based COTS system				
PE-101 Electronic transit fare payment	Use of smart cards for all public transit payments (fixed rail)	$ 5,750,000	$ 5,750,000	$ -	$ 2,750,000	Total	$ 2,187,500	$ 86,250,000
						Staffing	$ 1,500,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 687,500	
PE-101 Electronic transit fare payment	Use of smart cards for all public transit payments (Bus)	$ 8,500,000	$ 8,500,000	$ -	$ 2,500,000	Total	$ 3,625,000	$ 127,500,000
						Staffing	$ 3,000,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 625,000	
PE-102 Electronic toll collection	Use of a single standard throughout all of Mexico No costs developed at this time.					Total		
						Staffing		
						Facilities/Utilities		
						Other M&O		
PE-103 Electronic parking payment	Use of toll tags to pay for parking	$ 71,200	$ 71,200	$ 60,000	$ 10,000	Total	$ 5,600	$ 7,120,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O	$ 5,000	
PE-202 Integration of regional multi-modal payment systems	Allow smart cards to be used on all modes of public transit.	$ 541,200	$ 541,200	$ 240,000	$ 300,000	Total	$ 600	$ 10,824,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O		
GOT-101 Traffic Monitoring	Deployment of sensors along routes	$ 5,608,000	$ 104,992,000	$ 192,000	$ 103,200,000	Total	$ 11,120,000	$ 2,099,840,000
						Staffing	$ 800,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 10,320,000	
GOT-101 Traffic Monitoring	Deployment of cameras at strategic locations	$ 5,612,000	$ 105,648,000	$ 48,000	$ 104,000,000	Total	$ 11,200,000	$ 2,112,960,000
						Staffing	$ 800,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 10,400,000	
GOT-101 Traffic Monitoring	Monitoring of ETC users travel times for non-enforcement purposes	$ 685,000	$ 685,000	$ 300,000	$ 385,000	Total	$ 16,250	$ 27,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 16,250	
GOT-102 Surface Street Control	Advanced signal control systems	$ 270,000	$ 270,000	$ 100,000	$ 150,000	Total	$ 10,000	$ 54,000,000
						Staffing	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Facilities/Utilities	$ -	
						Other M&O	$ 10,000	
GOT-102 Surface Street Control	Lane control along directional routes	$ 1,641,200	$ 1,641,200	$ 140,000	$ 1,500,000	Total	$ 60,600	$ 82,060,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O	$ 60,000	
GOT-102 Surface Street Control	Incident diversion routing	$ 116,200	$ 116,200	$ 60,000	$ 55,000	Total	$ 19,350	$ 2,324,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O	$ 18,750	
GOT-103 Freeway Control	Deployment of lane control systems	$ 1,641,200	$ 1,641,200	$ 140,000	$ 1,500,000	Total	$ 73,100	$ 82,060,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O	$ 72,500	
GOT-103 Freeway Control	Dynamic speed limits	$ 1,841,200	$ 1,841,200	$ 140,000	$ 1,700,000	Total	$ 123,100	$ 36,824,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O	$ 122,500	
GOT-104 Preferential Treatment for Traffic Control (Signal Priority)	Emergency vehicle signal pre-emption in urban areas	$100,000	$ 130,000	$ 30,000	$ 100,000	Total	$ 10,000	$ 130,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 10,000	
GOT-105 Reversible Lane Management	Automated reversible lanes on federal rural routes	$ 954,000	$ 954,000	$ 204,000	$ 250,000	Total	$ 250,000	
						Staffing	$ 160,000	
						Facilities/Utilities	$ 50,000	
						Other M&O	$ 40,000	
GOT-105 Reversible Lane Management	Automated reversible lanes on arterials in urban areas	$ 754,000	$ 754,000	$ 204,000	$ 120,000	Total	$ 215,000	
						Staffing	$ 160,000	
						Facilities/Utilities	$ 30,000	
						Other M&O	$ 25,000	
GOT-106 Traffic Information Dissemination	Deployment and use of DMS for incident and congestion information	$ 209,600	$ 209,600	$ 9,600	$ 200,000	Total	$ 10,000	$ 125,760,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 10,000	
GOT-106 Traffic Information Dissemination	Deployment and use of HAR for incident and congestion information	$ 34,600	$ 34,600	$ 9,600	$ 25,000	Total	$ -	$ 11,072,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
GOT-107 Coordination of Surface Street and Freeway Control	Ramp closure gates for incidents	$ 10,000	$ 10,000	$ 5,000	$ 5,000	Total	$ 1,000	$ 6,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 1,000	
GOT-107 Coordination of Surface Street and Freeway Control	Dynamic travel time or congestion information approaching freeway entrances	$ 300,000	$ 300,000	$ 96,000	$ 204,000	Total	$ -	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GOT-107 Coordination of Surface Street and Freeway Control	Signal timing alternatives for detours of freeway incident traffic	$ 24,000	$ 24,000	$ 24,000	$ -	Total	$ -	$ 7,200,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GOT-108 Intermodal-Highway Junction Management	Train approaching warnings for roadways	$ 104,000	$ 104,000	$ 84,000	$ 20,000	Total	$ 2,000	$ 10,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 2,000	
GOT-108 Intermodal-Highway Junction Management	Estimate train crossing delays for roadways	$ 254,000	$ 254,000	$ 144,000	$ 110,000	Total	$ 11,000	$ 25,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 11,000	
GOT-108 Intermodal-Highway Junction Management	Train warning systems on selected vehicles (e.g., fire trucks, school busses)	$ 164,000	$ 164,000	$ 84,000	$ 80,000	Total	$ 8,000	$ 16,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 8,000	
GOT-109 Parking Management	Dynamic messaging on space availability	$ 82,000	$ 82,000	$ 12,000	$ 70,000	Total	$ 17,000	$ 8,200,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 17,000	
GOT-110 Work Zone Traffic Management	Use of portable DMS to inform travelers approaching a work zone of current lane configuration	$ 100,000	$ 100,000	$ -	$ 100,000	Total	$ 20,000	$ 2,000,000

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs			Full Deployment Costs
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	20,000	
	Portable barrier wall to provide reversible lane configuration	$ 120,000	$ 120,000	$ -	$ 100,000	Total	$	10,000	$ 2,400,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O		#REF!	
	Use of portable DMS to inform travelers	$ 50,000	$ 50,000	$ -	$50,000	Total	$	10,000	$ 1,000,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	10,000	
GOT-201 Variable road pricing	Discounted tolls for commercial vehicles off peak - no costs developed at this time			$ -					
GOT-202 Access management	Restricted areas around historic sites where access is limited to vehicles paying a premium	$ 2,320,000	$ 2,320,000	$ 320,000	$ 1,000,000	Total	$	600,000	$ 11,600,000
						Staffing	$	500,000	
						Facilities/Utilities	$	-	
						Other M&O	$	100,000	
GOT-204 Air Quality-based transport management	Restricted access to areas based on air quality and access granted by electronic tag	$ 2,260,000	$ 2,260,000	$ 260,000	$ 1,000,000	Total	$	600,000	$ 11,300,000
						Staffing	$	500,000	
						Facilities/Utilities	$	-	
						Other M&O	$	100,000	
GOT-204 Air Quality-based transport management	Roadside emissions testing	$ 40,000	$ 40,000		$ 40,000	Total	$	9,000	$ 4,000,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	9,000	
GOT-301 Roadway Construction and Maintenance Management	Use lane rental on construction projects tied with real time monitoring	$ 144,000	$ 144,000	$ 84,000	$ 60,000	Total	$	-	$ -
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	-	
GOT-303 Pavement Management	Create a pavement management and tracking system for use in planning and programming of projects	$ 84,000	$ 84,000	$ 24,000	$ 60,000	Total	$	-	
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	-	
GOT-304 Bridge Management	Create a bridge management and tracking system for use in planning and programming of projects	$ 84,000	$ 84,000	$ 24,000	$ 60,000	Total		#REF!	
						Staffing	$	-	
						Facilities/Utilities	$	-	

API[illegible]

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
GOT-305 Automated Road Management	Integration of various asset management systems with maintenance management systems	$ 144,000	$ 144,000	$ 60,000	$ 60,000	Total	$ 12,000	
						Staffing	$ -	
						Facilities/Utilities	$ 12,000	
						Other M&O	$ -	
GOT-306 Work Zone Safety Management	Provide information on maintenance and lane closure activities to the media	$ 168,000	$ 168,000	$ 84,000	$ 60,000	Total	$ 12,000	
						Staffing	$ -	
						Facilities/Utilities	$ 12,000	
						Other M&O	$ -	
GOT-307 Utility and Infrastructure Management?	Provide database for all communications infrastructure	$ 65,000	$ 65,000	$ -	$ 65,000	Total	$ 5,000	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 5,000	
	Provide asset management tool for all ITS equipment	$ 65,000	$ 65,000	$ -	$ 65,000	Total	$ 5,000	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 5,000	
GOT-401 Incident On-Site Motorist Assistance	Green Angels Service patrols in urban areas	$ 1,750,000	$ 31,588,800	$ 300,000	$ 3,100,000	Total	$ 14,719,400	$ 157,944,000
						Staffing	$ 13,894,400	
						Facilities/Utilities	$200,000	
						Other M&O	$ 625,000	
	Increased training for local police and other staff in motorist aid	$ 7,000	$ 217,000	$ -	$ 217,000	Total	$ -	$ 6,510,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GOT-402 Incident On-Site Traffic Management	Portable DMS to manage traffic at an incident	$ 25,000	$ 25,000	$ -	$25,000	Total	$ 2,500	$ 2,500,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 2,500	
	Increased training for local police in incident management	$ 7,000	$ 217,000	$ -	$ 217,000	Total	$ -	$ 6,510,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
	Incident command vehicle	$ 330,000	$ 330,000	$ -	$300,000	Total	$ 25,000	$ 1,650,000
						Staffing	$ -	
						Facilities/Utilities	$ 15,000	
						Other M&O	$10,000	
GOT-403 Incident and Event Coordination	Integration of response agency dispatch computers	$268,600	$ 514,000	$ 108,000	$ 400,000	Total	$ 28,000	
						Staffing	$ -	
						Facilities/Utilities	$ 3,000	
						Other M&O	$ 25,000	
	Increased training for responding agencies to improve coordination	$ 217,000	$ 217,000	$ -	$ 217,000	Total	$ -	$ 6,510,000
						Staffing	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs			Full Deployment Costs
						Facilities/Utilities	$	-	
						Other M&O	$	-	
GOT-404 Hazardous Materials Monitoring and Management	Real time sharing of information on hazardous materials with the local emergency responders	$10,000	$ 192,000	$ -	$ 186,000	Total	$	49,500	
						Staffing	$	-	
						Facilities/Utilities	$	3,000	
						Other M&O	$	46,500	
GI-201 Disaster Response Planning for Transport Network	Sharing of response plans with all affected agencies		$ -	$ -	$ -	Total	$	-	
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	-	
GI-301 Disaster Response Coordination	Communications technology to aid in the coordinated response	$ 1,108,000	$ 1,108,000	$ 108,000	$ 1,000,000	Total	$	125,000	$ 5,540,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	125,000	
MA-101 Road Weather Information Monitoring	Deploying weather stations and pavement condition systems	$ 40,000	$ 40,000		$ 40,000	Total	$	9,000	$ 4,000,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	9,000	
	Fog warning detection systems	$ 90,000	$ 90,000		$ 90,000	Total	$	14,000	$ 450,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	14,000	
MA-201 Water Level /Tidal Monitoring and Prediction	Water level monitoring at critical locations	$ 90,000	$ 90,000		$ 90,000	Total	$	14,000	$ 450,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	14,000	
MA-203 Pollution Monitoring	Monitoring of air quality integrated with traffic management centers	$ 72,000	$ 72,000	$ 24,000	$ 48,000	Total	$	-	$ 1,440,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	-	
TP-101 Public Transport Vehicle Internal Systems	Automated monitoring of all internal mechanicals and electronics			Consumer based COTS system					
TP-102 Public Transport Vehicle Fleet Tracking	AVL for transit vehicles			Consumer based COTS system					

APP

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
TP-201 Paratransit Fleet Dispatch	Automated receipt of requests	$ 888,000	$ 888,000	$ 60,000	$ 116,000	Total	$ 395,000	$ 17,760,000
						Staffing	$ 350,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 39,000	
	Automated dispatch of nearest vehicle	$137,000	$ 5,912,000	$ -	$ 5,200,000	Total	$ 1,681,000	$ 118,240,000
						Staffing	$ 350,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 1,325,000	
TP-2-202 Dynamic Ridesharing	Dynamic routing of paratransit to allow for en-route changes to add riders	$ 384,000	$ 384,000	$ 144,000	$ 240,000	Total	$ -	$ 7,680,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
IV-101 Pre-Trip Information – Traffic and Roadway	Real time congestion information on major roads by internet, TV, media	$ 810,000	$ 810,000	$ 108,000	$ 230,000	Total	$ 273,500	$ 16,200,000
						Staffing	$ 230,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 37,500	
IV-102 Pre-Trip Information – Public Transport (bus and rail)	Schedule adherence information by internet, TV, media	$ 192,000	$ 192,000	$ 60,000	$ 120,000	Total	$ 6,000	
						Staffing	$ -	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ -	
	Schedules and routes available by internet, phone	$ 350,000	$ 350,000	$ 108,000	$ 230,000	Total	$ 23,500	$ 7,000,000
						Staffing	$ -	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 17,500	
IV-201 On-Trip Information – Roadside	DMS with real time incident messages	$ 120,000	$ 120,000	$ 48,000	$ 72,000	Total	$ -	$ 2,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
	HAR with real time congestion information	$ 228,000	$ 228,000	$ 48,000	$ 180,000	Total	$ -	$ 4,560,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
IV-203 On-Trip Information – Public transport vehicle	Scrolling electronic banner on bus with stop/location information	$70,000	$ 1,050,000	$ 50,000	$ 1,000,000	Total	$ 5,000	$ 25,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 5,000	
IV-205 On-Trip Information through mobile devices	Messages sent to pagers with real time incident information on chosen route			Fee based consumer service				
IV-205 On-Trip Information through mobile devices	Ability to download real time congestion maps over mobile phone			Fee based consumer service				
IV-302 Travel Services Information – Personal interactive	Downloads from mobile phones for local restaurants			Fee based consumer service				

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
IV-303 Travel Services Information – Dedicated location	Broadcast information for service areas on low power HAR	$ 34,600	$ 34,600	$ 9,600	$ 25,000	Total	$ 1,250	$ 1,730,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 1,250	
IV 601 - Public Transit Fleet Data for Planning Purposes	Provide automated rider counting systems linked to a central database	$ 773,000	$ 30,572,000	$ -	$ 30,100,000	Total	$ 266,000	
						Staffing	$ 230,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 30,000	
								$ 5,786,212,400

APP

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
SP-202 Systems to monitor public sector fleet vehicles	Lane change warning systems	$ 8,000	$ 200,000	$ -	$ 200,000	Total	$ -	$ 3,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
SP-202 Systems to monitor public sector fleet vehicles	Vehicle-based variable speed alerting and limiting systems	$ 8,000	$ 200,000	$ -	$ 200,000	Total	$ -	$ 3,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
SP-401 Intelligent Intersection	Dynamic signing approaching complex intersections to provide safety warnings	$ 320,000	$ 320,000	$ 80,000	$ 240,000	Total	$ 15,000	$ 16,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 15,000	
SE-101 Automated 9-1-1 and Mayday Dispatch	Automated call to 911 if airbags deploy			Fee based private service				
	User initiated Mayday dispatch call			Fee based private service				
SE-102 Automated Vehicle Intrusion and Stolen Vehicle Monitoring	"Lojack " type stolen vehicle location information			Fee based private service				
SE-201 Emergency vehicle fleet tracking	AVL for emergency vehicles	$ 290,563	$ 1,654,000	$ 264,000	$ 610,000	Total	$ 540,000	$ 24,810,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ 240,000	
						Other M&O	$ 150,000	
SE-202 Emergency vehicle – traffic management coordination	Real time travel information in emergency vehicles for better route selection - provided to central system and radioed to vehicles	$ 272,000	$ 272,000	$ 60,000	$ 200,000	Total	$ 12,000	$ 4,080,000
						Staffing	$ -	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 6,000	
SE-301 Hazmat vehicle tracking	AVL for Hazmat vehicles with national real time monitoring of hazmat vehicles and loads	$ 2,560,000	$ 2,560,000	$ 300,000	$ 60,000	Total	$ 1,132,500	$ 2,560,000
						Staffing	$ 1,100,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 32,500	
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Driver initiated mayday notification			Fee based private service				
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated notification when airbags have deployed			Fee based private service				
SE-302 Automated Hazmat 9-1-1 / Mayday Notification	Automated notification when vehicle has detected a rollover			Fee based private service				
SE-303 Hazmat preclearance services	Preclear for hazmat vehicles at border crossings.		$ -		$0	Total	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Staffing	$0	
						Facilities/Utilities	$0	
						Other M&O	$0	
SV-204 Automated Cruise Control	Intelligent cruise control Vehicle platooning on an automated highway			Consumer based COTS system				
SV-301 Longitudinal Collision Avoidance	Intelligent cruise control Vehicle platooning on an automated highway			Consumer based COTS system				
SV-302 Lateral Collision Avoidance	Lane departure warning systems Adjacent vehicle detection systems			Consumer based COTS system				
SV-401 Vehicle Internal Systems Monitoring	Warning systems for all engine components			Consumer based COTS system				
TC-101 Automated Credential Filing	Create a system for automated processing of Commercial vehicle	$ 296,000	$ 920,000	$ 204,000	$ 416,000	Total	$ 235,000	$ 920,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 85,000	
TC-102 Automated Commercial Vehicle Administration	One-stop shopping for all Commercial Vehicle	$ 296,000	$ 920,000	$ 204,000	$ 416,000	Total	$ 235,000	$ 920,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 85,000	
TC-103 Automated Border Crossings	Bypass at border crossings using toll tag technology	$0	$ 1,000,000	$200,000	$500,000	Total	$ 235,000	$20,000,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 85,000	
TC-201 Commercial vehicle fleet tracking	Use of AVL to track locations of fleet and containers			Consumer based COTS system				
TC-202 Commercial vehicle fleet dispatching	Dispatch of carriers based on location of vehicles			Consumer based COTS system				
TC-203 Freight container tracking	Use of AVL to track container location							
	Alerts for cargo shifting/spilling			Consumer based COTS system				
TC-301 Vehicle and container arrival information exchange	Automated information exchange between shippers and carriers			Consumer based COTS system				
	Improved coordination with various modes of transport available to a shipper.			Consumer based COTS system				
TC-302 Customer freight information access (users are customers and shippers)	Customer access to location information in real time.			Consumer based COTS system				
TC-401 Intermodal center facility management	Automated access control	$60,000	$ 458,000	$ 48,000	$ 110,000	Total	$ 177,500	$ 11,450,000
						Staffing	$ 150,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 27,500	
TC-402 Intermodal vehicle and container control	AVL to track containers within a facility	$ 620,000	$ 620,000	$ 60,000	$ 60,000	Total	$ 282,500	$ 15,500,000

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Staffing	$ 250,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 32,500	
	System to coordinate shippers and customs within a facility	$ 296,000	$ 616,000	$ 204,000	$ 212,000	Total	$ 134,000	$ 15,400,000
						Staffing	$ 100,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 34,000	
TC-501 Dangerous Goods movement data sharing	Integration of services from all agencies responsible with dangerous goods	$ 323,225	$ 3,062,400	$ 300,000	$ 724,000	Total	$ 1,039,200	$ 3,062,400
						Staffing	$ 1,000,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 20,000	
TC-502 Dangerous Goods movement data registry	Creation of a national Dangerous Goods movement database	$ 230,638	$ 2,080,400	$ 204,000	$ 238,000	Total	$ 859,200	$ 2,080,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 40,000	
TC-503 Dangerous Goods movement fleet coordination	Detection and verification of route deviation	$ 2,560,000	$ 2,560,000	$ 300,000	$ 60,000	Total	$ 1,132,500	$ 2,560,000
						Staffing	$ 1,100,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 32,500	
TC-503 Dangerous Goods movement fleet coordination	Database of authorized drivers	$ 229,700	$ 2,050,400	$ 204,000	$ 208,000	Total	$ 864,200	$ 2,050,400
						Staffing	$ 800,000	
						Facilities/Utilities	$ 19,200	
						Other M&O	$ 45,000	
TC-504 Dangerous Goods movement police / safety coordination	Automated sharing of goods information with local law enforcement when there is an incident (enhancement to TC-503)	$ 48,000	$ 48,000	$ 24,000	$ 24,000	Total	$ -	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
TC-601 Remote access to commercial vehicle safety data	Automation of vehicle and container records	$ 231,500	$ 2,054,000	$ 204,000	$ 208,000	Total	$ 866,000	$ 2,054,000
						Staffing	$ 800,000	
						Facilities/Utilities	$ 21,000	
						Other M&O	$ 45,000	
TC-601 Remote access to commercial vehicle safety data	Automate sharing of records with local law enforcement (assuming TC-601 is in place)	$ 48,000	$ 48,000	$ 24,000	$ 24,000	Total	$ -	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
TC-602 Monitoring Vehicle Loads	Virtual Weigh Station	$ 700,000	$ 700,000.00	$ 50,000	$ 650,000	Total	$ 182,500	$ 14,000,000
						Staffing	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Facilities/Utilities	$ -	
						Other M&O	$ 182,500	
TC-701 Commercial vehicle internal systems monitoring	Monitoring of all relevant systems throughout a commercial vehicle			Consumer based COTS system				
TC-702 Commercial vehicle driver alertness monitoring	Automated driver alertness monitoring			Consumer based COTS system				
TC-702 Commercial vehicle driver alertness monitoring	Lane departure warning systems			Consumer based COTS system				
PE-101 Electronic transit fare payment	Use of smart cards for all public transit payments (fixed rail)	$ 5,750,000	$ 5,750,000	$ -	$ 2,750,000	Total	$ 2,187,500	$ 86,250,000
						Staffing	$ 1,500,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 687,500	
PE-101 Electronic transit fare payment	Use of smart cards for all public transit payments (Bus)	$ 8,500,000	$ 8,500,000	$ -	$ 2,500,000	Total	$ 3,625,000	$ 127,500,000
						Staffing	$ 3,000,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 625,000	
PE-102 Electronic toll collection	Use of a single standard throughout all of Mexico No costs developed at this time.					Total		
						Staffing		
						Facilities/Utilities		
						Other M&O		
PE-103 Electronic parking payment	Use of toll tags to pay for parking	$ 71,200	$ 71,200	$ 60,000	$ 10,000	Total	$ 5,600	$ 7,120,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O	$ 5,000	
PE-202 Integration of regional multi-modal payment systems	Allow smart cards to be used on all modes of public transit.	$ 541,200	$ 541,200	$ 240,000	$ 300,000	Total	$ 600	$ 10,824,000
						Staffing	$ -	
						Facilities/Utilities	$ 600	
						Other M&O		
GOT-101 Traffic Monitoring	Deployment of sensors along routes	$ 5,608,000	$ 104,992,000	$ 192,000	$ 103,200,000	Total	$ 11,120,000	$ 2,099,840,000
						Staffing	$ 800,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 10,320,000	
GOT-101 Traffic Monitoring	Deployment of cameras at strategic locations	$ 5,612,000	$ 105,648,000	$ 48,000	$ 104,000,000	Total	$ 11,200,000	$ 2,112,960,000
						Staffing	$ 800,000	
						Facilities/Utilities	$ -	
						Other M&O	$ 10,400,000	
GOT-101 Traffic Monitoring	Monitoring of ETC users travel times for non-enforcement purposes	$ 685,000	$ 685,000	$ 300,000	$ 385,000	Total	$ 16,250	$ 27,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 16,250	
GOT-102 Surface Street Control	Advanced signal control systems	$ 270,000	$ 270,000	$ 100,000	$ 150,000	Total	$ 10,000	$ 54,000,000
						Staffing	$ -	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs			Full Deployment Costs
						Facilities/Utilities	$	-	
						Other M&O	$	10,000	
GOT-102 Surface Street Control	Lane control along directional routes	$ 1,641,200	$ 1,641,200	$ 140,000	$ 1,500,000	Total	$	60,600	$ 82,060,000
						Staffing	$	-	
						Facilities/Utilities	$	600	
						Other M&O	$	60,000	
GOT-102 Surface Street Control	Incident diversion routing	$ 116,200	$ 116,200	$ 60,000	$ 55,000	Total	$	19,350	$ 2,324,000
						Staffing	$	-	
						Facilities/Utilities	$	600	
						Other M&O	$	18,750	
GOT-103 Freeway Control	Deployment of lane control systems	$ 1,641,200	$ 1,641,200	$ 140,000	$ 1,500,000	Total	$	73,100	$ 82,060,000
						Staffing	$	-	
						Facilities/Utilities	$	600	
						Other M&O	$	72,500	
GOT-103 Freeway Control	Dynamic speed limits	$ 1,841,200	$ 1,841,200	$ 140,000	$ 1,700,000	Total	$	123,100	$ 36,824,000
						Staffing	$	-	
						Facilities/Utilities	$	600	
						Other M&O	$	122,500	
GOT-104 Preferential Treatment for Traffic Control (Signal Priority)	Emergency vehicle signal pre-emption in urban areas	$100,000	$ 130,000	$ 30,000	$ 100,000	Total	$	10,000	$ 130,000,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	10,000	
GOT-105 Reversible Lane Management	Automated reversible lanes on federal rural routes	$ 954,000	$ 954,000	$ 204,000	$ 250,000	Total	$	250,000	
						Staffing	$	160,000	
						Facilities/Utilities	$	50,000	
						Other M&O	$	40,000	
GOT-105 Reversible Lane Management	Automated reversible lanes on arterials in urban areas	$ 754,000	$ 754,000	$ 204,000	$ 120,000	Total	$	215,000	
						Staffing	$	160,000	
						Facilities/Utilities	$	30,000	
						Other M&O	$	25,000	
GOT-106 Traffic Information Dissemination	Deployment and use of DMS for incident and congestion information	$ 209,600	$ 209,600	$ 9,600	$ 200,000	Total	$	10,000	$ 125,760,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	10,000	
GOT-106 Traffic Information Dissemination	Deployment and use of HAR for incident and congestion information	$ 34,600	$ 34,600	$ 9,600	$ 25,000	Total	$	-	$ 11,072,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	-	

APP

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
GOT-107 Coordination of Surface Street and Freeway Control	Ramp closure gates for incidents	$ 10,000	$ 10,000	$ 5,000	$ 5,000	Total	$ 1,000	$ 6,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 1,000	
GOT-107 Coordination of Surface Street and Freeway Control	Dynamic travel time or congestion information approaching freeway entrances	$ 300,000	$ 300,000	$ 96,000	$ 204,000	Total	$ -	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GOT-107 Coordination of Surface Street and Freeway Control	Signal timing alternatives for detours of freeway incident traffic	$ 24,000	$ 24,000	$ 24,000	$ -	Total	$ -	$ 7,200,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GOT-108 Intermodal-Highway Junction Management	Train approaching warnings for roadways	$ 104,000	$ 104,000	$ 84,000	$ 20,000	Total	$ 2,000	$ 10,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 2,000	
GOT-108 Intermodal-Highway Junction Management	Estimate train crossing delays for roadways	$ 254,000	$ 254,000	$ 144,000	$ 110,000	Total	$ 11,000	$ 25,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 11,000	
GOT-108 Intermodal-Highway Junction Management	Train warning systems on selected vehicles (e.g., fire trucks, school busses)	$ 164,000	$ 164,000	$ 84,000	$ 80,000	Total	$ 8,000	$ 16,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 8,000	
GOT-109 Parking Management	Dynamic messaging on space availability	$ 82,000	$ 82,000	$ 12,000	$ 70,000	Total	$ 17,000	$ 8,200,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 17,000	
GOT-110 Work Zone Traffic Management	Use of portable DMS to inform travelers approaching a work zone of current lane configuration	$ 100,000	$ 100,000	$ -	$ 100,000	Total	$ 20,000	$ 2,000,000

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs			Full Deployment Costs
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	20,000	
	Portable barrier wall to provide reversible lane configuration	$ 120,000	$ 120,000	$ -	$ 100,000	Total	$	10,000	$ 2,400,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O		#REF!	
	Use of portable DMS to inform travelers	$ 50,000	$ 50,000	$ -	$50,000	Total	$	10,000	$ 1,000,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	10,000	
GOT-201 Variable road pricing	Discounted tolls for commercial vehicles off peak - no costs developed at this time			$ -					
GOT-202 Access management	Restricted areas around historic sites where access is limited to vehicles paying a premium	$ 2,320,000	$ 2,320,000	$ 320,000	$ 1,000,000	Total	$	600,000	$ 11,600,000
						Staffing	$	500,000	
						Facilities/Utilities	$	-	
						Other M&O	$	100,000	
GOT-204 Air Quality-based transport management	Restricted access to areas based on air quality and access granted by electronic tag	$ 2,260,000	$ 2,260,000	$ 260,000	$ 1,000,000	Total	$	600,000	$ 11,300,000
						Staffing	$	500,000	
						Facilities/Utilities	$	-	
						Other M&O	$	100,000	
GOT-204 Air Quality-based transport management	Roadside emissions testing	$ 40,000	$ 40,000		$ 40,000	Total	$	9,000	$ 4,000,000
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	9,000	
GOT-301 Roadway Construction and Maintenance Management	Use lane rental on construction projects tied with real time monitoring	$ 144,000	$ 144,000	$ 84,000	$ 60,000	Total	$	-	$ -
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	-	
GOT-303 Pavement Management	Create a pavement management and tracking system for use in planning and programming of projects	$ 84,000	$ 84,000	$ 24,000	$ 60,000	Total	$	-	
						Staffing	$	-	
						Facilities/Utilities	$	-	
						Other M&O	$	-	
GOT-304 Bridge Management	Create a bridge management and tracking system for use in planning and programming of projects	$ 84,000	$ 84,000	$ 24,000	$ 60,000	Total		#REF!	
						Staffing	$	-	
						Facilities/Utilities	$	-	

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
GOT-305 Automated Road Management	Integration of various asset management systems with maintenance management systems	$ 144,000	$ 144,000	$ 60,000	$ 60,000	Total	$ 12,000	
						Staffing	$ -	
						Facilities/Utilities	$ 12,000	
						Other M&O	$ -	
GOT-306 Work Zone Safety Management	Provide information on maintenance and lane closure activities to the media	$ 168,000	$ 168,000	$ 84,000	$ 60,000	Total	$ 12,000	
						Staffing	$ -	
						Facilities/Utilities	$ 12,000	
						Other M&O	$ -	
GOT-307 Utility and Infrastructure Management?	Provide database for all communications infrastructure	$ 65,000	$ 65,000	$ -	$ 65,000	Total	$ 5,000	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 5,000	
	Provide asset management tool for all ITS equipment	$ 65,000	$ 65,000	$ -	$ 65,000	Total	$ 5,000	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 5,000	
GOT-401 Incident On-Site Motorist Assistance	Green Angels Service patrols in urban areas	$ 1,750,000	$ 31,588,800	$ 300,000	$ 3,100,000	Total	$ 14,719,400	$ 157,944,000
						Staffing	$ 13,894,400	
						Facilities/Utilities	$200,000	
						Other M&O	$ 625,000	
	Increased training for local police and other staff in motorist aid	$ 7,000	$ 217,000	$ -	$ 217,000	Total	$ -	$ 6,510,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GOT-402 Incident On-Site Traffic Management	Portable DMS to manage traffic at an incident	$ 25,000	$ 25,000	$ -	$25,000	Total	$ 2,500	$ 2,500,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 2,500	
	Increased training for local police in incident management	$ 7,000	$ 217,000	$ -	$ 217,000	Total	$ -	$ 6,510,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
	Incident command vehicle	$ 330,000	$ 330,000	$ -	$300,000	Total	$ 25,000	$ 1,650,000
						Staffing	$ -	
						Facilities/Utilities	$ 15,000	
						Other M&O	$10,000	
GOT-403 Incident and Event Coordination	Integration of response agency dispatch computers	$268,600	$ 514,000	$ 108,000	$ 400,000	Total	$ 28,000	
						Staffing	$ -	
						Facilities/Utilities	$ 3,000	
						Other M&O	$ 25,000	
	Increased training for responding agencies to improve coordination	$ 217,000	$ 217,000	$ -	$ 217,000	Total	$ -	$ 6,510,000
						Staffing	$ -	

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GOT-404 Hazardous Materials Monitoring and Management	Real time sharing of information on hazardous materials with the local emergency responders	$10,000	$ 192,000	$ -	$ 186,000	Total	$ 49,500	
						Staffing	$ -	
						Facilities/Utilities	$ 3,000	
						Other M&O	$ 46,500	
GI-201 Disaster Response Planning for Transport Network	Sharing of response plans with all affected agencies		$ -	$ -	$ -	Total	$ -	
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
GI-301 Disaster Response Coordination	Communications technology to aid in the coordinated response	$ 1,108,000	$ 1,108,000	$ 108,000	$ 1,000,000	Total	$ 125,000	$ 5,540,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 125,000	
MA-101 Road Weather Information Monitoring	Deploying weather stations and pavement condition systems	$ 40,000	$ 40,000		$ 40,000	Total	$ 9,000	$ 4,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 9,000	
	Fog warning detection systems	$ 90,000	$ 90,000		$ 90,000	Total	$ 14,000	$ 450,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 14,000	
MA-201 Water Level /Tidal Monitoring and Prediction	Water level monitoring at critical locations	$ 90,000	$ 90,000		$ 90,000	Total	$ 14,000	$ 450,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 14,000	
MA-203 Pollution Monitoring	Monitoring of air quality integrated with traffic management centers	$ 72,000	$ 72,000	$ 24,000	$ 48,000	Total	$ -	$ 1,440,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
TP-101 Public Transport Vehicle Internal Systems	Automated monitoring of all internal mechanicals and electronics			Consumer based COTS system				
TP-102 Public Transport Vehicle Fleet Tracking	AVL for transit vehicles			Consumer based COTS system				

APP

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
TP-201 Paratransit Fleet Dispatch	Automated receipt of requests	$ 888,000	$ 888,000	$ 60,000	$ 116,000	Total	$ 395,000	$ 17,760,000
						Staffing	$ 350,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 39,000	
	Automated dispatch of nearest vehicle	$137,000	$ 5,912,000	$ -	$ 5,200,000	Total	$ 1,681,000	$ 118,240,000
						Staffing	$ 350,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 1,325,000	
TP-2-202 Dynamic Ridesharing	Dynamic routing of paratransit to allow for en-route changes to add riders	$ 384,000	$ 384,000	$ 144,000	$ 240,000	Total	$ -	$ 7,680,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
IV-101 Pre-Trip Information – Traffic and Roadway	Real time congestion information on major roads by internet, TV, media	$ 810,000	$ 810,000	$ 108,000	$ 230,000	Total	$ 273,500	$ 16,200,000
						Staffing	$ 230,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 37,500	
IV-102 Pre-Trip Information – Public Transport (bus and rail)	Schedule adherence information by internet, TV, media	$ 192,000	$ 192,000	$ 60,000	$ 120,000	Total	$ 6,000	
						Staffing	$ -	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ -	
	Schedules and routes available by internet, phone	$ 350,000	$ 350,000	$ 108,000	$ 230,000	Total	$ 23,500	$ 7,000,000
						Staffing	$ -	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 17,500	
IV-201 On-Trip Information – Roadside	DMS with real time incident messages	$ 120,000	$ 120,000	$ 48,000	$ 72,000	Total	$ -	$ 2,400,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
	HAR with real time congestion information	$ 228,000	$ 228,000	$ 48,000	$ 180,000	Total	$ -	$ 4,560,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ -	
IV-203 On-Trip Information – Public transport vehicle	Scrolling electronic banner on bus with stop/location information	$70,000	$ 1,050,000	$ 50,000	$ 1,000,000	Total	$ 5,000	$ 25,000,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 5,000	
IV-205 On-Trip Information through mobile devices	Messages sent to pagers with real time incident information on chosen route			Fee based consumer service				
IV-205 On-Trip Information through mobile devices	Ability to download real time congestion maps over mobile phone			Fee based consumer service				
IV-302 Travel Services Information – Personal interactive	Downloads from mobile phones for local restaurants			Fee based consumer service				

APP

DETAIL COST

Service	Project/Program	Demonstration Project	Total Cost to deploy and operate for 2 years	Design	Deployment	Annual Costs		Full Deployment Costs
IV-303 Travel Services Information – Dedicated location	Broadcast information for service areas on low power HAR	$ 34,600	$ 34,600	$ 9,600	$ 25,000	Total	$ 1,250	$ 1,730,000
						Staffing	$ -	
						Facilities/Utilities	$ -	
						Other M&O	$ 1,250	
IV 601 - Public Transit Fleet Data for Planning Purposes	Provide automated rider counting systems linked to a central database	$ 773,000	$ 30,572,000	$ -	$ 30,100,000	Total	$ 266,000	
						Staffing	$ 230,000	
						Facilities/Utilities	$ 6,000	
						Other M&O	$ 30,000	
								$ 5,786,212,400

Product Category: Traffic Management (TM), Traffic Detection and Monitoring (TD), Traffic Information and Communication (TI), Fares and Toll Systems (FT) and Public Transport (PT)

Company Name	Type	Product Category	Country	Address	Telephone	Email	Website
Royer Signaltechnik GmbH	Manufacuturer	TM, TD	Germany	Werner Von Siemens Strasse 2	0049-5101-9196-0	info@royersignal.de	http://www royersignal de/
Adolf Nissen Elektrobau GmbH	Manufacuturer	TM,TD, TC, FT, PT	Germany	Friedrichstaedter Chaussee 4 25832 Toenning	49 4861-6120	export@nissen.de	http://www.nissen.de/
Aesys S.a.P	Manufacturer	TM,TD, TC, FT, PT	Italy	Via Artigiani 41 24060 Bursaporto,GB	39 - (0)35 - 683000	info@aesys.it	http://www.aesys.it/
Amano Electronics Europe N.V./S.A.	Manufacturer	TM,TD, FT, PT	Belguim	Westerring	32(0)89-323920	parking@amano.be	http://www.amano.be/eng/index.html
Astucia (UK) Ltd.	Manufacturer	TM,TD	United Kingdom	2 Kings Hill Ave. Kings Hill, West Malling, Kent	44 (0)1732 878700	sales@astucia.co.uk	http://www.astucia.co.uk/
Automatic Systems	Manufacturer	TM,PT	Belguim	5 Ave. Mercator, 1300 Wavre	32 10 23 02 11	jdewinter@automatic-systems.be	jdewinter@automatic-systems.be
Banner Engineering	Manufacturer	TM,TD, FT, PT	Belguim	Koning Albert I Laan 50, 1780 Wemmel	32-2-4560780	mail@bannerengineering.be	http://www.bannerengineering.com/intertraffic
Barco Control Rooms	Manufacturer	TM,TD	Belguim	Industriezone Noordlaan 5,8520 Kuurne	32 56 368 211	sales.bcd@barco.com	sales.bcd@barco.com
Bergauer AG	Manufacturer	TM,TD	Switzerland	Tafernstrasse 16a CH 5405 Baden	41-56-483 00 10	info@bergauer.ch	http://www.bergauer.ch/
Bremicker Verkehrstenchnik	Manufacuturer	TM,TD	Germany	Am Oeferi 37 - 43, 82362 Weilheim	49 881/642-0	info@bremicker-vt.de	http://www.bremicker-vt.de/
Capsys ASA	Manufaturer	TM, TD, TC, FT, PT	France	Parc Technologique -190 Chemin des Fontaines 38190 Bernin	33 (0)4-76089075	commercial@capsys-fr.com	http://www.capsys-fr.com/
Captel S LS WIM	Manufacturer	TM, TD, TC, FT	France	Z.A.E. des Avants, 43270 ST-Mathieu-De-Trevers	33.467.552.570	captels@mnet.fr	http://www.captels.com/
Cestle d.o.o.	Manufacturer	TM, TM, FT		Puhova ulica 2, 1000 Ljubljana	38615681719	siwim@cestel.si	http://www.siwim.com/
Citation Management	Service	TM,TD,TC,FT	United States	Suite 1600, 633 West Wisconsin Ave., 53203 Milwaukee, WI	1 888 8CITATION	twendler@citationmanagement.com	http://www.citationmanagement.com/
Citilog	Manufacturer	TM, TD,TC	France	5 Ave. d 'italie, 75013 Paris	33 1 53 94 53 95	citilog@citilog.com	http://www.citilog.com/
Commend Internaltion GmbH	Manufacturer	TM	Austria	Saalachstrassee 51, 5020 Salzburg	43-662-85 62 25-0	marketing@commend.com	http://www.commend.com/
Data Display Nederland B.V.	Manufacturer	TM, TD, TC, FT, PT	Netherlands	P.O. Box 162, 3340 Ad, Hendrik IDO Ambacht	31 78 6840504	nfo@data-display.nl	http://www.data-display.nl/
Data Collect Verkehrsdatentechnic GmbH	Manufacturer	TM, TD, TC	Germany	Heinrich-Hertz-Strassee 1, 50179 Kerpen, NRW	49-2273-59560	Info@DataCollect.de	http://www.datacollect.de/
Delta	Manufacturer	TM,	Denmark	Venlighedsvej 4, 2970 Hoersholm	45-72194000	delta@delta.dk	http://www.roadsensors.com/
Dynasig spol. s.r.o.	Manufacturer	TM,	Czech Republic	Kohoutovicka 610/116 641 00 Brno-zebetin	420546217480	info@dynasig.cz	http://www.dynasig.cz/
East West Infinity (Pvt.) Ltd.	Manufacturer	TM, TD, TC, FT	Pakistan	146 Industrial Triangle, Kahuta Rd. 440000, Islamabad	51-111222101	info@eastwestin.com	http://www.eastwestin.com/
Electronque Controle Mesure France (E.C.M. France)	Dealer, distributor, agent	TM, TD, TC, FT	France	Parc d'Activites de Brabois, 4 Rue du Bois Chene le Loup, 54500 Vandoeuvre-les-Nancy	33 3 83 44 24 13	info@ecm-france.com	http://www.ecm-france.com/
Elkosta Security Systems GmbH & Co.	Manufacturer	TM	Germany	Dr. Dornemann-Strasse 1, 38529 Salsgitter	49 (0)5341-802110	thorsten.grunwald@elkosta.de	http://www.elkosta.de/

EL TEC Elektronik AG	Manufacturer	TM, TD, TC, FT, PT	Germany				
Epsilon Software Assistance SA	Services	TM,TD,TC	Switzerland	Jarastrasse 10 4142 Munchenst Basellandschaft	0041 61 416 95 50	info@epsilon.ch	http://www.epsilon.ch/
Erdi Wegbebakening B.V.	Manufacturer	TM,TD	Netherlands	Rechte Tocht 3-5 1507 BZ Zaandam	075-6173357	INFO@ERDI.NL	http://www.erdi.nl/
Fabema Mobile Ampelsysteme	Manufacturer	TM	Germany	Haehnstrasse 51515 Kuerten	49 2207-965850	info@fabema.com	http://fabema.com/
Fata DTS S.p.a	Services	TM, TD, TC, FT, PT	Italy	Strada Statale N. 24 10044 Pianezza, Turin	39 (0) 11-9668347	proposal.dts@fatadts.it	http://www.fatadts.it/
Fraunhofer Insitute for Autonomous Intelligent Systems	Research	TM	Germany	Schloss Birlinghove 53754 Sankt Aug	0049 2241 142466	info@ais.fraunhofer.de	http://dito-ext.ais.fraunhofer.de/zeno/web?action=content&rootid=16030
Gesig-Gesellschaft fur Singalanlagen Gesellschaft m.b.H.	Manufacturer	TM, TD, FT, TC	Austria	Wattgasse 20 1160 Wien	443-1-48535440	info@ais.fraunhofer.de	http://www.gesig.at/
Gevas Software Systementwicklung und Verkehrsinformatik GmbH	Manufacturer	TM	Germany	Leuchtenbergring 20 81667 Muenchen	49-(0)89-255597-0	software@gevas.de	http://www.gevas.de/
Golden River Traffic Ltd.	Manufacturer	TM, TD, FT, PT	United Kingdom	Churchill Road, Bicester	1869-362800	sales@goldenriver.com	http://www.goldenriver.com/
GTI Infra	Infrastructure Management	TM, TD, TC, PT	Netherlands	Postbus 1628 3260 BC Oud-Beij, Juid-Holland	0186 60 62 00	info-infra@gti-group.com	http://www.gti-group.com/nl/markten/infra/
Hazard Safety Products Limited	Manufacturer	TM	Unided Kingdom	55-57 Bristol Rd. Birmingham, West Midlands	0121-4464433	sales@hazard.co.uk	http://www.hazard.co.uk/
HCIS	Manufacturer	TM, TD, TC, FT	France	Rue Gallarde 89100 ST-Clemen	33-386655794	hoummady@hcis.fr	http://www.hcis.fr/
Horizont Klemmfix GmbH	Manufacturer	TM	Germany	Homberger Weg-4- 34497 Korbach	49 5631-565-200	signal@horizont.com	http://www.horizont.com/
Ibergegur Systems S.A.U.	Manufacturer	TM	Spain	Vapor, 36 - Pol. Ind. La Ferreria 08110 Montcada I Reixac, Barcelona	34 932 257 400	jpascual@ibersegur.es	http://www.ibersegur.com/
Icoms Communications S.A.	Manufacturer	TM, TD, TC	Belgium	Avenue Albert Einstien 11I, 1348 Louvain-La-Neuve	32 10 45 41 02	info@icomscommunications.be	http://www.icomscommunications.be/
Image Sensing Systems Europe	Manufacturer	TM, TD, TC, PT	United Kingdom	3 Allens Orchard, Brampton Nr. Huntingdon, Cambridgeshire	44 (0) 1480.39916	europe@imagesensing.com	http://www.imagesensing.com/
Imtech Nettenbouv B.V.	Services	TM, TD, TC, FT,PT	Netherlands	Postbus 725, 3800 AS Amersfo	033 450 22 11		http://www.nettenbouw.nl/
International Fiber Systems Europe Ltd.	Manufacurer	TM	United Kingdom	1 Abbey Wood Road, Kings Hill WEST MALLING KENT	44 1732-522777		http://www.ifs.com/
International Road Dynamics Inc.	Manufacturer	TM, TD, TC, FT	Canada	702-43rd Street East S7K 3T9 SASKATOON Saskatchewan	1 306-6536600		http://www.irdinc.com/
Isbak, Inc.	Manufacturer	TM, TD, TC, PT	Turkey	Cendere Yolu 52 80360 KAGITHANE-ISTANBUL	212-2945658		http://www.isbak.com.tr/
Kaal	Manufacturer	TM, TD, TC, FT, PT	Netherlands	Gasstraat Oost 7 5349 AH OSS Noord Brabant	31 (0) 412-674747		http://www.kaal.nl/
Jade Electronics B.V.	Distributor	TM, TD, TC FT, PT	Netherlands	Postweide 135 4285 DV Woudrichem Noord Brabant	31 (0) 183-303988		http://www.jade-bv.nl/

Kistler Instrumente AG	Manufacturer	TM, TD, FT	Switzerland	Eulachstrasse 22 8408 Winterthur	41 52 224 11 11	http://www.kistler.com/
La Semaforica S.n.c.	Manufacturer	TM, TD	Italy	Via Ponticello 17, 35129 Padova, Pd	39 049 8074002	http://www.lasemaforica.com/
Laser Technology, Inc	Manufacturer	TM, TD, TC, FT, PT	United States	7070 South Tucson Way 80112 Englewood Colorado	1-303-649-1000	http://www.lasertech.com/
Lawo Mark IV Industies GmbH	Manufacturer	TM	Germany	Stockfeldstrasse 1, 76437 Rastatt	49 7222-10010	http://www.lie.de/
LogObject AG	Software Eng.	TM, TD, TC, FT, PT	Switzerland	Technoparkstrasse 1 8005 ZÜRICH ZH	41 (1) 4451700	http://www.logobject.ch/
micKs MSR Gmbh	Manufacturer	TM,TD, TC	Germany	Alpgaustrasse 24 87561 OBERSTDORF	49-8322-9792 0	http://www.micks.de/
Momatec GmbH	Services	TM, TD	Germany	Diepenbenden 44 52076 AACHEN	241-602766	http://www.momatec.de/
M-Tech AG	Manufacturer	TM, TD, TC, PT	Germany	RRobert-Bosch-Strasse 41 73770 Denkendorf	49-711-34550100	http://www.mtech-ag.com/
M-UniComp BmbH	Manufacturer	TM	Germany	Plauener Strasse 163 -165 / Haus 1 13053 BERLIN	49-30-98696154	http://www.unicomp-berlin.de/
Niechoj electronci GmbH	Manufacturer	TM, TD, FT, TC	Germany	Bildstock 9 /1 88085 LANGENARGEN	0049-7543-93470	
Nortech International	Manufacturer	TM, TD, TC	South Africa	32a Wiganthorpe Road 3201 Pietermaritzburg Kwa Zulu Natal	27 (0) 33 3453456	http://www.nortech.co.za/
Oxford Plastic Systems Ltd.	Manufacturer	TM, TD, PT	United Kingdom	Enstone Business Park / Airfield ENSTONE Oxfordshire	0044 1608 678888	http://www.oxfordplastics.com/
Peek Traffic B.V.		TM, TD, TC, FT, PT	Netherlands	Basicweg 16 3821 BR AMERSFOORT	31 (0) 33 454 1777	http://www.peekglobal.com/
Petards Mobile Intelligence A/S	Manufacturer	TM, TD	Denmark	Fabriksparken 14 2600 Glostrup Copenhagen	45 43 260 400	http://www.petardsonline.com/
PSI Transportation GmbH		TM, TD, TC, PT	Germany	Hohenzollerndamm 150 14199 BERLIN	49 30 89714-0	http://www.psitrans.de/
PTV Planung Transport Verkehr AG	Manufacturer	TM, PT	Germany	Stumpfstrasse 1 76131 KARLSRUHE	49-721-9651-0	http://www.ptv.de/cgi-bin/index.pl?ply=4
PWS Ireland Ltd.	Manufacturer	TM, TD, TC, PT	United Kingdom	Greenbank Industrial Estate NEWRY N. Ireland	44 2830264511	http://www.pwssigns.com/pages/welcome.asp?cat01=1&cat02=1
QSG Verkehrstechnik GmbH	Manufacturer	TM, TD	Germany	Planetenfeldstrasse 106-108 44379 DORTMUND	49 231-1087670	http://www.qsg-verkehrstechnik.de/
Quixote	Manufacturer	TM, TD, TC, PT	United States	Suite 3000, 1 E. Wacker Drive 60601 Chicago	1 312-467-9625	http://quixotecorp.com/
Radarlux Radar Systems GmbH	Manufacturer	TM, TD, TC, FT PT	Germany	Buergerbuschweg 48 51381 LEVERKUSEN Nordrhein-Westfalen	49 (0) 2171-9093 0	http://www.radarlux.de/
Ramet C.H.M.a.s	Manufacturer	TM, TD	Czech Republic	Letecka 1110 686 04 KUNOVICE	420 572 415 251	Letecka 1110
Rotapanel International B.V.	Manufacturer	TM	Netherlands	Plutoweg 2 8938 AB LEEUWARDEN	31-58-2880000	http://www.rotapanel.com/
RTB GmbH & Co. KG	Manufacturer	TM,TD, TC	Germany	Am Vorderfloess 6 33175 BAD LIPPSPRINGE	49 (0) 5252 51319	http://www.rtb-bl.de/

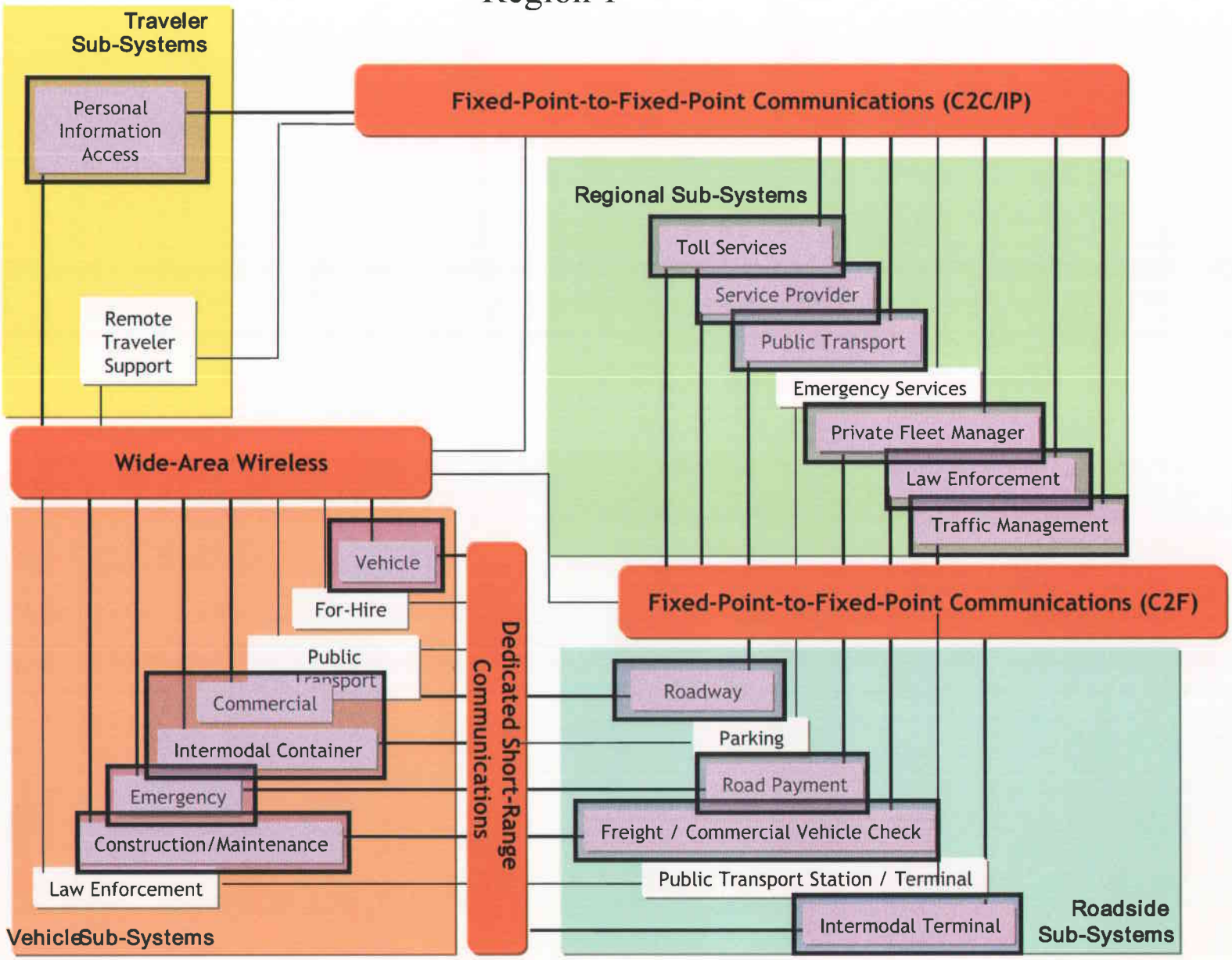
S.C.A.E.S.p.A.	Manufacturer	TM, TD, TC, FT	Italy	Via A Volta 6, 20090 Segrate, MI	39 02 269301	http://www.scae.net/
S.I.S.A.S. S.r.l.	Distributor	TM	Italy	Via Sputnik 8, 06074 Ellera Scalo - Corciano, PG	39 75-5171451	http://www.sisas.it/
Sagem SA		TM, TD, FT, TC	France	27 Rue Leblanc 75512 PARIS CEDEX 15	33 1 40 70 60 95	http://www.sagem.com/
Schuh & Co. GmbH Systemtechnik		TM, TD	Germany	Goethestrasse 17 D-82110 Germerring, Bavaria	49 (0) 89-8941310	http://www.schuhco.de/
Schweers Informationsstechnologie GmbH	Manufacturer	TM	Germany	Rudolf-Diesel-Strasse 1, 40670 Meerbush	2159-52920	http://www.schweers.de/
Sebach, Inc.	Manufacturer	TM	United States	South Royal Atlanta DriveSouth Royal Atlanta Drive 5127 30084 Tucker GA 4 Tucker, GA	1-404-366-2723	http://www.sebach.com/
Semex	Manufacturer	TM	Mexico	Chapultepec 1836 Ote, Col Buenos Aires, 64800 Monterrey, Nuevo Leon	(52) 81-8128-4000	http://www.semex.com.mx/
Sick AG		TM, TD,FT		Sebastian-Kneipp-Strasse 1, 79183 Waldkirch	7681-2020	www.sick.com
Siemens Intelligent Traffic Systems	Manufacuturer	TM, TD, TC, FT, PT	Germany	Hofmannstrasse 51 D-81359 Munich	49 89 722 266 06	http://www.industry.siemens.de/traffic/index_en.php
Sierzega Elektronik GmbH	Manufacturer	TM, TD, TC, FT, PT	Austria	Thürnau 55, 4062 Thening	43-(0)7221-64114-14	http://www.sierzega.com/
Signalbau Huber GmbH	Manufacturer	TM, TD, PT	Germany	Bingener Strasse 30, 80993 Muenchen	49-89-89688-100	http://www.signalbau-huber.de/
Smart Microwave and Radar Technology GmbH	Manufacturer	TM, TD, FT, PT	Germany	Moltkestrasse 25 42799 LEICHLINGEN	2175-884460	http://www.smart-microwave.de/
Sodi Scientifica S.p.a.	Manufacturer	TM, TD	Italy	Via Poliziano 20 50040 SETTIMELLO DI CALENZANO, FI	39 055-886 861	http://www.sodi.com/
Square System International	Manufacturer	TM, TD, TC	France	7 Rue Soutrane 06560 VALBONNE	33 4 93 65 27 57	http://www.square-system.fr/
Steria Transport	Services	TM, TD	France	12 Rue Paul Dautier 78142 VELIZY-VILLACOUBLAY	33 (0)34886499	http://www.steria.com/
TagMaster AB	Manufacturer	TM, TD, PT	Sweden	Kronborgsgränd 1 SE-16487 KISTA	46 8 632 19 50	http://www.tagmaster.com/
Tec Traffic Systems B.V.	Distributor	TM, TD, TC, FT, PT	Netherlands	Newtonbaan 3 3439 NK NIEUWEGEIN Netherlands	030-6023000	http://www.tectraffic.nl/Nederlands/index.php
Technical Traffic Solutions A/S	Manufacturer	TM, TD, TD, PT	Denmark	Havnegade 23 5000 Odense C	45 6313 4090	http://www.tts.dk/eng/default.asp
Technobox GmbH	Manufacturer	TM	Germany	Kornharpenerstrasse 122 a 44791 BOCHUM NRW	0234-95590	http://www.technobox.de/
Technolution B.V.		TM, TD, TC, FT, PT	Netherlands	Zuidelijk Halfrond 1 2801 DD GOUDA	31(0)182 59 40 00	http://www.technolution.nl/default.htm?html/bck/top.htm~topFrame
Telvent Trafico y Transporte, S.A.	Manufacturer	TM, TD, TC, FT,PT	Spain	Valgrande 6 28108 Alcobendas Madrid	34 902 335 599	http://www.telvent.com/

Thole Parkeersystemen B.V.	Manufacturer	TM, TD, TC, FT, PT	Netherlands	Marssteden 38 7547 TC ENSCHEDE Overijssel	31(0)53-4285700	http://www.thole.nl/
TPA Traffic & Parking Automation B.V.	Manufacturer	TM, TD, PT	Netherlands	Postbus 5000 6802 EA ARNHEM	31 26 355 35 35	http://www.tpa-nl.com/
Traffic Data Systems	Manufacturer	TM, TD, TC, FT	Germany	Gostritzer Strasse 61-63 01217 DRESDEN	49 351-8718199	http://www.traffic-data-systems.com/
Traffimex	Manufacturer	TM	Belgium	Bd. Edmond Machtenslaan 91 bus 19 1080 BRUSSELS	32 2 410 25 03	http://www.traffimex.com/
Trafsys A/S	Manufacturer	TM, TD, TC	Norway	Fabrikkgaten 5 5059 BERGEN	47 55 20 86 90	http://www.trafsys.no/
Truvelo	Manufacturer	TM, TD	South Africa	PO Box 14183 0140 Lyttelton, Centurion Gauteng	27 11 3141405	http://www.truvelo.co.za/
Vector ACS BV	Distributor	TM	Netherlands	Valkenburgerlaan 93 2103 AM Heemstede	31 (0)23 5282150	http://www.vectoracs.com/
Verkehrs-Systeme AG	Distributor	TM	Switzerland	Neue Bahnhofstrasse 160 4132 MUTTENZ	41 61 466 68 80	http://www.vs-plus.com/
Via Traffic Controlling BmbH	Manufacturer	TM, TD, TC, PT	Germany	Maybachstrasse 39 51381 LEVERKUSEN	0049-2171-504930	http://viatraffic.de/
Vialis Verkeer & Mobiliteit bv		TM, TD, TC, FT, PT	Netherlands	Oude weg 115 2003 RR Haarlem	31 (0)23 51 89 191	31 (0)23 51 89 191
Vilati Signalbau Huber Forgalomtechnika Kft.	Manufacturer	TM, TD	Hungary	Gyömröi Út 120 1103 BUDAPEST	36-1-43139-99	http://www.signalbau-huber.hu/
Weiss-Electronic GmbH	Manufacturer	TM, TD, TC, FT, PT	Germany	Niederkircher Strasse 16 54294 TRIER	49-651-810020	http://www.weiss-electronic.de/
Zamir Recongnition Systems Ltd.	Manufacturer	TM, DT, FT	Israel	Manachat Technology Park 96 951 JERUSALEM	972 2 679 7460	http://www.zamir.com/

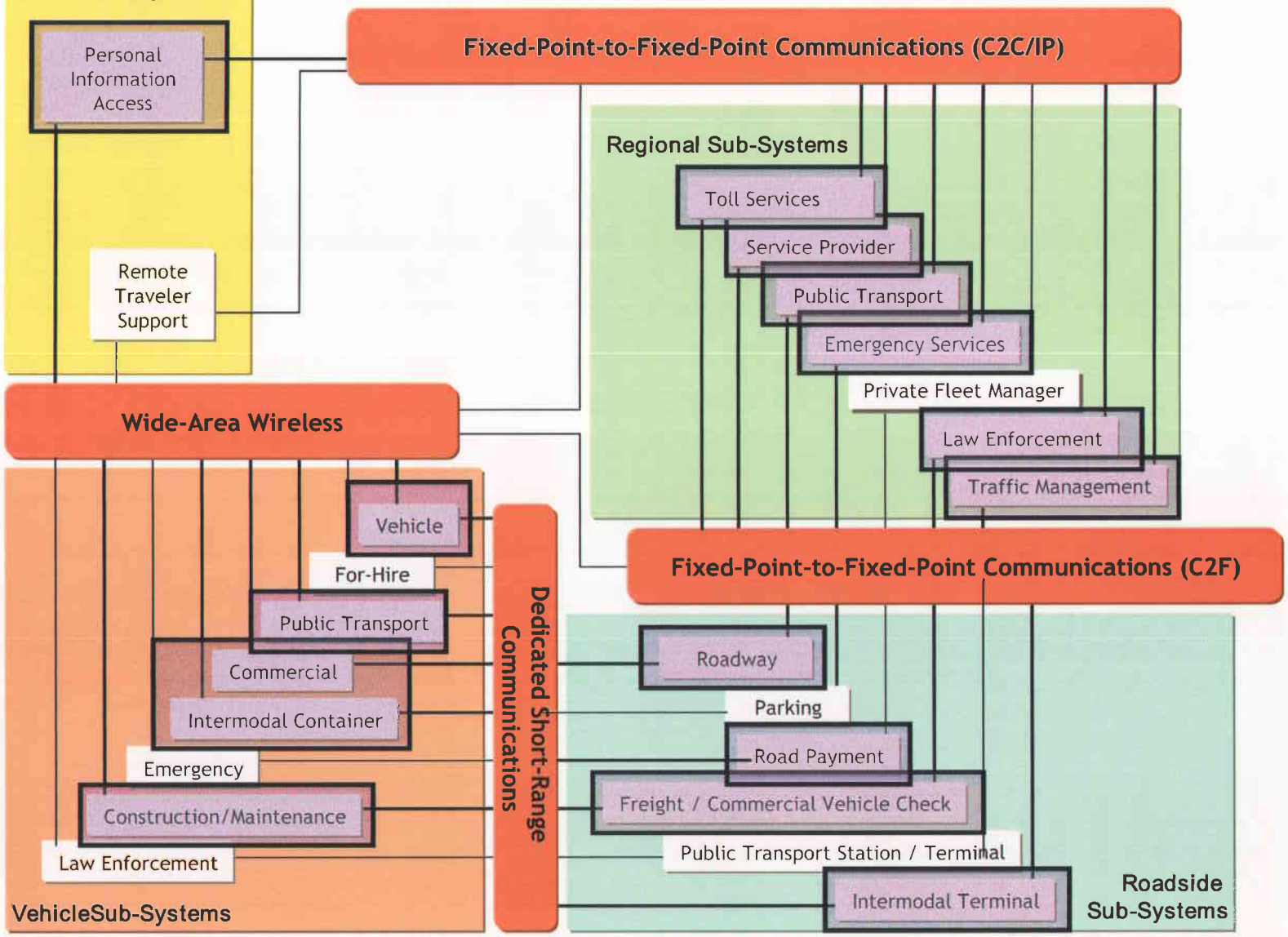
The following pictures represent the ITS Architecture for the seven identified regions

Many regions are very similar at the high level view presented. However, it is expected that the similarity in services will likely evolve over the coming years and change the mid range view of each regional ITS Architecture. Additionally, the level of deployment and integration of those services are expected to vary considerably across regions.

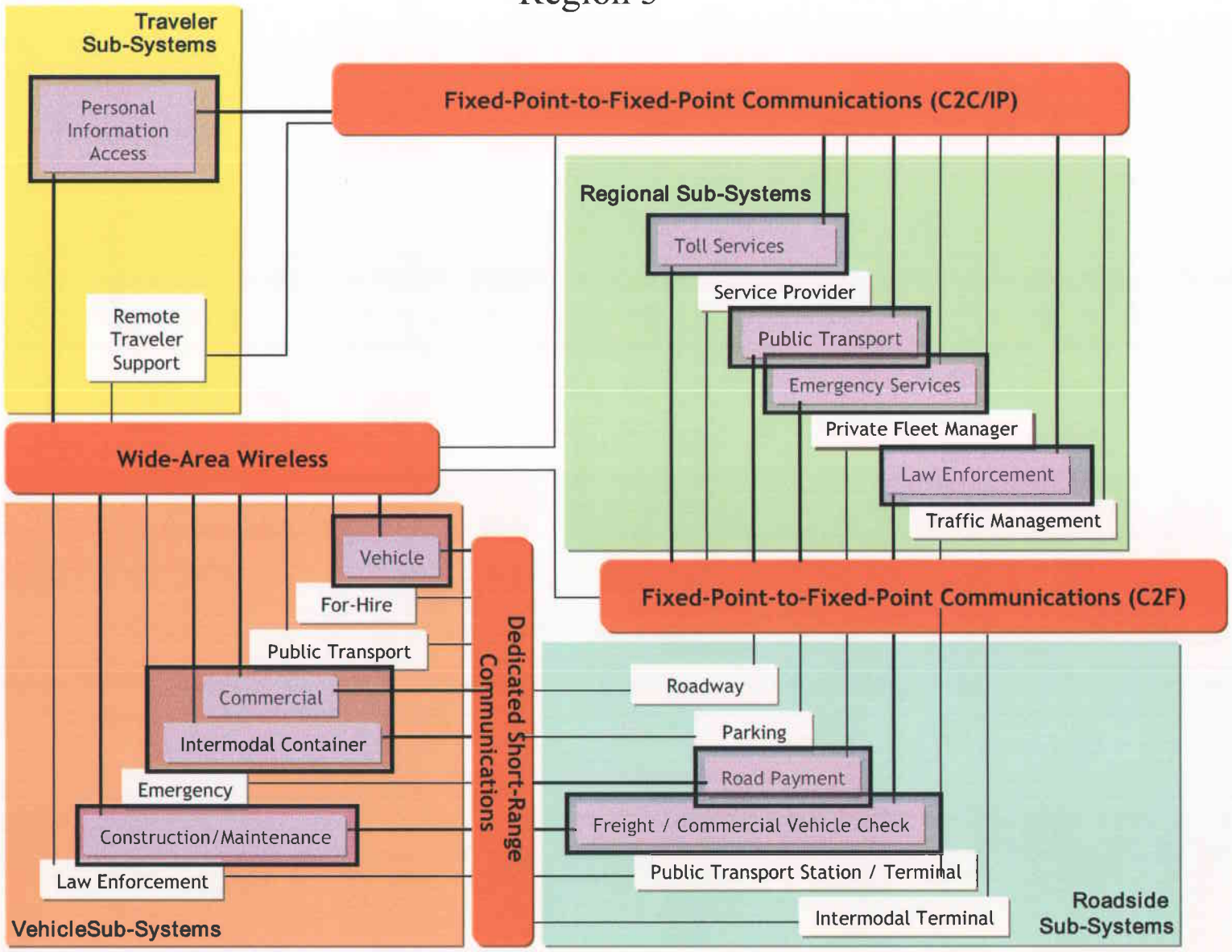
Region 1


Traveler Sub-Systems
Personal Information Access
Remote Traveler Support
Fixed-Point-to-Fixed-Point Communications (C2C/IP)
Regional Sub-Systems
Toll Services
Service Provider
Public Transport
Emergency Services
Private Fleet Manager
Law Enforcement
Traffic Management
Wide-Area Wireless
Vehicle
For-Hire
Public Transport
Commercial
Intermodal Container
Emergency
Construction/Maintenance
Law Enforcement
Vehicle Sub-Systems
Dedicated Short-Range Communications
Fixed-Point-to-Fixed-Point Communications (C2F)
Roadway
Parking
Road Payment
Freight / Commercial Vehicle Check
Public Transport Station / Terminal
Intermodal Terminal
Roadside Sub-Systems

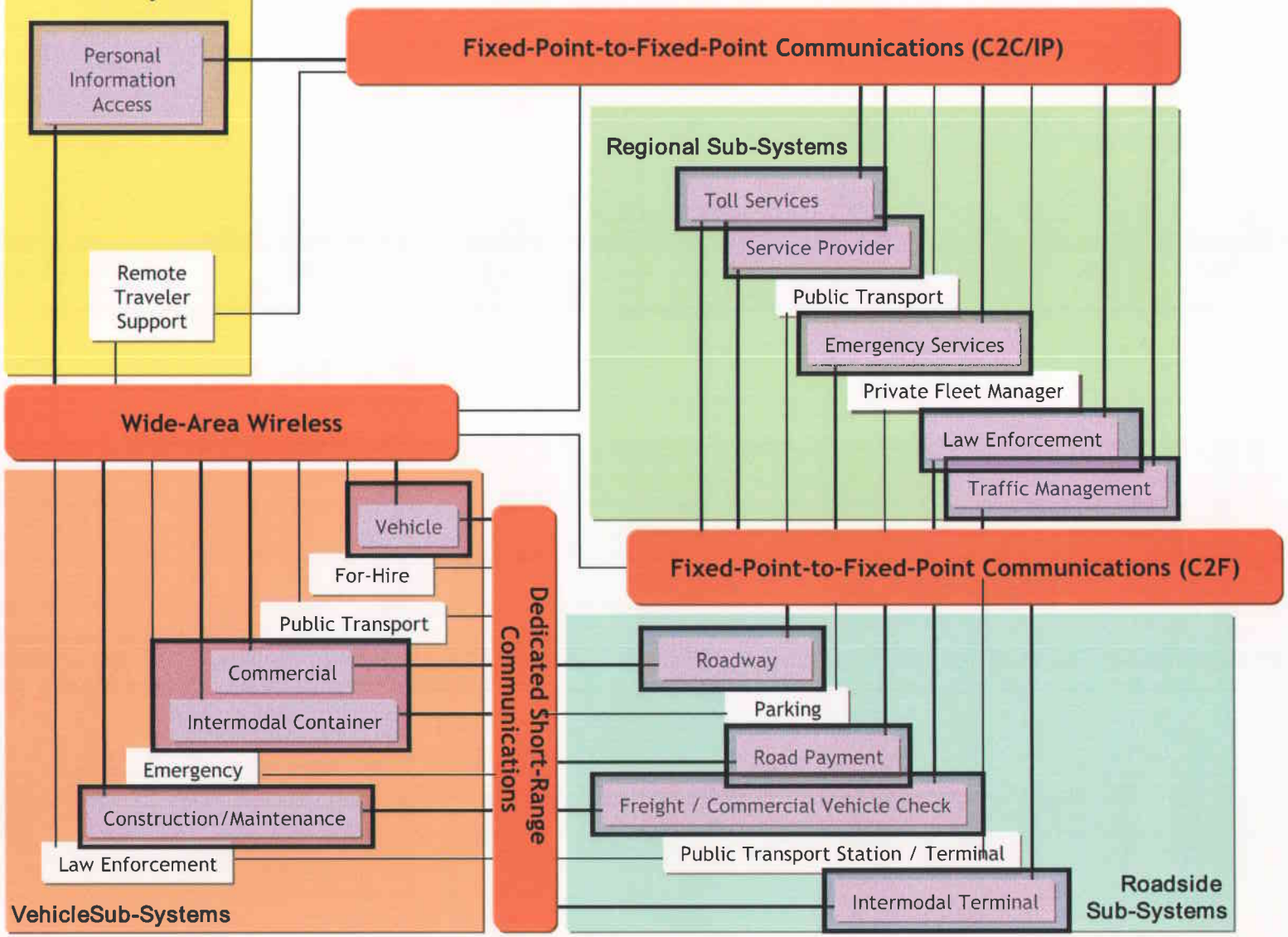
Region 2


Traveler Sub-Systems
Personal Information Access
Remote Traveler Support
Fixed-Point-to-Fixed-Point Communications (C2C/IP)
Regional Sub-Systems
Toll Services
Service Provider
Public Transport
Emergency Services
Private Fleet Manager
Law Enforcement
Traffic Management
Wide-Area Wireless
Vehicle
For-Hire
Public Transport
Commercial
Intermodal Container
Emergency
Construction/Maintenance
Law Enforcement
VehicleSub-Systems
Dedicated Short-Range Communications
Fixed-Point-to-Fixed-Point Communications (C2F)
Roadway
Parking
Road Payment
Freight / Commercial Vehicle Check
Public Transport Station / Terminal
Intermodal Terminal
Roadside Sub-Systems

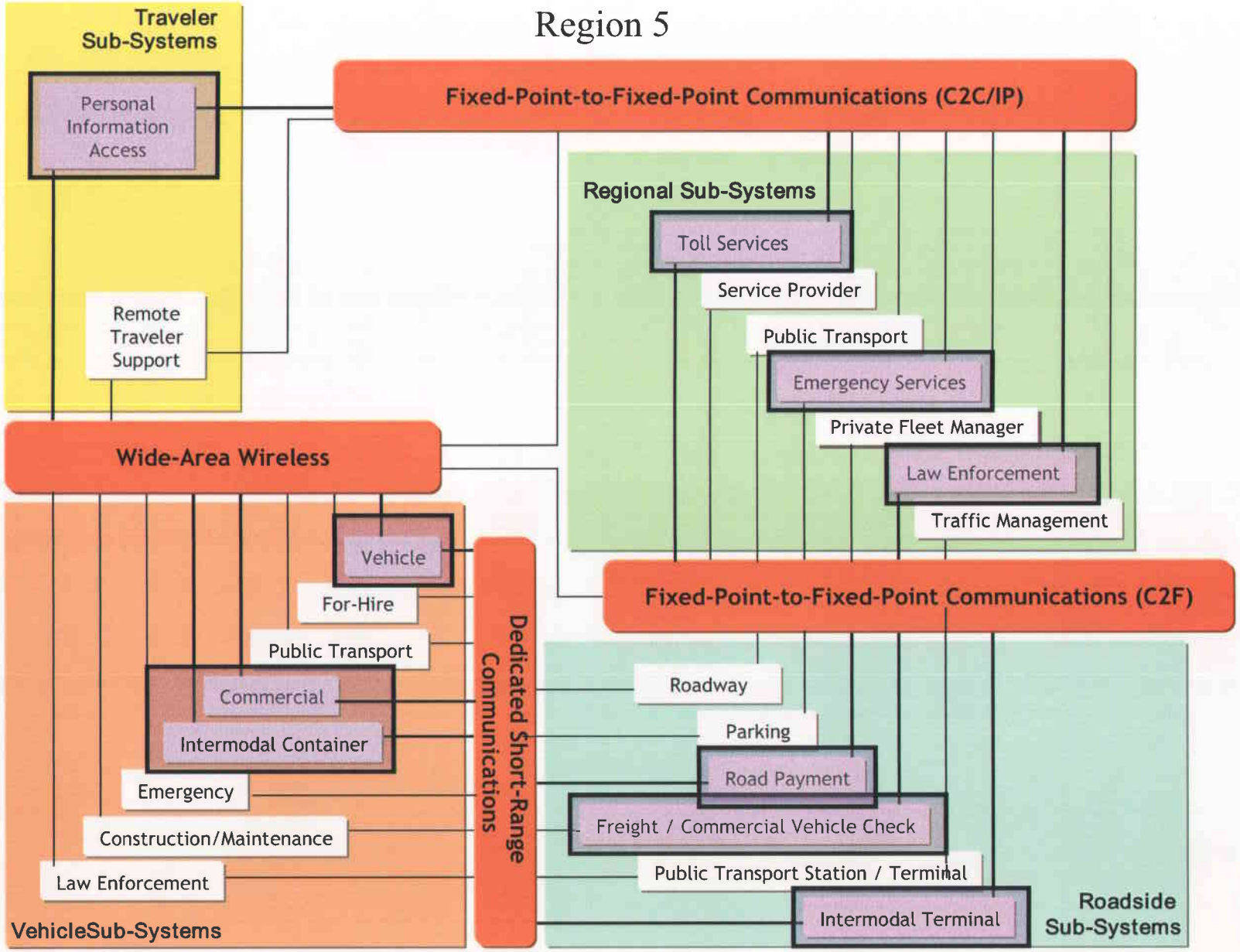
Region 3


Traveler Sub-Systems
Personal Information Access
Remote Traveler Support
Fixed-Point-to-Fixed-Point Communications (C2C/IP)
Regional Sub-Systems
Toll Services
Service Provider
Public Transport
Emergency Services
Private Fleet Manager
Law Enforcement
Traffic Management
Wide-Area Wireless
Vehicle
For-Hire
Public Transport
Commercial
Intermodal Container
Emergency
Construction/Maintenance
Law Enforcement
VehicleSub-Systems
Dedicated Short-Range Communications
Fixed-Point-to-Fixed-Point Communications (C2F)
Roadway
Parking
Road Payment
Freight / Commercial Vehicle Check
Public Transport Station / Terminal
Intermodal Terminal
Roadside Sub-Systems

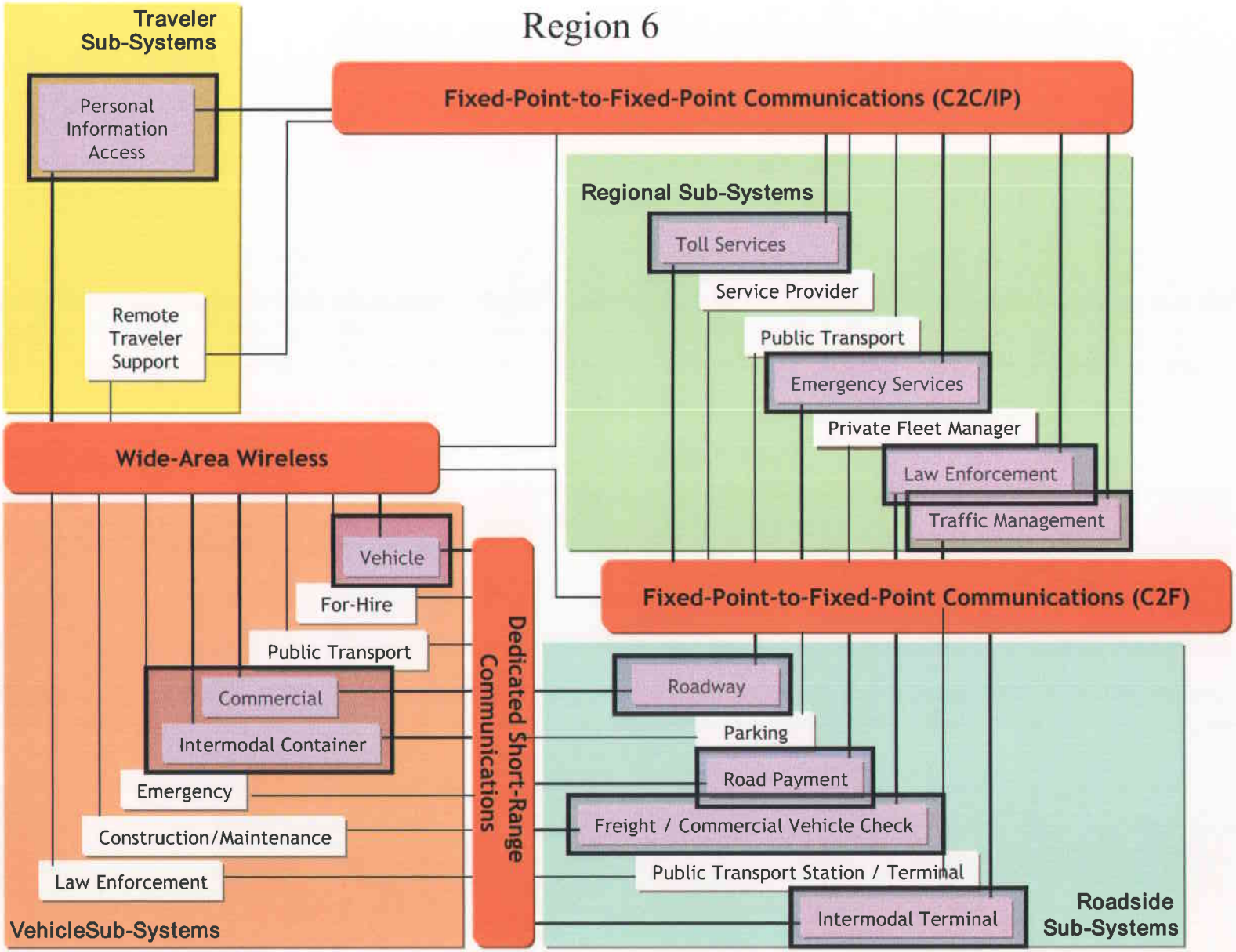
Region 4


Traveler Sub-Systems
Personal Information Access
Remote Traveler Support
Fixed-Point-to-Fixed-Point Communications (C2C/IP)
Regional Sub-Systems
Toll Services
Service Provider
Public Transport
Emergency Services
Private Fleet Manager
Law Enforcement
Traffic Management
Wide-Area Wireless
Vehicle
For-Hire
Public Transport
Commercial
Intermodal Container
Emergency
Construction/Maintenance
Law Enforcement
VehicleSub-Systems
Dedicated Short-Range Communications
Fixed-Point-to-Fixed-Point Communications (C2F)
Roadway
Parking
Road Payment
Freight / Commercial Vehicle Check
Public Transport Station / Terminal
Intermodal Terminal
Roadside Sub-Systems

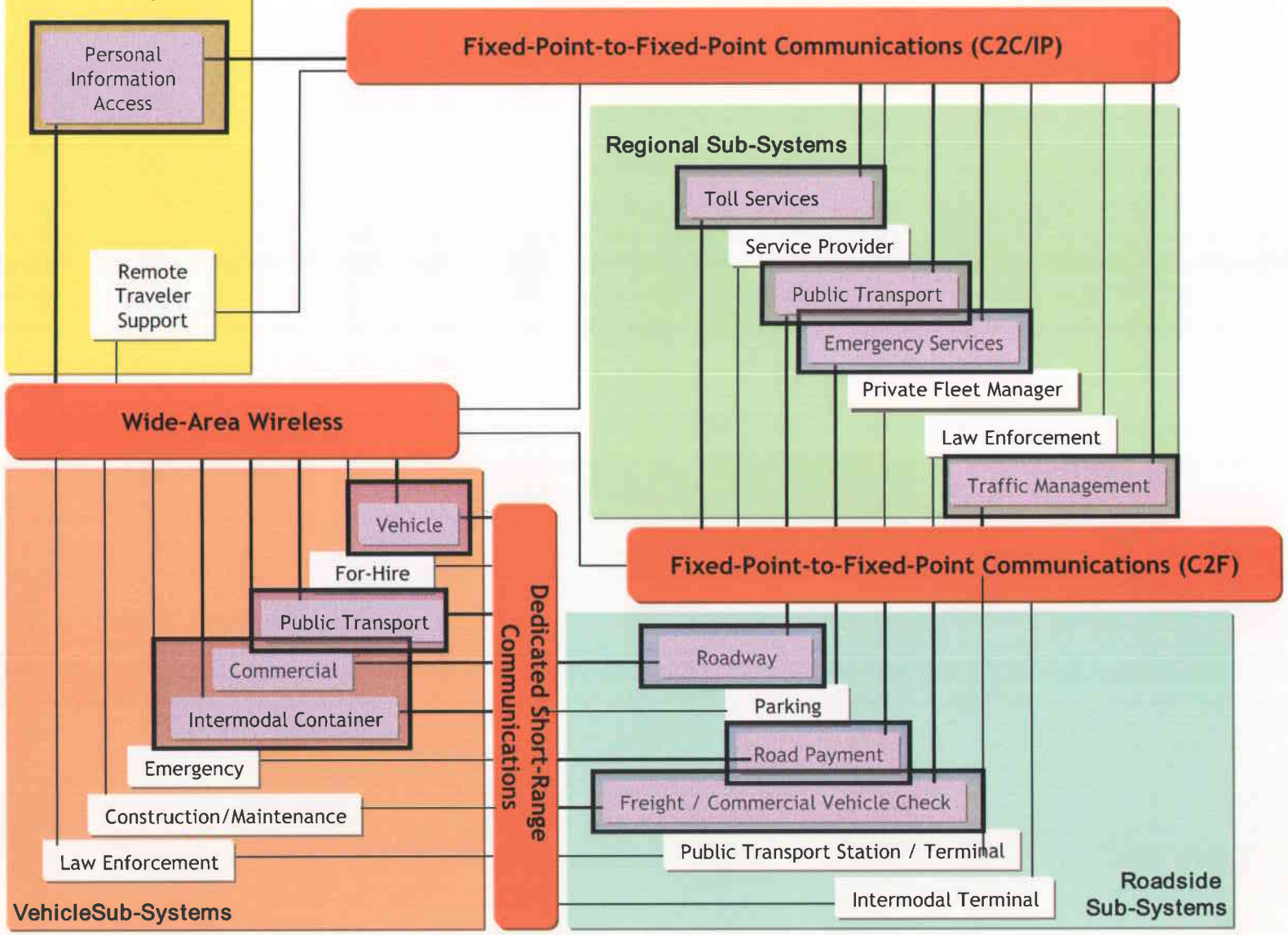
Region 5


Traveler Sub-Systems
Personal Information Access
Remote Traveler Support
Fixed-Point-to-Fixed-Point Communications (C2C/IP)
Regional Sub-Systems
Toll Services
Service Provider
Public Transport
Emergency Services
Private Fleet Manager
Law Enforcement
Traffic Management
Wide-Area Wireless
Vehicle
For-Hire
Public Transport
Commercial
Intermodal Container
Emergency
Construction/Maintenance
Law Enforcement
VehicleSub-Systems
Dedicated Short-Range Communications
Fixed-Point-to-Fixed-Point Communications (C2F)
Roadway
Parking
Road Payment
Freight / Commercial Vehicle Check
Public Transport Station / Terminal
Intermodal Terminal
Roadside Sub-Systems

Region 6


Traveler Sub-Systems
Personal Information Access
Remote Traveler Support
Fixed-Point-to-Fixed-Point Communications (C2C/IP)
Regional Sub-Systems
Toll Services
Service Provider
Public Transport
Emergency Services
Private Fleet Manager
Law Enforcement
Traffic Management
Wide-Area Wireless
Vehicle
For-Hire
Public Transport
Commercial
Intermodal Container
Emergency
Construction/Maintenance
Law Enforcement
VehicleSub-Systems
Dedicated Short-Range Communications
Fixed-Point-to-Fixed-Point Communications (C2F)
Roadway
Parking
Road Payment
Freight / Commercial Vehicle Check
Public Transport Station / Terminal
Intermodal Terminal
Roadside Sub-Systems

Region 7


Traveler Sub-Systems
Personal Information Access
Remote Traveler Support
Fixed-Point-to-Fixed-Point Communications (C2C/IP)
Regional Sub-Systems
Toll Services
Service Provider
Public Transport
Emergency Services
Private Fleet Manager
Law Enforcement
Traffic Management
Wide-Area Wireless
Vehicle
For-Hire
Public Transport
Commercial
Intermodal Container
Emergency
Construction/Maintenance
Law Enforcement
VehicleSub-Systems
Dedicated Short-Range Communications
Fixed-Point-to-Fixed-Point Communications (C2F)
Roadway
Parking
Road Payment
Freight / Commercial Vehicle Check
Public Transport Station / Terminal
Intermodal Terminal
Roadside Sub-Systems

Appendix F Summary

In the course of reviewing the final deliverables with the Mexican National ITS Architecture, it became apparent that there were some issues that required some additional explanation. This appendix contains a series of white papers that address these issues. None of these whitepapers change the intent or the meaning of the text in the final deliverable, but they do provide additional explanation and clarification. The following is a list of the whitepapers and the chapters of the final document to which they are relevant:

- ITS Architecture Development Overview – Chapters 3, 5, and 8
- Legal and Institutional Issues – Chapter 4
- Regional ITS Architecture Development – Chapters 5, 8, and 10
- Funding Table Summary – Chapter 6
- Pesaje Facil Economic Review – Chapters 6 and 10
- Air Quality Quantities – Chapter 7
- ITS Technology Assessment – Chapter 9
- ITS Project Development Explanation – Chapters 9 and 10
- Immediate Action Plan – Chapter 10

These documents should be considered within the context of the entire ITS Architecture.

Mexico National ITS Architecture
ITS Architecture Development Overview

The development of the Mexico National ITS Architecture was a very long and complex undertaking. A wide variety of stakeholders were involved, and numerous international sources were used to develop the final architecture. This memo will provide an overview of the process that was used to develop the National ITS Architecture for Mexico.

Input to the Architecture

The very first step was to identify what sources were available to provide input to the development of the National ITS Architecture. This includes both people and systems. As the stakeholders were gathered and the inventory initiated, problems or issues were then identified. These ranged from institutional to technical. They included financing and societal concerns. Anything that transportation affects, or is affected by. From this, some initial global concepts were identified.

Vision – the first concept to develop was the global vision that the ITS Architecture should serve. That vision was defined as follows:

Recognizing the continuing importance of all modes of transport to the quality of life of every Mexican, and that information and operations activities can be more effective than infrastructure, information technologies will be applied as an integrated program to the national transport tasks, to deliver a significant net contribution to Mexico's economic, transport, environmental and social needs and objectives over the next decade. Esta contribución permitirá que haya mejoras en la seguridad al viajar, desempeño y seguridad de las personas y los bienes; y permitirá un mejor intercambio de información esencial para el desempeño y la información de transporte dentro de México y con otros países. Igualmente ayudará a generar los recursos y rendimiento necesarios para mejorar aún más los servicios de transporte en el país.

The vision is intended to demonstrate that ITS is an important part of the transportation solution. Not the only solution, but an important tool for the use of the Mexican authorities.

Needs (Goals) – the needs were developed from the stakeholders from a list of issues. Each issue could have several needs. Some of the issues identified included the following:

- Public transport dependency
  - 80%+ of the trips in some regions are by public transport
  - Unlicensed services fill rural demand
- Limitations of road network
  - Most limited-access roads are toll roads
  - Many unwilling to pay tolls use other, inadequate alternative routes
  - Some regions have limited alternatives

- road work or weather closures can result in major delays or inconvenience
- Inefficient regulation of freight
  - Overweight vehicles cause substantial wear-and-tear on the road network
  - Trucks subject to repeated, redundant police inspections on single trips
  - Delays at border crossings
- Security issues / theft of cargo
- Railroads do not always get right-of-way at grade crossings (affects safety/attractiveness of rail as freight carrier alternative)

The final formal list of needs identified in the development of the Mexico National ITS Architecture represents those items that are of greatest concern to Mexico.

NEEDS STATEMENTS (GOALS)
Need 1 – Reduce accidents, fatalities, and injuries on the roadway network.
Need 2 – Increase security at the border crossings.
Need 3 – Increase security of people and goods throughout the entire transportation system.
Need 4 – Improve consistency of freight information standards and data between Mexico and other nations.
Need 5 – Improve documentation and correction of commercial vehicle operational and safety problems.
Need 6 – Improve management of road pricing and revenues
Need 7 – Manage changes in traffic flow conditions
Need 8 – Reduce the impact of incidents on the transportation network.
Need 9 – Provide improved management of regional public transport resources.
Need 10 – Enhance travel accessibility for citizens living outside major urban regions.
Need 11 – Reduce transportation impacts on air quality
Need 12 – Improve information on travel in Mexico

Objectives – Each need was then developed further into specific objectives. The list of objectives was agreed to as follows:

Objective 1.1	**Reduce** the number and severity of preventable **incidents**
Objective 1.2	**Reduce** the number and severity of fatalities due to **incidents** (see also Objective 8.4)
Objective 1.3	**Reduce** the number and severity of injuries due to **incidents** (see also Objective 8.4)
Objective 2.1	**Eliminate** border passages who constitute **security risks**
Objective 2.2	Increase the percentage of eligible national residents who are pre-cleared through border crossings.
Objective 3.1	Provide ability for law officials to **access** truck and freight identification and profile **information** throughout country
Objective 3.2	**Protect** freight and personal identification **information** from being accessed by non-authorized individuals

Objective 4.1	Provide ability to **access identification** of trucks and freight eminating from neighboring countries as well as Mexico
Objective 4.2	**Improve accessibility to** truck and freight **information** by traffic and law enforcement personnel.
Objective 5.1	Eliminate redundant inspections for commercial vehicles on same trip
Objective 5.2	**Make data** on specific commercial vehicle operational and safety problems **accessible** by all licensing and law enforcement agencies
Objective 6.1	**Eliminate revenue losses** and "leakage" from current tolling and other revenue mechanisms
Objective 6.2	**Increase revenues** to more proportionately reflect those vehicles and conditions which create more stress on the roadway network
Objective 7.1	**Monitor** changes in traffic flow on a continuous basis
Objective 7.2	**Reduce unpredictability and inconsistency** of traffic flow
Objective 7.3	**Reduce incidents** occurring as a result of changes in traffic flow conditions.
Objective 8.1	**Reduce** duration of **unscheduled incidents**
Objective 8.2	**Reduce** upstream delays as a result of **incidents**
Objective 8.3	**Reduce** secondary **incidents** which occur upstream of incident locations.
Objective 8.4	**Reduce** fatalities or injuries which occur as a result of **incidents.** (see also Objective 1.2 and 1.3)
Objective 9.1	Improve public transport schedule adherence
Objective 9.2	**Reduce waits** at public transport stations and stops during periods of high travel demand
Objective 9.3	**Reduce criminal activities** on vehicles and at public transport facilities
Objective 10.1	**Reduce travel times** for public or shared transport between rural or smaller communities
Objective 10.2	Reduce the number of unlicensed public transport / shared-ride services
Objective 10.3	**Reduce the time required to connect** between different transport services.
Objective 11.1	**Reduce pollution** caused by point-based sources (e.g., autos, buses)
Objective 12.1	**Reduce** wasted trips **and delay** due to closures, accidents, road work, weather or other travel impediments.

Societal Issues

While this initial work was being completed, the inventory work included identifying societal issues. This included identifying financial issues. Some work was accomplished with initial financial plans related to projected early winner projects. Additionally, international sources of funding were identified to help address the gap between needs and available funds.

Also included here was work related to the environment. Air quality in particular was addressed, although Mexico has already been addressing this issue for some time. Some work was accomplished on other quality of life issues. This includes increased safety –

both in terms of reduction of accidents and injuries, and reduction of stolen freight. Both of these issues were the primary concern of all stakeholders. The objectives reflect this concern. Additionally, the stakeholders were asked to help determine rankings of future efforts by evaluating the relative importance of various deployment factors.

Finally, the preservation of the history of Mexico was also noted as a concern. The preservation of the historic districts in the major cities, as well as the national parks and environmentally sensitive areas was noted and included. Many of the ITS projects in the final plan reflect attempts at this preservation.

Financial Analysis

An early financial analysis was performed. There were several issues this analysis was to address:

- Potential benefit cost ratios
- Initial indications of cost
- Potential funding sources

At this relatively early stage within the development, only a few selected short term projects were identified. Detailed costs and benefits were developed for those that had the most promise.

While all had a positive benefit cost ratio, the total costs of the initial projects was still well beyond current budget concepts. The benefits over twenty years of the first four projects were quantified at $4.2B US. The costs, though, were a very significant $452M US. While this does represent a 9.3 BC ratio, it still requires a significant investment on the part of Mexico.

A wide variety of potential funding sources were identified. Those international funding sources included NAFINSA (Nacional Financiera), Crédito PYME, BANOBRAS, FORTEM II (funded by IDB), CONACYT (Consejo Nacional de Ciencia y Tecnología). Local and private sector opportunities were identified at a high level.

Inventory

There are several ITS systems already in operation across all of Mexico. Each was developed as a stand alone system – some in competition with each other. The major systems identified are as follows:

- US-Mexico border crossing and electronic freight pre-clearance
  - SENTRI (expedites cross-border commuter travel)
  - FAST (expedites border crossings for freight carriers who have received security preclearance)
  - Electronic Data Exchange (northbound travel to US)
  - Container Security Initiative (prescreening of US-bound containers)
- Electronic toll collection
  - Several services (CAPUFE-IAVE system and others)

        - Title 21 compliance
    - Currently in process of upgrading to newer technology
- Advanced traffic management systems
    - Mexico, Monterrey, other key cities
    - No common standard for traffic controllers
    - No common communication standards for ITS devices

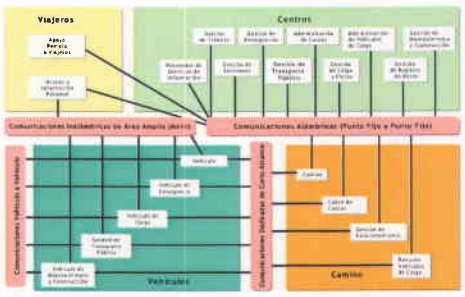
- Public transport ITS
    - Rail passenger info
    - Some bus AVL
    - Contactless smart cards (Guadalajara)

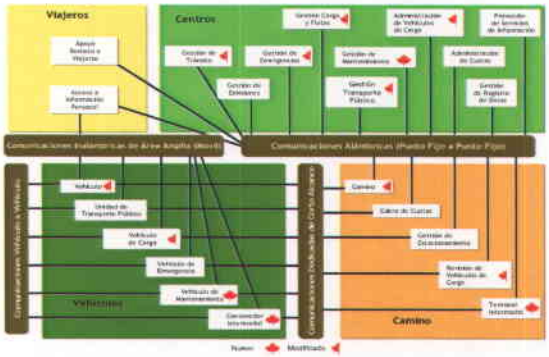
This inventory reveals certain other issues within Mexico. The first is the incompatibility between the various electronic toll collection systems. This is compounded by a lack of a national database on vehicles and licenses. There are also some inconsistencies in deployment of modern traffic control practices and systems. Finally, there is no standardization for traffic controllers and ITS communications (there is a mix of proprietary local systems and mainly US products).

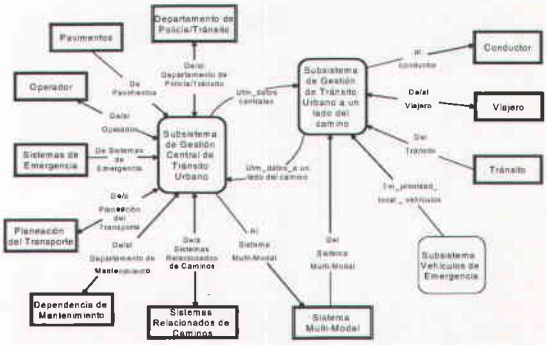
All of these factors are considered as the Mexico National ITS Architecture is developed.

Technical Analysis

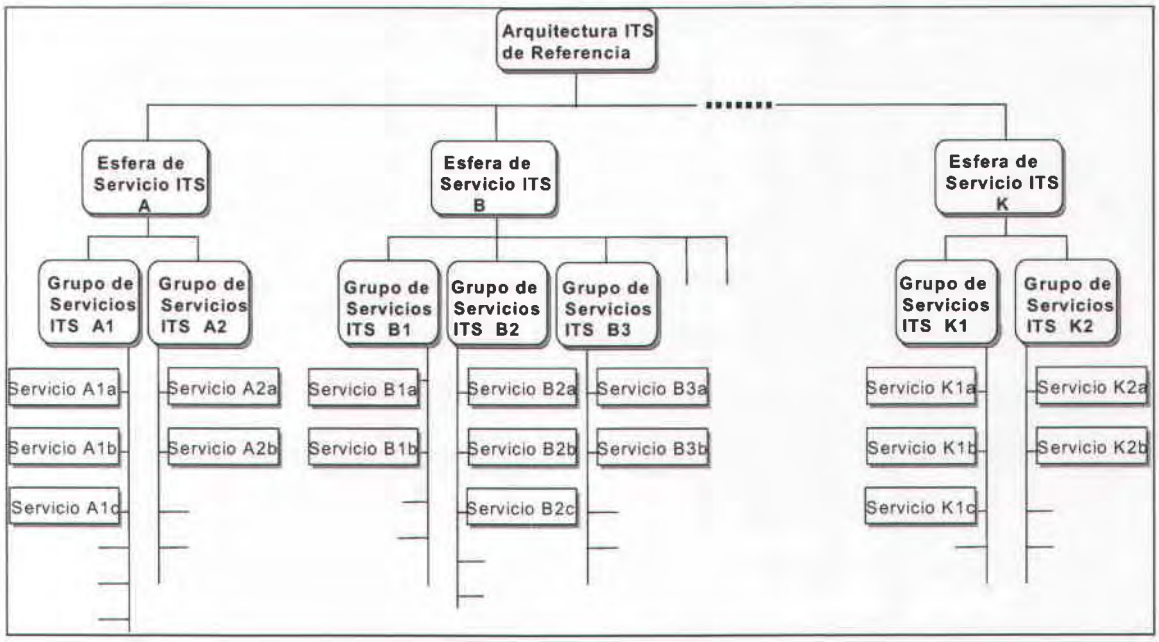
There are already existing ITS Architectures all over the world. In developing the Mexico National ITS Architecture, the intent was never to copy another architecture, but to learn from the previous efforts and create an ITS Architecture that is best suited for Mexico. This began with examining the three most prevalent ITS Architectures – US, Canada, and Europe. In addition, current ongoing international work under ISO was examined.







The end result of the analysis was a service based ITS Architecture in line with the current ISO standards work, but with considerable borrowing of details from the US and Canadian ITS Architectures. The service based ITS Architecture is similar in format to all of the current ITS Architectures and should be easily integrated with any of them. The format of the ITS Architecture is shown below.

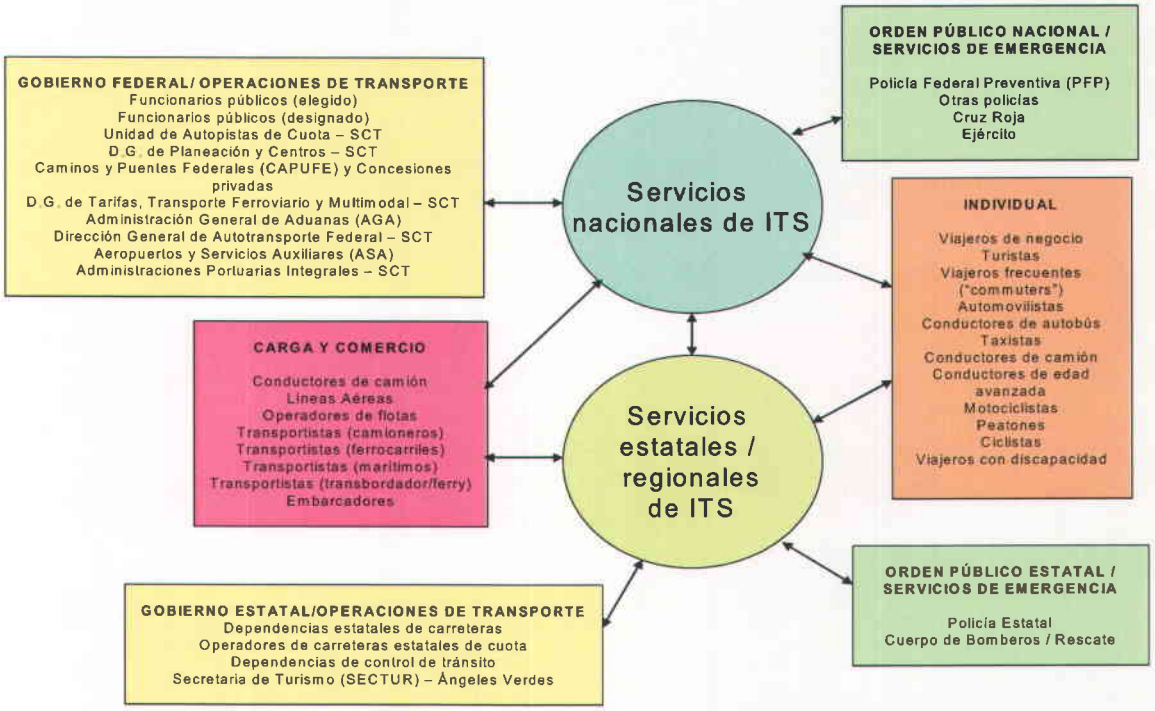


Concept of Operations

Once the framework was established, the organization and institutional issues within Mexico were considered. From the previous efforts, Mexico was considered both alone, and against the established concept of operations from Canada and the US. Several key items were identified.

- Mexico has direct Federal involvement in actual highway operations (primary network)
- The roadway and rail infrastructure is less-developed than other nations with existing ITS Architectures
- Mexico has an emphasis on toll-based financing in construction and operation of roads – most limited-access roads are toll roads
- Mexico has an underdeveloped information exchange capability (Both interstate and Federal-state)
    - Multiple police inspections on interstate freight trips
    - Limited abilities to track suspect or stolen vehicles and property
- And in general, political control is more centralized but technology standardization and programming is less coordinated

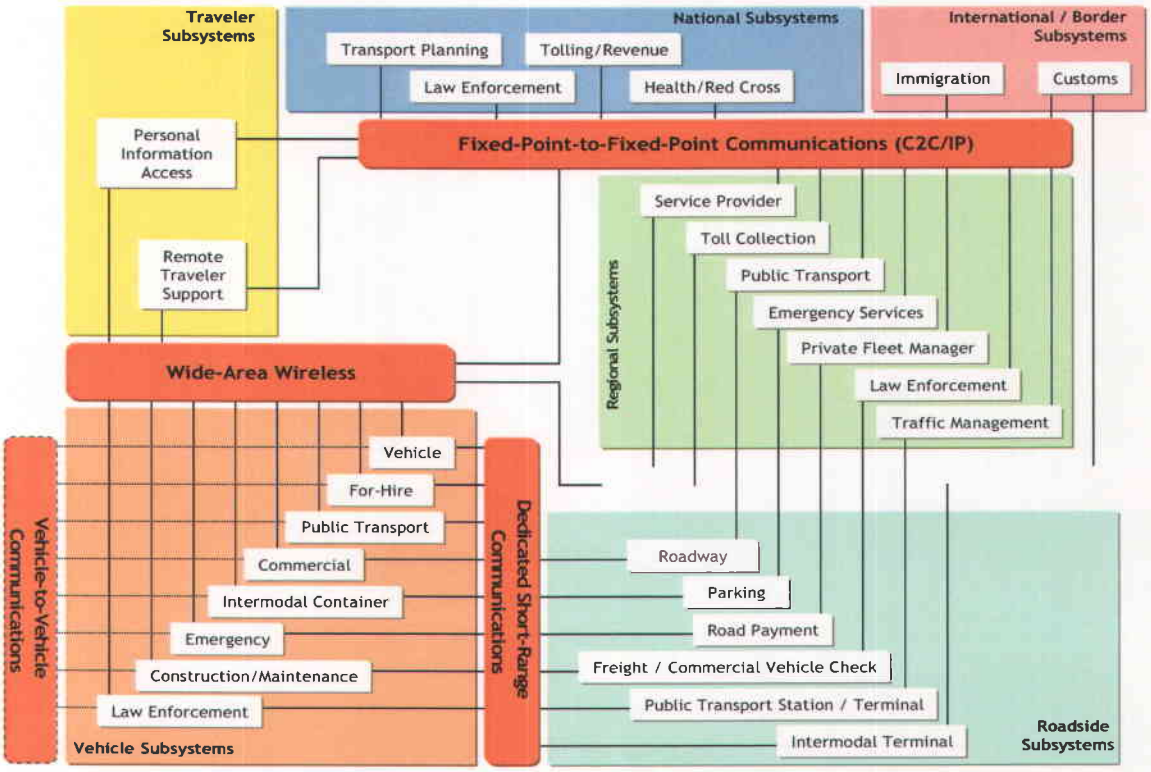
The resulting organizational diagram depicts what services reside at what level within Mexico. Because of limited national information connectivity, national, interstate and international information exchange is critical. To deploy ITS on a regional or state level, a framework similar to U.S. national architecture is appropriate. So the national architecture will thus incorporate many aspects of the U.S. architecture but will not look the same.



The Chorizo Diagram

The "Sausage" Diagram is probably the most visible element within the US Architecture. The above diagram went through several iterations illustrating the various divisions of responsibilities, then the high-level interconnects, and finally the needs related to standards. The end result is the "Chorizo" diagram shown on the next page.

This diagram highlights the systems and services that are contained within the Mexico National ITS Architecture.



Identifying Services

At this point, the process went back to the ISO framework identified earlier, and matched the needs and organization of Mexico, to the ISO services domains The following candidate service domains were identified from ISO TR 14813-1 revised:

- Traveler Information
- Traffic Management and Operations
- Vehicle Safety and Monitoring
- Freight Transport
- Public Transport
- Emergency Services
- Electronic Payment
- Personal Safety
- Weather / Environment Monitoring
- Disaster Response Management and Coordination
- National Security

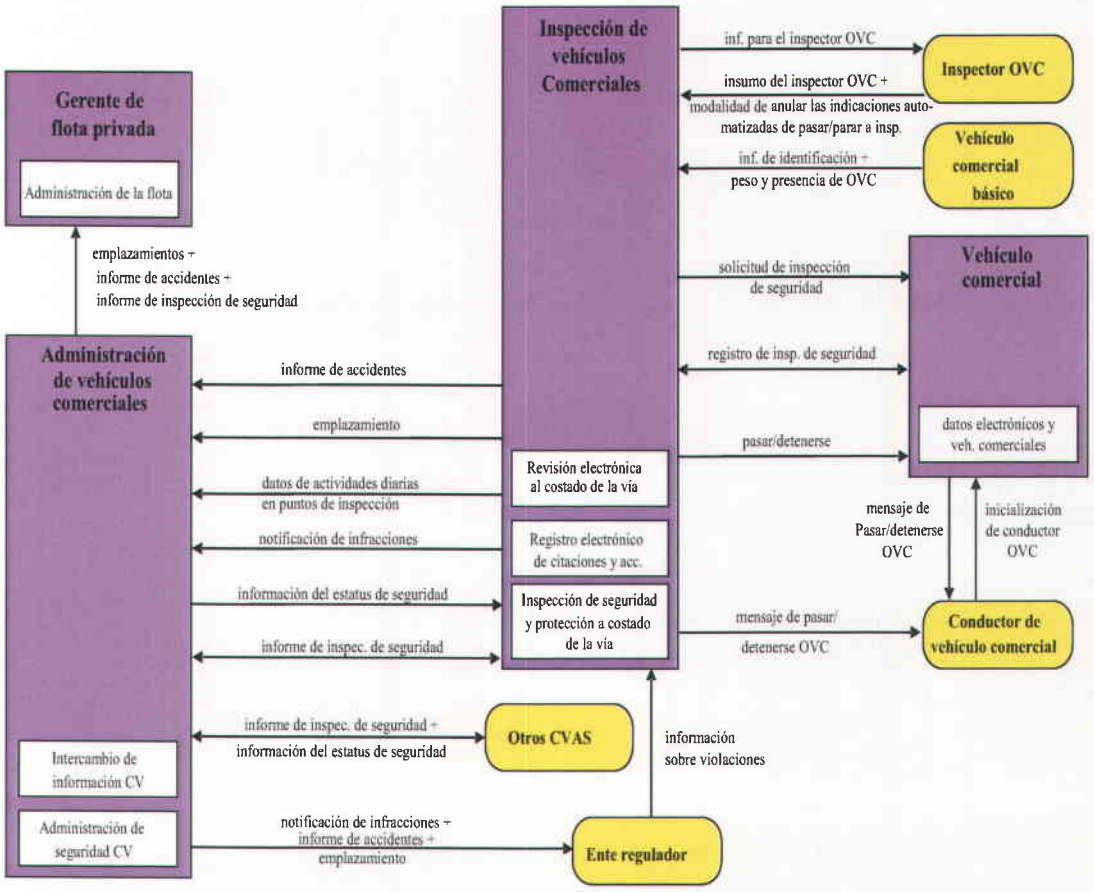
The Users and Providers were identified also. Users included the traveling public and freight operators, but some of the service providers are also service users. Providers included customs/immigration, law enforcement, emergency services, road operators, public transport, and service and product providers.

From the initial list of service domains, groups of services were identified, followed by the actual service. A sample of this breakdown is provided below:

(TC) Grupos de Servicios para el Transporte de Carga	TC.1 Trámites Administrativos para Vehículos Comerciales	**TC-101 Registro Automático de Credenciales**
		TC-102 Administración Automatizada de Vehículos Comerciales
		TC-103 Cruces Fronterizos Automatizados
	TC.2 Gestión de Flotas de Transporte de Carga	**TC-201 Localización de la flota de vehículos comerciales**
		TC-202 Despacho de la flota de vehículos comerciales
		TC-203 Localización de los contenedores de carga
	TC.3 Gestión de la Información Intermodal	**TC-301 Intercambio de información sobre la llegada de contenedores y vehículos (los usuarios son los nodos y transportistas intermodales y flotas)**
		TC-302 Acceso a información sobre la carga para los clientes (los usuarios son los clientes y embarcadores
	TC.4 Gestión y Control de centros intermodales	**TC-401 Gestión de la central intermodal**
		TC-402 Control de vehículos y contenedores intermodales
	TC.5 Gestión de carga peligrosa	**TC-501 Intercambio de datos sobre el transporte de Carga Peligrosa**
		TC-502 Registro de datos sobre el transporte de Carga Peligrosa
		TC-503 Coordinación de la flota a cargo del transporte de Carga Peligrosa
		TC-504 Coordinación policíaca / de seguridad para el transporte de Carga Peligrosa
	TC.6 Inspección Automática de Seguridad al Costado del Camino	**TC-601 Acceso remoto a la información sobre la seguridad de vehículos comerciales**
		TC-602 El Vehículo del monitor Carga
	TC.7 Monitoreo de Seguridad a Bordo de Vehículos Comerciales	**TC-701 Monitoreo de los sistemas internos de los vehículos comerciales**
		TC-702 Monitoreo del estado de alerta de los conductores de vehículos comerciales

Each of the identified services has a more detailed service diagram. The diagram details the various components that are contained within this service. Here, at this detailed level, the Mexico ITS Architecture is very similar to the US architecture. There are 97 developed detailed service diagrams. An example of a detailed service diagram is as follows:

TC601 - Acceso Remoto a los Datos de Seguridad del Vehículo Comercial



Program Development

Using the financial models identified earlier, and the list of services identified as part of the technical process, 124 individual projects were identified. These projects and services were ranked by the stakeholders and compared against the architecture to ensure they all represented valid projects. At this point, detailed cost estimates were developed for all projects. The cost estimates were for public sector costs only. Items such as in-vehicle route planning are more consumer based projects.

From the detailed cost estimates, an initial program was developed. Projects were identified for immediate, short, medium, and long term. A portion of the program is shown below.

	Proyecto/Programa	Nombre	Integración y Coordinación	Legado	Temprano o Inicio Temprano	Corto plazo	Mediano plazo	Largo plazo
SN –101 Monitoreo de vehículos que transportan materiales peligrosos (hazmat) y explosivos	Sistema VACUS para la inspección remota de vehículos Utilizado en los cruces fronterizos.	Vacus - frontera				Demo - Nacional	Inicial - Nacional	Completo - Nacional
SN –101 Monitoreo de vehículos que transportan materiales peligrosos (hazmat) y explosivos	Sistema VACUS para la inspección remota de vehículos Utilizado en aplicaciones móviles.	VACUS - Móvil				Demo - Nacional	Completo - Nacional	
SN-301 Recolección e intercambio nacional de información	Base de datos de registro de vehículos a nivel nacional (tanto comerciales como automóviles particulares)	Base de datos de Matrículas de Vehículos			Demo – Regional	Inicial - Nacional		Completo - Nacional
SN-301 Recolección e intercambio nacional de información	Base de datos nacional de registro de conductores	Base de datos de Registro de Conductores de Vehículos			Demo – Regional	Inicial - Nacional		Completo - Nacional
SN-302 Cooperación entre múltiples agencias nacionales	Estableciendo una red segura y automatizada para compartir información y privacidad	Comun. seguras entre dependencias					Demo - Nacional	Inicial - Nacional
TC-101 Registro Automático de Credenciales	Crear un sistema para el trámite automatizado de los vehículos comerciales	Credenciales Automáticos para Vehículos	Proyectos SN			Demo - Nacional	Inicial - Nacional	Completo - Nacional
TC-102 Administración Automatizada de Vehículos Comerciales	Compra de todo bajo un techo para todos los Vehículos Comerciales	Obtención de Permisos en "una sola parada"	Proyectos SN				Demo - Nacional	Inicial - Nacional
TC-102 Administración Automatizada de Vehículos Comerciales	Trámite Aduanal Automatizado	Aduana Automatizada			E-Carga	Inicial - Nacional	Completo - Nacional	
TC-103 Cruces Fronterizos Automatizados	Pasar sin detenerse en los cruces fronterizos utilizando la tecnología toll tag	Cruce Fronterizo Automatizado	X	FAST y otros		Inicial - Nacional	Completo - Nacional	
TC-202 Despacho de la flota de vehículos comerciales	Despacho de transportistas en base a la localización de los vehículos	Despacho de Flotas		Disponible comercialmente				
TC-203 Rastreo de los contenedores de carga	Uso de LAV para rastrear la localización de los contenedores	Rastreo de Contenedores	X	Corredor de Tijuana		Inicial - Nacional	Completo - Nacional	
TC-203 Rastreo de los contenedores de carga	Aviso si la carga se desplaza o derrama	Integridad de los Contenedores		Disponible comercialmente				
TC-301 Intercambio de información sobre arribo de contenedores y vehículos	Intercambio automatizado de información entre embarcadores y transportistas	Sistema de Gestión de Puertos	X			Demo - Nacional	Inicial - Nacional	Completo - Nacional
TC-301 Intercambio de información sobre arribo de contenedores y vehículos	Mayor coordinación con las diferentes modalidades de transporte disponibles para un embarcador	Gestión de Contenedores	X			Demo - Nacional	Inicial - Nacional	Completo - Nacional

Summary

The above outlines the process that was followed in developing the Mexico National ITS Architecture. The end result of this project can be highlighted in several components. First, the Chorizo diagram which outlines the basic relationships. Second, the detailed service diagrams which detail the individual functions that need to be considered. And finally, an initial program from which Mexico can begin expanding their ITS deployments.

As mentioned from the beginning, an ITS Architecture is a living document. It will need to be maintained and updated. It will evolve as Mexico evolves. But it should always remain an effective tool in guiding the development of new ITS projects.

National Mexico ITS Architecture
Institutional And Legislative Recommendations

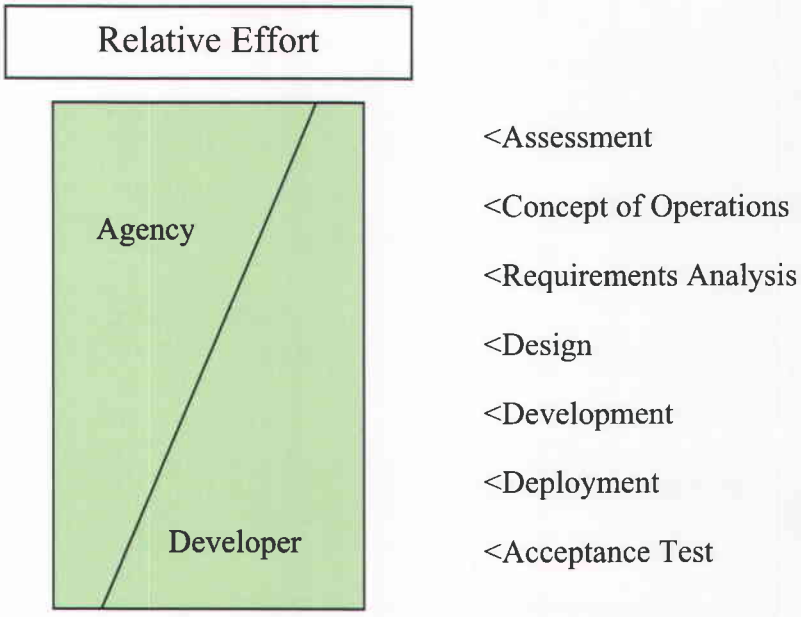
Institutional issues are discussed in several places within the submitted documents including Task 1, Task 2, Task 7, and the corresponding chapters of the final ITS Architecture document. This memo is intended to highlight recommendations for change within Mexico

It was stated in Task 2 that there were no major institutional impediments to advancing ITS in Mexico. While this is true, there are several areas where improvements could be made to better facilitate the advancement of ITS. The major issues are summarized below.

Procurement Methods

First, the question is "What are you procuring"? The ITS Architecture process along with the Systems Engineering process both argue that ITS systems should not be procured as a product. There are specific components and process that must be followed in order to facilitate integration of systems. The only other way to provide integration is to choose one vendor and use them for everything for the next twenty years. This method has proven itself expensive and it does not guarantee integration.

From the USDOT National Highway Institute training course on Systems Engineering, there are specific roles for both the agency and the contractor. The following diagram illustrates the level of effort of each at various stages.



In the Systems Engineering process, the Developer leads the execution of the process, while the agency needs to participate in the process. For example, in the Assessment stage, the Developer will do the work to prepare workshops and meet with stakeholders, but the agencies themselves will put in more effort in terms of staff hours than the Developer. As the process gets closer to implementation, the Developer is spending more effort on the project, but the agency still has an important role. Additionally, at most stages (especially the latter stages), an agency could hire an additional consultant to help them with their role in the process. For example, during the Acceptance Test phase, the agency can hire an independent consultant to conduct the testing and report back to them.

So, the agency needs to recognize from the beginning that they will always have a role and responsibility in the project, and that at the various stages, they can procure different assistance.

In the Task 8 document, contracting services was discussed at length. This included the RFI/RFQ/RFP process. This memo addresses a larger picture – the type of contract. Again from the USDOT NHI Systems Engineering course, there are several different contracting alternatives that have been identified.

- Consultant Design / Low Bid Contractor
- Systems Manager
- Systems Integrator
- Task Order
- Design / Build
- Personal Services

All of these procurement methods involve consultants – not just contractors. The main difference between them is where the line is between consultant and contractor. The following table summarizes the timing of when services are procured.

Stage	Consultant Design – Contractor	Systems Manager	Systems Integrator	Design/Build
Planning	Hire Consultant	Hire Consultant	Hire Consultant	
Design	Consultant completes	Consultant Completes	Select Supplier during this stage	Select Design – Build contractor at the beginning of this stage
Implement	Select Contractor at Beginning of this stage	Select Contractor or Supplier during this stage	Supplier Implements under Systems Integrator supervision	Contractor Implements

The Task Order contract follows a similar path as the System Integrator, but is typically reserved for more modest efforts. Under this type of contract, the agency must be very specific in defining the task for the consultant. This process has the lowest risk, but requires detailed advance planning. The personal services contracts are used for supplemental staff. It is typically a procurement of an individual's services for a defined period. This is typically for additional office staff but can be used when specific technical skills are required.

The lowest risk process is either the Systems Manager or Systems Integrator when it comes to procuring ITS systems. They provide significant support in the planning and design phases, which is most critical for ITS projects and system integration. They can remain under contract until the system is installed and tested. If much of this work can be written into task orders, it will further reduce the risk.

The potentially least expensive process is the Design/Build process. The process will most likely be lower cost to install, as the contractor has every incentive to deploy quickly and end the contract. However, this process carries the most risk, as the agency has less involvement in the design and deployment process, and is sometimes left with a system that does not meet their original needs.

Public private partnerships are a separate set of procurement possibilities. Each one of these is typically unique. A private entity believes they have a means of making a profit, and the public agency believes they have a means of meeting the public good at a low cost. To date, few ITS services have paid for themselves directly (most have a great benefit to cost ratio, but the benefit is typically in quality of life not direct dollars). These efforts need to be examined thoroughly by any agency before proceeding.

Recommendation – Mexico examine current procurement practices against other practices to determine which has the greatest potential for success against the risk of failure. The more thorough approaches are generally recommended, but they bring with them increased consultant costs for technical and administrative assistance.

Inter and Intra-agency Data Sharing

The core principal behind all ITS is integration. Each system works well on its own, but as they are integrated together, everyone realizes the benefits of increased productivity and more efficient operations.

One large stumbling block to achieving this goal is the lack of coordination within Mexico of databases and information. For example, open road tolling can only succeed if there is one national database of license plates with accurate information.

Several projects were identified in the program in Task 8 related to interagency data sharing. The biggest issue with this item is that ITS is only one of the many users of a potential new system. Any new system has to serve its primary goal first, and meet

internal requirements before the ITS application can be truly considered. For this reason, these efforts are a high priority for the ITS program – simply because they will take many years to implement before any ITS system can truly benefit.

Under this issue, the main data elements that need to be supported are as follows:

Vehicle license
Vehicle owner
Individual driver license
Violation information on vehicle
Violation information on driver
Relationship of vehicle and driver to permitted transit services
Relationship of vehicle and driver to permitted cargo services

The business process of standardizing the approach, security, and database sharing of this information is most critical. In order for the data to be useful, it has to be up to date and accurate. If the process is flawed, the data will be flawed. So the entire business process needs to be reviewed and the appropriate systems created to ensure national data sharing. While the ITS system owners should be a part of the process from the beginning, true use of the data will generally have to wait until the new systems are deployed.

Recommendation – a total business review of those government functions related to vehicle licensing and permitting as well as individual licensing. Automation and data sharing should be priorities, with security and personal privacy as important components.

Standards

The issue of standards are discussed in Task 7 section 3.1.2.3 (US Standards discussion), 3.1.5.1 (European Standards discussion), 3.2.1 (recommendation to adopt US Standards in general), 3.4.6, (Discussion of communication standards), and section 5.5 Architecture Communications and Standards. Within these discussions, many existing standards were discussed and identified.

The larger issue is the development of a formal national process for developing standards. Either a university or a professional organization can be of great assistance to SCT in developing and maintaining ITS standards. The intent is not to limit competition, but to ensure compatibility and minimal levels of functionality and performance. For example, signal systems do not have to be integrated nation-wide, and a single vendor is not necessary or desirable, but each system should be able to share information and timing plans with other systems.

Recommendation – to use the US based NTCIP standards as a starting point. Other international standards can be introduced where they show a better application to the Mexican market. Any adopted standard will evolve within Mexico, just as NTCIP and ISO standards continue to evolve. Either establishing new mechanisms, or using existing processes to create and maintain national standards.

Mandate State Transportation Plans

Systems Engineering and ITS Architectures are based on the belief that some additional planning up front can make a big difference in the success of the deployment later on. Because of this, planning efforts take on a greater importance than in other transportation efforts.

Since ITS is just one piece of the transportation puzzle, it is not very cost and time effective to have each region go through an ITS planning process while not considering many of the other aspects of transportation. To this end, it should be required of each state that a long-range master plan for transportation be completed. ITS should be one of the included elements of the plan, along with freight, public transit, general mobility, safety, and other aspects. These plans should address anticipated capital projects and operations issues over the lifespan. It would be very beneficial for the process to follow the Systems Engineering process - by developing a concept of operations and some requirements.

The US DOT Federal Aid Policy Guide 23 CFR 940 addresses the implementation of ITS and its application to ITS Architectures and standards within the United States. This section requires an ITS Architecture be in place and requires the following as the minimal requirements to establish an regional ITS Architecture

(1) A description of the region;
(2) Identification of participating agencies and other stakeholders;
(3) An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture;
(4) Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture;
(5) System functional requirements;
(6) Interface requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture);
(7) Identification of ITS standards supporting regional and national interoperability; and
(8) The sequence of projects required for implementation.

The first four items come from the initial stakeholder meetings with each region. Item 5 (and item 3) are specific to the Systems Engineering Process. Items 6 and 7 build from the national ITS architecture. Item 8 is the plan of projects. All of these items are typical components of a regional transportation plan with the exception of 5, 6, and 7 which are specific to ITS.

Recommendation – mandate states and/or regions create and maintain an ITS Architecture if they wish to deploy any ITS systems with national funds.

Ownership and Rights to Data

Personal privacy is a concern everywhere. In general, it is positive to share demographic data with private firms. They can better target their marketing efforts on those most likely to procure from them, and the general public does not waste time with marketing that has little to do with them. However, concerns over identity theft and other targeted crimes has to be balanced with this openness.

Many of the current private sector interests within ITS are focused on the usefulness and value of personal data. This is seen as a major market for the future. Within transportation, most information that is collected is more macroscopic – there is no real identity to an individual data element. However, as mobile phones add GPS and other location services, this anonymity is being reduced.

It is typical that whomever installs the sensors, takes ownership of the data created by those sensors. As information is provided to third parties and value added (combining multiple sources, adding additional information like weather, etc.), then the ownership of the new product often shifts. In negotiating various agreements with private entities (including the media), it is not necessary that the public sector retain ownership. If the sale of non-personal information does not endanger the public and is deemed worthwhile, ownership can be negotiated away. However, it is critical that at the onset, the public sector owns the data it has created.

The primary concerns should be that the public sector investment allows them to realize any potential revenue, and that the privacy of the individual is maintained. Beyond this, use of the data will likely improve transportation across many areas.

Recommendation – have Mexican legal authorities review existing laws to determine the best balance between individual rights and public good and to ensure that the public sector retains its rights to data (and therefore potential revenue) from infrastructure that the public sector has installed.

Mexico National ITS Architecture
Regional ITS Architecture Development

Three training posters were provided to SCT to allow for easy production and dissemination of explanations of what the ITS Architecture is, and how it should be used. These are not intended to replace more in depth training classes, only to provide a guide for field staff to follow as they begin working with the ITS Architecture.

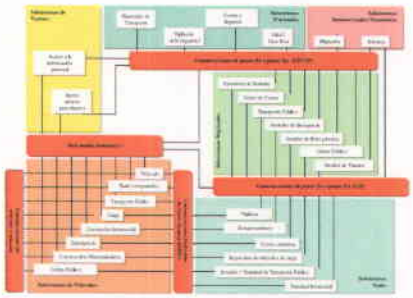
This memo explains how to use the poster for developing a regional ITS Architecture. Under the National ITS Architecture development project, several high level regional architectures were developed. The entire nation was split into seven regions, basically along some existing trade corridors. Regional ITS Architectures can be developed for any size region. They can be anywhere from a single metropolitan area to a multi-state region. The intent is always to provide some continuity and greater detail in a region where integration is critical.

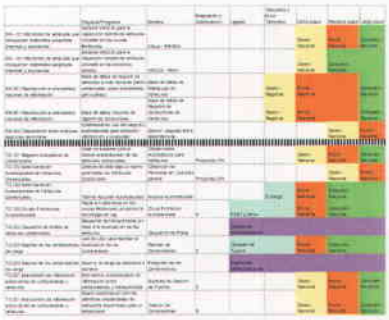
Keep in mind that the purpose of any ITS Architecture is to provide a framework for choosing and developing ITS projects to provide the greatest ability to integrate the projects successfully. The ultimate goal in a regional ITS Architecture is identifying the projects so that as they are built, they can be properly integrated. The process can be divided into the following steps.

Start with the National ITS Architecture

The National ITS Architecture will always exist for all parts of Mexico, regardless of whether a regional ITS Architecture exists. The key components are as follows:

- Chorizo Diagram showing the links between systems
- The service diagrams in Appendix A of the final ITS Architecture document
- Any identified standards
- The national concept of operations
- The current national ITS program





Ideally, everyone should be familiar with the National ITS Architecture. Realistically, everyone should review the components listed above.

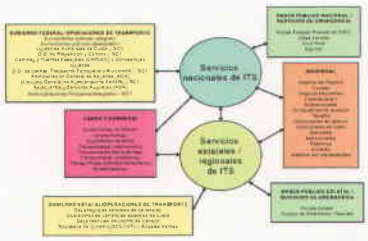
Identify the Region

For a regional ITS Architecture to benefit the implementing agencies, they must have a common purpose. If the transportation network is too fragmented or too great in size, the stakeholders do not have a common need and the region should either be smaller, or the stakeholders should use the national ITS Architecture.

There are several steps that are necessary to identify the region. They are a subset of those steps used in creating the national ITS Architecture.

1. Gather the stakeholders
    a. This should be an open process. The more agencies are allowed to participate (not forced, but given an opportunity) the greater the input and value
    b. Both private and public sector should be considered
    c. Identify who will "own" (be responsible for maintaining) the regional ITS Architecture
2. Define the region
    a. Geographic size
    b. How many years will the ITS Architecture consider (typically 20, but it could be for as little as 5 if the region is very aggressive)
    c. After the size and years are identified, the stakeholders may change. Some stakeholders may drop out and others may need to join.
3. Create an inventory
    a. Start with those projects identified in the national ITS Architecture
    b. Add smaller local efforts and systems
    c. Look at both existing projects, and those that are expected to be completed in the short term
4. Identify Goals and Objectives
    a. Start with the national needs – add or subtract as fits the region
    b. Start with the national goals and objectives – add or subtract

Create the Concept of Operations



At this point, the stakeholders need to determine how they will operate together. They will have already identified all of the stakeholders and through the inventory, they will have identified what systems are or will be operational. The Concept of Operations needs to identify many operational issues including the following:

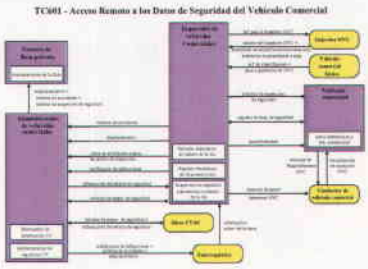
- Who will maintain each system
- Which systems will need to exchange information
- Who will maintain the communications
- Who will maintain the field devices
- Who has ownership of the information

- Who will be able to see the data
- What new memorandums of understanding are necessary

The intent with this document is to ensure all participants agree to their ultimate responsibilities before projects are developed.

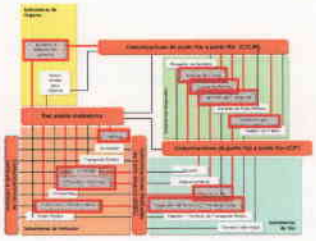
Identify Services

The services identified as part of the national ITS Architecture are contained within Appendix A of the final document. While the services may grow or shrink over time, the current list should provide a service for any project that is under consideration within Mexico for the short term.



At the regional ITS Architecture level, the services need to be identified, but not detailed. That is, if any components within a service meet the goals and objectives of the region, the service should be included in the regional ITS Architecture. The intent is that as projects are developed within the region, they should be able to pull the appropriate service diagram and begin the more detailed project level architecture work.

Define the Regional ITS Architecture



All the necessary work has already been completed for developing the regional ITS Architecture. The stakeholders need to assemble everything into a single document. The document will contain everything accomplished already (from identifying the stakeholders through identifying the services). A new regional Chorizo Diagram should be created, and more detailed interfaces between systems may be added.

If desired, the experts at the national level can review the regional ITS Architecture for compliance with the national ITS Architecture. Compliance can be demonstrated through the following reviews:

- Did the region follow all of the steps outlined above?
- Have they used the same terminology?
- Is it to a sufficient level of detail?
- Have they created something new (this is not non-compliance, rather a new item may require changes to the federal ITS Architecture)?

Develop Initial Program

The National ITS Architecture can be used as a staring point. Through the stakeholder process, many needs and goals should have been identified. These need to be translated into

defined projects. The projects should be programmed into short, medium, or long term projects.

The key aspect of the program is that it allows all stakeholders to see what projects (and therefore what services or functions) they can expect others to develop. This in turn should promote the development of more project ideas, and should aid in the development of project level ITS Architectures.

It is not necessary that a new project idea must already be included in the regional ITS Architecture. However, all new projects should be communicated to the owner of the regional ITS Architecture so that the architecture can be updated to include the new project.

Maintenance

An ITS Architecture is a living document. That is, as projects occur, needs change, new problems arise, the ITS Architecture needs to change with them. It does not have to be changed every time there is a single new project or idea, but it should not be considered a static document that can be used for many years without another review.

In the stakeholder process, an owner should have been identified. It is their responsibility to ensure that the ITS Architecture document is maintained and improved as the region changes. This can be done by continuous minor revisions (as long as they are well documented) or by a review every 1-3 years by the full group of stakeholders.

In all cases, the stakeholders need to understand from the beginning that while the benefits of an ITS Architecture are great (system interoperability, enhanced tools, etc.), the commitment to the process is long term. It should not be too demanding on time, but it will continue beyond the first effort.

Mexico National ITS Architecture
Funding Sources for Early Winner Projects

During the development of the Mexico National ITS Architecture, the early winner projects were compared against potential funding sources. The listed potential sources are meant to cover the capital expenditures, however, some of them may also be used to pay for the operating and maintenance expenses that otherwise would require government subsidy financing.

It is critical that the submitting authority review the latest requirements of each source, and prepare a sufficient justification for the project at the time of submittal. Rules and goals of each are expected to vary over time.

Potential Financing Source	Info Viaje	Angeles Urbanos	E-Carga	Pesaje Facil	Autobus Rural
NAFINSA	M	N	Y	Y	M
Pyme	M	N	Y	Y	M
BANOBRAS/Credit	M	Y	Y	Y	N
BANOBRAS/Fortem	Y	M	N	N	M
CONACYT/Avance	Y	N	Y	Y	M
CONACYT/Fiscal Subsidy	M	N	Y	N	M
Municipal Placement of Securities	N	M	N	N	M
Y: Eligible, M: May be Eligible, N: Not Eligible					

Each of the sources is discussed below with the assumed association to each of the early winner projects.

NAFINSA (Nacional Financiera)
A development banking institution with the mandate to promote the overall development and modernization of the industrial sector with a regional approach; stimulate the development of financial markets

This source is primarily interested in the promotion and assistance of the industrial capabilities of Mexico. The projects must be directly related to industrial development. E-Carga and Pesaje Facil directly impact the movement of goods which directly impacts the cost of doing business in Mexico. They are eligible. Info Viaje and Autobus Rural are projects that impact some smaller businesses – those in web based development, computer services, and transportation services. SCT could make the argument that these industries need help, or that they support other industries directly. Depending on a variety of factors at the time of submittal, they may or may not be eligible. Angeles Urbanos is a direct public sector service, unrelated to industry in Mexico. Therefore, it is not eligible.

Crédito PYME

This source focuses on working capital needs or acquisition of fixed assets such as machinery, equipment and buildings, and technological development and improvement of environmental quality. It is available for firms as well as for entrepreneurs.

This source is focused on fixed assets and environmental quality. The systems that would be purchased for E-Carga, and Pesaje Facil are good fits for this type of funding. Info Viaje, again, requires some computer and communications infrastructure which could be supported as does Autobus Rural. Angeles Urbanos is more of a direct service and would likely not be eligible.

BANOBRAS /Crédito

This is a niche for equipment related with emergencies and security. It is specifically associated with radio communications for surveillance and emergency, as well as for special equipment. Eligible lendees are federal, state and municipal (local) governments, as well as private concessionaries of public services (such as transportation services).

Incident management is directly related to emergencies, so the Angeles Urbanos is eligible. E-Carga and Pesaje Facil both deal with cargo which is a significant security concern in Mexico, so they would be eligible. Info Viaje deals with communications and somewhat with emergencies (in terms of disseminating information), so it is possible that it would apply to the criteria. Autobus Rural does use communications, but has nothing to do with emergencies or securities, so it is likely not eligible.

BANOBRAS /FORTEM II (funded by IDB)

Focused on transportation and urban traffic projects (specific characteristics of the projects need to be discussed with Banobras in order to determine eligibility of the project). Eligible lendees are only municipal governments

Info Viaje is directly related to transportation and urban traffic problems, so it should be eligible. Angeles Urbanos is also related to these categories, but may not be run by a municipal government. Autobus Rural is focused on rural transit, but this feeds into the urban transit system and may be eligible. E-Carga and Pesaje Facil are not specific to urban areas or likely to be led by municipal governments and are assumed to not be eligible.

CONACYT (Consejo Nacional de Ciencia y Tecnología) / AVANCE

"Programa de apoyo para la creación de nuevos negocios a partir de desarrollos científicos y tecnológicos-AVANCE" (Support program for new venture creation based on scientific and technological research and development).

The technology to be applied must have already been proven, should be copy- righted and entirely developed. It is focused on other strategic sectors: Information Technology (IT), and Electronic and Telecommunications. The credit can be applied to: working capital needs, fixed assets, or consultancy.

Info Viaje, E-Carga, and Pesaje Facil all rely on proven technologies in the information technology sector. All three are eligible for funding here. Autobus rural does have some communications and may be eligible. Angeles Urbanos is much more of a direct service project and would likely not be eligible for this funding source.

CONACYT / Fiscal subsidies (tax shield)
The investment must be qualified by CONACYT (per above) in order to be eligible for fiscal subsidy.

A tax shield is of little value to public agencies. This eliminates Angeles Urbanos and Pesaje Facil from consideration. E-Carga could be eligible depending on how the project is structured. Info Viaje and Autobus Rural may be eligible depending on who is applying and the specifics of the project.

Securities placed by municipalities.
These are focused mainly on waste management, water supply and disposal, public supermarkets, and urban transportation. The guarantees are the federal funds assigned to municipalities.

Again, E-Carga and Pesaje Facil are not urban projects and would not be directed by municipalities. Info Viaje is an urban project but will likely not be led by a municipality. Depending on how the application is structured, it may be eligible. Angeles Urbanos and Autobus Rural are both services that aid urban transportation. They would likely be eligible, but it depends on the structure of the request and the particular project.

Mexico National ITS Architecture
Pesaje Facil Economic Review

Pesaje Facil is the project name for a "virtual weigh station". Rather than construct large fixed facilities that are expensive to build and maintain, and are often easily bypassed, small indistinguishable sites are created to weigh commercial vehicles at high speed. This system would deploy hidden sensors across multiple highways that would provide indications of vehicles that are grossly violating weight restrictions. The system is not used for enforcement, only classification. So those trucks that show up as gross violators are pulled over by the police and weighed on a portable scale.

Therefore, rather than stopping and checking all vehicles (which is wasteful for those legal carriers), the system allows police to target the gross violators. The police could then remove these violators from the traffic stream without causing legal carriers to be delayed. The result is an efficient use of resources. Also, by targeting gross violators, the agencies can remove those vehicles that cause the most damage to the roadways. This results in much improved pavement life for all vehicles to enjoy. This also allows for more efficient travel for legal carriers that then provides decreased travel times and increased efficiencies making Mexican industry more competitive with others.

Costs

One assumption on the costs is that the pavement where the sensors are placed needs to be in good condition. If the pavement is in poor condition, it results in trucks bouncing over the scales which reduces the accuracy considerably. It is not recommended to reconstruct several hundred feet of pavement near the scale because this would draw attention to the site and possibly result in truckers either avoiding the location or possibly vandalizing the system.

The scales themselves cost approximately $125,000 US per lane installed. The software and hardware to go with the system, in addition to the cabinet are approximately $10,000 US. Communications is still an unknown. It is assumed that the police would have a wireless connection to a laptop, but the system could be run completely locally. A cost of $10,000 US is assumed for the wireless connection. To complement the high speed WIM, a static wheel load scale is also required. Once a suspected vehicle is pulled over, the wheels can be weighed to verify the true weight. For each fixed scale, two wheel load scales at approximately $50,000 US each are also required. Total initial investment will be $370,000 US for a two lane section of roadway. Ongoing maintenance of the scales should be assumed. A fee of $25,000 US per year assumes annual preventative maintenance as well as replacement of the scales every five years. It is also assumed that communications and power cost up to $5,000 US per year, depending on local providers.

Total cost for four (4) installations across Mexico would be $1,380,000 US in first year costs with annual operating expenses of $120,000 US per year.

Benefits

There are three basic benefits to Mexico – increased pavement life, reduced enforcement costs, and reduced operating costs for the private sector.

PAVEMENT
Overweight trucks cause tremendous damage to the pavement throughout Mexico. The assumption would be that once installed the police could remove several trucks a day which results in significantly less wear and tear on the roadway network (with the heavy trucks no longer on the road).

Current research has not developed a simple formula for the calculation of a per-truck cost for overweight vehicles. Much depends on axel spacing and loading, as well as tire pressure, current pavement condition, etc. However, there are numerous studies that document the cumulative cost of overweight vehicles. North Carolina DOT estimates the annual cost for all overweight vehicles at $130M US. Arizona DOT estimates the annual cost at $160M US. This includes both pavement life reduction, as well as bridge maintenance and failures. Overweight vehicles cause up to twice the damage that a fully loaded legal truck causes.

Considering the size of Mexico relative to these states, it is easy to see estimated damages approaching the $1B US every year. Even a modest decrease in the number of overweight trucks will easily pay for the 4 recommended facilities.

Enforcement is expensive as many personnel and assets are required each time a detail is set up. Assuming a small staff of 10 officers at an average wage of $15 US per hour, with scale equipment that values at $1,000 US per hour, each detail costs $1,150 US per hour to operate. Assuming a relatively high violation rate of 25%, a detail that pulls over all trucks will take approximately 3.5 times longer to catch the same amount of overweight vehicles as one that targets pre-weighed vehicles with a 90-95% accuracy.

This can be viewed two ways. First, the patrols would only have to work 1 hour for every current 3.5 hours to provide the same service. This results in a reduction of 72% of their time. If the patrols operate a conservative 1000 hours a year, that is a reduction of 720 hours a year or a savings of $828,000 US every year. The system would pay for itself in two years.

The other way to look at this is in a three fold increase in fines, assuming the patrols maintain their current workload. Current maximum fines are around $150 Pesos per violation. Assuming a violation rate of 25%, the controlling factor will be how quickly the detail can process each violator. If we assume the calibrated portable scale takes 10 minutes per vehicle, we can assume 6 vehicles are caught per hour. If the details work 1000 hours per year, that is $900,000 Pesos per year. This is approximately the amount necessary for annual maintenance on 3 WIM sites. This represents a six year pay off on a system based on fines alone.

Finally, there is the savings to the private sector. Legitimate carriers would not be targeted, and would have the number of stops they are forced to endure reduce dramatically, and almost be eliminated. If a truck normally spends 3 hours a week in inspections, that is 156 hours a year. The value of the driver and goods (time, fuel, wear and tear, reduced value of goods due to delay) are estimated at $50 US per hour. For each truck, that is a savings of almost $8,000 per year. With the number of trucks in the millions, the savings to the private sector pay for the scales in the first few months of operations.

B/C Ratio

In this simplified approach, no present day value is calculated (the discount rate is assumed to be 0). Over 20 years, the total cost for four installations is $1,855,000 US. The benefits from reduced manpower needs was estimated at $16,560,000 US – a 9 to 1 benefit cost ratio. The private sector savings were estimated at $7,800 per year per truck. With an estimated 1,000,000 legitimate commercial vehicles, over 20 years that adds to $156 Billion US savings to the private sector industry – a benefit cost ratio of about 1000 to 1.

The increased lifespan of the roadways was not estimate. However, at a total cost of nearly $2 M US, and assuming the trucks eliminated from the roadway would impact several hundred kilometers of roadway, even a small resurfacing job over tens of kilometers would be equivalent to the cost of the system. It is expected that the benefit would be more on the order of magnitude of that of the private sector benefits.

Mexico National ITS Architecture
Air Quality Impacts of Early Winner Projects

The four early winner projects were identified as the following:

- Info Viaje – a traveler information system to provide congestion, incident, road work and closure information via the internet
- E-Carga – an electronic manifest project to help speed the processing of commercial vehicles in ports and at borders
- Pesaje Facil – a virtual weigh station project to target gross weight violators while allowing legally loaded vehicles to proceed without delay

As discussed in Chapter 7, the air quality benefits and impacts of ITS projects are not well documented internationally. The majority of the benefits were more directly measured in reduced delays. Without a single source for estimated air quality impacts, other independent sources were found.

Info Viaje

By providing advanced traveler information, travelers are able to make modal, route, and timing choices to avoid congestion or incidents. Thus, they reduce the amount of time spent idling and sometimes reduce automobile trips altogether.

The best source for benefits was the study done by Tech Environmental for the SmarTraveler project in Boston, MA. The study estimated daily savings of the following pollutants:

- VOC – 498 kg/day
- NOx – 25 kg/day
- CO – 5032 kg/day

This was estimated from a reduction of 28,800 trips out of 2.9 million registered drivers. In 2000, Mexico D.F. had approximately 1.3 million registered vehicles – about half that from the Boston study. While a more detailed analysis is recommended to account for a variety of other environmental factors, a simple application of half the emissions from the earlier study still illustrates a significant improvement in air quality for Mexico.

Pollutant	Daily Impact of Info Viaje (Kg)
VOC	249
CO	2516
NOx	12

E-Carga and Pesaje Facil

Both of these projects rely on the same principal – reduction of truck idle time. For E-Carga it is idle time in ports and at inspection points. For Pesaje Facil it is idle time in line at weigh stations.

The USDOT FHWA sponsored U.S. – Canada International Mobility and Trade Corridor project studied the air quality impacts of delays at border crossings. The following table illustrates the estimated emissions per vehicle per hour of idle time:

Pollutant	Grams/idle hour/truck
VOC	44.74
CO	135.53
NOx	129.82

For E-Carga, it is assumed that the trucks do not idle in the port while they are waiting for their paperwork, but that they do idle in inspection lines. An average of two inspections per trip were assumed in Chapter 6. If each inspection delays a truck 15 minutes, that is a 30 minute savings per truck per day. For Pesaje Facil, there are many less truck weight stations. It can be assumed only one weight inspection would be encountered for every four trips. This would result in a cost of approximately 4 minutes per truck per day.

SCT-DGAF provided the total number of the larger semi-trucks that are of most interest to E-Carga and Pesaje Facil as 279,112. If we assume that not all of the trucks are making trips every day (80% usage) results in an estimated 223,290 truck trips each day. This translates to a total hourly idle time reduction for E-Carga and Pesaje Facil of 112,000 and 15,000 hours respectively. The resulting impacts are shown below.

Pollutant	Daily Impact of E-Carga (Kg)	Daily Impact of Pesaje Facil (Kg)
VOC	4995	666
CO	15131	2017
NOx	14494	1932

The benefits outside of air quality were documented in Chapter 6 and other locations.

National Mexico ITS Architecture
ITS Technology Assessment:

ITS technologies have been discussed in numerous places throughout this project. Existing systems were identified and inventoried in Chapter 2 and specific project applications were discussed in Chapter 8. Also, vendor listings are provided in one of the appendices.

This paper is dedicated to identifying the major technologies within each of the service domains. This is not meant as an exhaustive discussion of all available technologies. It is important to note that the decision on what technology to use is highly dependent on the individual project application.

Traveler Information

The collection and distribution of traveler information may take several forms. Highway Advisory Radio, Dynamic Message Signs (DMS), traveler telephone systems, internet websites, connections to media outlets, and the provision of information kiosks at various locations all provide a means of disseminating traveler information.

Sharing information with media outlets can be done by setting up agreements with the media. Once a centralized database of information has been established the dissemination of information should fall to those individuals maintaining the database.

A number of other proven methods of providing roadway information exist. Dynamic message Signs located at transit stops with information on the next bus, use of color coded maps showing speeds, send information to individuals' cell phones; all of these methodologies currently exist. Most of these require additional information infrastructure before they can be deployed.

A brief summary of traveler information techniques is shown below:

Type	Visual	Audio
Roadway-based	• Dynamic Message Signs	• Highway Advisory Radio
Non-roadway based	• Kiosks • Broadcast display of CCTV • Traveler information web sites • Personal digital assistants	• Highway Advisory Telephone • Radio
In-Vehicle based	• In-vehicle navigation systems (GPS)	• In-vehicle mayday-type systems • Digital radio • Radio

Improved Real-Time Traffic Information Services (ATIS central database)

Providing near real-time information regarding roadway, incident and weather condition information is a complex task and requires extensive coordination. The focus of this effort is to collect, process, and distribute multimodal traveler information from multiple sources.

A regional traveler information database requires extensive data collection, processing, and distribution capabilities (collect the data, make sense of it, share the resulting information). Reliable communications infrastructure is necessary for such a clearinghouse. Several ITS technologies along with communication infrastructure serve as building blocks for a regional information clearinghouse.

A data processing system has several responsibilities – to process, manage, and determine quality of data in the system. Central processing typically requires custom software to perform all responsibilities with the data (quality check, processing, etc.) It is important to identify where data will be sent. This initially means to determine a physical location to receive field data. The physical location may need to (at first) accommodate several computers – which means have adequate power supply, room, heating and cooling systems, and communications.

Central hardware components consist of at least one server which will receive field data and share it with GRSM staff on a workstation. The workstation will require development of a graphical user interface (GUI) to display the data received in a useful, user-friendly manner. Most field components come with software that performs these functions. When several field elements information is being received at the central database, and the information requires much effort to view the information in a logical manner, and/or the information received is becoming burdensome on those staff that are using the information, then it is time to consider acquisition of custom-tailored software to compile the various field elements' systems into one system.

Information compiled on incidents, traffic images and counts, maintenance and construction plans, work zones, transit service details, etc. is pushed into the regional clearinghouse by different agencies that are involved in operations and collection of useful transportation traveler information. The information pushed in to the central database is then distributed using various methods.

Variable Message Signs: Variable message signs use various different technologies to provide elaborate signing with programmable messages. These signs provide both fixed legend type information and variable real time information about available parking spots and other parking information.

The following listing presents descriptions of some of the common variable message sign technologies.

Light Emitting Diode (LED) – generate their own light when the diode is electrically charged. To achieve the brightness levels required for exterior use, the LED's lamps are clustered into pixels.

Fiberoptic Shutter – Fiberoptic glass optical fibers direct light from a single halogen lamp to the viewing surface, whereby a lens amplifies the fiberoptic dot. Shutters rotate to either expose or block the fiberoptic dot.

Reflective Disk – Reflect light from some external source. The viewing face is formed by an array of permanently magnetized circular disks or rectangular indicators, which when rotated, form the message pattern. They require power only when the message is being changed.

LED Fiberoptic Enhanced Reflective Disk – These hybrid signs combine two VMS technologies to exhibit qualities of both. The pixels in use depend upon the reflective disk principles of operation with the LED or Fiberoptic dot shown when the disk is in the "on" position.

Liquid Crystal Display (LCD) – This technology relies upon an electrical current to change the orientation of crystals to either block or allow back-lighting to be visible on the viewing surface. Legibility characteristics are excellent; however, this technology is ver environmentally-sensitive and limited in the brightness output.

Portable Changeable Message Sign (PCMS): A PCMS is a smaller version of the VMS that can be relocated quickly within a region. A PCMS is housed on a trailer or on a truck bed and can be deployed quickly for meeting the temporary requirements frequently found in work zones or accident areas. The message is limited by the size of the sign (usually three lines with eight characters per line). Currently, PCMS can be deployed using two different technologies as shown in the table below:

Technology	Description	Advantages	Disadvantages
Flip Disk	This technology utilizes a system of small circular, square, or rectangular disks, individually rotating or flipping to form characters on the PCMS. Each disk has reflective material on one side that, when "flipped", is exposed to form the message. This PCMS type requires external illumination for nighttime viewing but the message remains in the event of a power disruption.	• Proven technology • Low power requirements • Provides a shape legible message • Can still utilize sign if light source fails • High reliability	• More moving parts leads to additional maintenance • Reflective disk surfaces can become sun-bleached over time • Not very visible during low level light conditions at long distances

LED	Light Emitting Diode (LED) technology utilizes clusters of solid-state diodes that form a single pixel. When voltage is applied, each diode glows. By turning voltage on or off, each pixel cluster is manipulated into forming the characters or pattern of the displayed message. Back up power is required in the cabinet to maintain the displayed message in the event of a power disruption.	• Visibility is good under most lighting conditions • Fewer moving parts require less maintenance • LED are rated for 100,000 hours of service • Proven technology	• Smaller cone of vision reduces message legibility at close distances • Diodes can be sensitive to heat • Moderate reliability • Requires continuous power supply

Highway Advisory Radio (HAR)

A HAR system is a low-powered AM or FM radio station that broadcasts messages to motorists who receive them through standard automobile radios. HAR provides motorist information similarly to VMS but can provide more detailed information. The information broadcast can include:

- Congestion reports,
- Hazardous conditions,
- Travel times,
- Alternate routes,
- Special event information,
- Parking locations,
- Weather and road conditions, and
- Construction information.

HAR installation is made up of five separate components:

- Audio Source
- Radio Transmitter
- Antenna System
- Ground System
- Communication System

While there are several different systems within the Highway Advisory Radio category, the type most typically used is the 10-watt "Traditional" HAR. For this application, HAR consists of individual transmitter sites (or stations) located along a roadway, with each

transmitter broadcasting at a range of 3 to 5 miles. Communications with each transmitter are typically via dial-up telephone.

Traditional HAR deployments may be either permanent or portable. Permanent HAR sites are often pole-mounted, with the antenna also attached to the pole. Portable HAR transmitters are typically trailer-mounted, with the antenna and grounding plane adapted for a portable application. Portable HAR is typically used for highway construction, incident management and special events. Consisting of wireless a solar power array and cell-phone control, portable HAR are capable of being transferred from site to site, and has a broadcast range near that of permanently built stations (3-5 miles).

Other HAR include "Low-Power" HAR and system-wide HAR. Although HAR is limited to a maximum power output of 10 watts, "low-power" HAR technology uses a series of interconnected and synchronized 0.1-watt transmitters. This transmission technology may be broadcast over any unused commercial frequency. The main advantage to low power HAR is that the messages transmitted are targeted to specific zones.

Synchronized HAR has increasingly become a popular deployment type, using traditional 10-watt transmitters (3-5 mile radius) systematically placed to create a regional "synchronization zone". Motorists hear the same message anywhere within the synchronized zone. Properly deployed, this type of deployment eliminates interference and delivers a universal broadcast to a synchronized area.

Traffic Management and Operations

Signal Systems

The oldest type of technology is the electromechanical controller. Cycle lengths were programmed by installing appropriate gears and the cycle was split into various intervals by inserting pins on a timing dial.

Microprocessor-based controllers allow new features including, alternative phase sequences and new detector operating modes. However, competing vendors produced proprietary systems.

The National Electrical Manufacturers Association (NEMA) TS1 standard (introduced in the 1980's) was successful in establishing standards for isolated actuated intersection control, but is not sufficient for deploying more advanced features. At about the same time,, the California Department of Transportation (Caltrans) and the New York Department of Transportation (DOT) developed a specification designed to provide both standard connectors and portable software called the Model 170.

In the 1970s, the U.S. Federal Highway Administration (FHWA) developed a structured approach to centralized traffic signal control called urban traffic control software (UTCS). Many of the concepts and system displays currently used were initially developed during the deployment of these early UTCS systems.

The National Transportation Communications for ITS Protocol (NTCIP) effort and the Advanced Traffic Controller (ATC) effort have renewed interest and capabilities in real-time adaptive traffic control. NTCIP has made great strides in enabling interoperability of different vendors if they implement all of the standards. However, NTCIP is not completely comprehensive yet, and all vendors have not implemented all features yet.

The ATC effort resulted in an update to the 170 controllers and is also known as the 2070 controllers. Since then, the ATC standards have evolved beyond the 2070.

Improved Traffic Monitoring and Detection

Without appropriate data collection, most ITS technologies will not have useful information to process or distribute. Data collection to some degree or the other is involved in most if not all ITS technologies. Reliable and effective data collection may be the most important advanced technology available.

Data collected can consist of volume (number of vehicles passing a point), occupancy (the amount of time a vehicle is within the detection zone), speed, and vehicle classification data (length, weight, number of axles, etc.). Detectors may only collect one lane of roadway per detector or several lanes per detector. Maturity, life cycle, and reliability of these technologies varies. Mounting criteria for the detectors, along with power and communication needs also influence which type of detector may be used.

Vehicle detector stations collect real time data on roadway traffic flow. There are several technologies that may be utilized for data collection depending on the environment and the type of data needed to be collected.

Inductive Loop: Inductive-loop detectors are the most extensively utilized detectors in the United States and around the world. They provide data on volume, speed, and density (occupancy). The technology consists of a loop wire of one or more turns embedded in the pavement and connected to an electronic amplifier (located in the controller cabinet). This detector identifies the presence or passage of a vehicle.

Radar/Microwave: This detector is not pavement-intrusive and is commonly used to monitor vehicle speeds for law enforcement and traffic management applications. Some advanced radar/microwave detectors can also be used as presence detectors. Because they use electromagnetic energy, radar/microwave sensors are typically unaffected by weather conditions, especially when measurements are made from a short distance. They can also be used for both day and night operations. Radar/microwave systems can provide volume, speed, occupancy, and presence detection.

Ultrasonic: These detectors (e.g., smartsonic) are passive acoustic sensors and automated-signal and information-processing systems that listen (no energy is radiated by the system) for the noise generated by stationary or moving vehicles in a detection zone on the roadway. Only those vehicle sounds from within a specific detection zone are retained. Sounds from locations outside the detection zone (such as an adjacent lane) are severely attenuated and are ignored. The detection process for vehicle sound energy is analogous to the way the metal in vehicles is detected as those vehicles pass over a loop. It is an overhead-mounted system with limited side mount. Ultrasonic detection fully emulates loop-output signals, and

thus requiring no modification to existing system hardware or software. Ultrasonic systems can provide volume, speed, occupancy, presence, and classification data.

Infrared: There are two types of infrared detectors: active and passive. *Active infrared detectors* focus a narrow beam of energy onto an infrared-sensitive cell, and vehicles are detected when they pass through the beam, interrupting the signal. These detectors can be used either as presence or pulse detectors. Detector performance can be affected by weather conditions (fog, rain, snow) causing inconsistent beam patterns. *Passive infrared detectors* do not transmit energy, but measure the amount of energy emitted by objects in their field of view. Infrared detection systems can provide volume, speed, occupancy, presence, and classification data.

Video Image Processing: With video image processing, cameras provide images that are used by a video processor to emulate traffic data. It is possible to define multiple detection locations within the camera viewing area. These "pseudo detectors" are not fixed, but may be moved by the operator if desired. The type of signal processing algorithm used by the image processor dictates the type of data obtainable by the system. These systems can provide volume, occupancy, and presence detection. In more advanced systems, individual vehicles are tracked as they pass through the field of view, allowing identification of speed, vehicle classifications and travel times in the detection zone. Most processing algorithms have been optimized to compensate for shadows, illumination changes, and reflections.

Closed Circuit Television (CCTV): CCTV systems have been used for many years in the United States and around the world to provide visual surveillance of the freeway system. *Fixed location* CCTV systems include video cameras that are permanently mounted either on existing structures or on specially installed camera poles. This type of system consists of various components, including the following:

- Video camera unit
- Mounting structure (existing or installed)
- Controller cabinet housing the control equipment
- Communication system connecting camera to control center
- Video monitors and camera controls located in control center

Video images from cameras may be transmitted to a control center using either full motion video or compressed video. Full motion video allows real-time video to be transmitted to the control center. Real-time video is typically transmitted at a rate of 30 frames per second. This transmission type results in no information loss; however, it requires a wide communication bandwidth, such as that provided by coaxial cable or fiber optic cable.

Compressed video is an attractive option when it is not feasible to install the communication medium required for full motion video. An advantage of compressed video transmission is that video data can be transmitted over conventional telephone lines and cellular channels.

With compressed video techniques, transmission rates of 8 to 10 frames per second are possible. Because some information is lost between picture frames, the resulting image

appears slightly "jerky." The image, however, is adequate for monitoring freeway operations. A compressed video system typically includes the following:

- Compression and decompression (codec) computer for each camera/monitor link
- Appropriate software
- Communications medium (typically a leased ISDN [Integrated Service Digital Network] line).

Standard cameras, monitors, and control hardware can be used, and therefore, can be reused if the communications medium is upgraded to allow for full motion video transmission.

The newest trend in CCTV is for IP addressable equipment, so that cameras and their images can be controller over the internet.

Weigh in Motion

The Weigh in Motion (WIM) Sensor is the key equipment component to measuring the weight of trucks and identifying overweight trucks. The most commonly deployed WIM sensors are the following:

- Single Load Cell
- Bending Plate
- Piezo quartz
- Piezoelectric (ceramic).

The performance of any WIM system is both site dependent and travel dependent. Site dependent results are expected to vary based on installation of the sensor, road conditions, and roadway geometrics. Travel dependent results are expected to vary based on the condition and loading of the vehicle which contributes to vehicle bouncing and shifting of the load within the trailer/container or redistribution of the contents of individual shipping units through the suspension system.

Piezoelectric sensor

Historically, the most common WIM sensor for traffic data collection purposes is the Piezoelectric sensor. The basic construction of this sensor consists of a solid copper strand, surrounded by a piezoelectric material, which is covered by a copper sheath. When pressure is applied to the piezoelectric material an electrical charge is produced.

More recently the piezo quartz sensor has gained popularity because this sensor is insensitive to changes in temperature when installed in a structurally sound pavement, particularly portland cement concrete. Quartz is a nearly perfect transducer material and has a flawless linear output, that remains stable under changing temperatures. The piezo quartz sensor is approximately three (3) feet in length, requiring four sensors abutted together to cover a twelve (12) foot traffic lane.

Piezoelectric sensors requires a minimum vehicle speed of approximately 10 mph, suggesting locations approaching toll lanes should be avoided. Another shortcoming is the narrow contact area with a truck's tire results in the pavement and sensor simultaneously sharing the

wheel load that varies based on type and inflation of the tire. Consequently, the resulting output signal from the senor varies for different vehicle types. When properly installed and calibrated, a piezoelectric WIM system should be expected to provide gross vehicle weights that are within 15% of the actual vehicle weight for 95% of the trucks measured. Piezo quartz sensors are capable of achieving an accuracy of 10% of the actual vehicle weight with a level of confidence of 95%. Piezoelectric sensors have a relatively short life relative to the alternative WIM systems. Reliability is highly dependent on pavement conditions, temperature variations and installation.

Bending Plate

A bending plate WIM system uses a technology distinctly different than a piezoelectric sensor to determine vehicle weight. Strain gauges bonded to the underside of a steel plate installed flush with the pavement are used to measure the strain induced in the plate by a vehicle's wheel load. A bending plate scale consists of two 2' x 6'steel platforms installed either adjacent to each other to provide continuous 12 foot coverage or staggered typically 16 feet to achieve greater independence of the left and right wheel load measurements. The measured strain in each plate is then translated into a corresponding vehicle axle load. A bending plate scale installation typically includes two inductive loops (see the typical installation detail below). These inductance loops are used for the following: to detect approaching vehicles, to differentiate and separate closely spaced vehicles, and to measure speed. In addition, an axle sensor may also be installed to provide vehicle length and axle spacing information.

An accuracy of 5-10% of the actual vehicle weight can be expected based on a measured truck quantity providing a level of confidence of 95% and when the bending plate WIM system is properly installed and calibrated. Most important is the condition of the roadway pavement prior to installation. Poor pavement conditions can be expected to result in poor performance.

Single Load Cell

The most common version of this technology operates by installing one or more hydraulic cylinders containing oil below each of two independent weighing platforms to transfer wheel loads into hydraulic pressure that is correlated with axle weights. These platforms are most often configured in a single alignment to cover a 12-foot lane while independently providing weight estimates for the right and left tire(s) of each axle. The system electronics records and analyzes changes in pressure output by each scale, converts to a wheel load and sums them to obtain the axle weight. Each weighing platform is installed flush with the pavement surface and typically provides a surface area of 6 feet by 3.2 feet. A single load cell scale provides one hydraulic load cell or strain gauge load cell at the center of each platform that measures the force applied to the scale.

When properly installed and calibrated, a single load cell WIM system can be expected to provide gross vehicle weights that are within 6% of the actual vehicle weight for 95% of the trucks measured.

Highway-Rail Intersection

ITS technologies hold promise for improving information, communication, and control at highway-rail crossings and may be deployed to improve levels of safety unattainable with

conventional approaches. ITS technologies offer options for more powerful tracking and communication of the status of trains throughout a rail network. Advanced Train Control Systems (ATCS) involve the application of computers, digital data communication, and other advanced technologies to the management and control of the railroad, locomotives, maintenance and inspection efforts, and elements of the railroad infrastructure. ATCS implementation promises improvement in operational efficiency, employee and public safety, and customer service. Also, technologies as familiar as loop detectors or as new and rapidly developing as video detection and Doppler radar are being used or considered for use for monitoring crossings.

Vehicle Services

The vast majority of technologies in this service area are those supplied by auto manufacturers. They include items such as collision avoidance systems, lane departure warning systems, pre-crash restraint systems, etc. As these systems are outside of the procurement responsibilities of public agencies, and highly proprietary, the individual systems are not ranked or discussed as part of this paper.

Freight Transport

Road freight fleet management systems generally consist of a number of telematic systems which use remote devices on both freight vehicles and trailers to control and monitor freight operations. This data can be used by freight managers to get the most efficiency out of their fleet of vehicles. Fleet efficiency can result in reductions in fleet mileage, operational costs and fuel consumption as well as improvements in safety.

Data systems focus on the following areas:

- Data on the performance of both drivers and vehicles;
- Vehicle tracking systems;
- Two way communications between the vehicle/driver and the manager;
- Trailer tracking;
- Paperless manifest and proof of delivery;
- Traffic information and
- On-board navigation systems.

All of these areas involve a couple of technologies. There must be computers in the truck to monitor systems and provide communications. There must be a means of tracking the location of the vehicle. And the managers must have computers to receive and process all the necessary information.

The computer systems on either end will not be discussed here. Again, they are generally proprietary and there are several vendors that can meet the needs of any shipper or carrier. They can be used for overall management of the loads, as well as monitoring the vehicle and all of its systems.

Location is typically done via satellite and GPS. As trucks can go almost anywhere on the roadway network (and sometimes off the roads), creating an infrastructure to locate the vehicle is cost prohibitive. While GPS is the standard for tracking vehicle location, communications can be either via satellite or cellular network. Again, proprietary RF requires the trucks stay on a facility with the infrastructure and is not typically used.

Container tracking is often by other methods similar to toll tags. Theoretically, the container is either in a fixed facility (e.g., a port or on a train) or it is tied to a specific vehicle that already has GPS. However, this does not allow tracking of stolen containers and if the container is separated from the vehicle it is lost. Some more recent tests have placed cellular tags on containers or GPS units. As security and preclearance become bigger issues, it is likely that satellite tracking of all containers will become more commonplace.

Automated Roadside Safety Inspection

This provides real-time access to safety performance records, thus increasing the accuracy and decreasing the time required for roadside inspections. Some aspects of the manual inspection process may be automated through the use of sensors and diagnostics.

The two components are real time communications with a central database containing the latest driver, vehicle, and load information. This is similar to other technologies described in this paper.

The automated inspection of units can be done by a variety of new systems. They generally use non-intrusive means (x-rays or gamma rays) to monitor the contents of a truck to determine if illegal goods are within. These systems can be hand held or truck mounted. The hand held ones have much less power and can only see portions of the vehicle. All of these systems are expensive.

Public Passenger Transportation

Transit AVL

AVL technologies have been used successfully by several transit agencies and have provided encouraging benefits. AVL systems also support several other transit ITS applications like "Next-Bus", traveler information for transit customers, transit signal priority, etc.

Unlike freight, most public transport vehicles do remain on fixed routes – the exception being personalized public transport. For fleets of transit vehicles, use of dedicated short range communications (DSRC) applications is possible. DSRC involves a transmitter/transponder on the vehicle which will communicate with receivers located throughout a route or system. A vehicle may not be in continuous communications, but will exchange information on approaching the next intersection or stop. DSRC is often supplemented with RF or cellular for continuous voice communications with the drivers.

Cellular Digital Packet Data (CDPD) or other digital cellular services are also often used. They provide adequate bandwidth for the exchange of data, but are often unable to transmit

full motion video. Cellular coverage is usually complete in the urban areas, but is dependent on system demand.

Fleet Management for transit is similar to that for freight – there must be hardware on either end that is compatible. Again, there are several vendors that supply complete systems off the shelf.

Emergency Services

The items under this domain include tracking hazardous materials and managing emergency vehicle fleets. Both of these are very similar to the discussions above involving transit and freight fleet management.

Emergency Management

Emergency management systems coordinate responses to incidents, whether these are traffic accidents, incidents involving hazardous materials or threats to personal security.

Emergency Notification Systems, sometimes referred to as "mayday" or "collision notification" systems, have been developed to reduce the time between when the crash occurs and when medical services are provided. By improving information transfer between the trauma care physician and emergency medical service personnel they result in faster, more appropriate care, thus saving lives and reducing disabilities resulting from crashes.

Personal security systems are designed to provide assistance in cases other than when there has been a crash. A number of services may be provided: A hidden panic button that sends a silent call for help to 911 with the exact location provided by the GPS system; voice communication so that the driver can ask for roadside assistance or the location of the closest gas station or mechanic; if a car is stolen, the GPS can provide the location of the automobile to the police and remote control of the automobile's engine and electrical operating systems allows the automobile to be unlocked remotely if the keys are locked in the automobile, the horn to be honked if the driver forgets where the car is parked, or the engine to be shut off is the car is stolen.

The primary objective of emergency vehicle management systems is to reduce the time it takes emergency vehicles to respond to an incident after its detection.

Electronic Payment

Electronic Toll Collection (ETC) is a technology that allows for electronic payment of highway tolls. ETC systems take advantage of vehicle-to-roadside communication technologies to perform an electronic monetary transaction between a vehicle passing through a toll station and the toll agency. Typically, a prepaid account is deducted the appropriate toll amount. ETC systems require transponders or tags as well as vehicle detection and classification and enforcement technologies. The detection and classification systems determine that a vehicle is present and what toll that vehicle should be charged. The tag and collection system exchange data that allows the vehicle to be charged the appropriate toll, and then the enforcement system is used if the system determines the vehicle does not have a valid transponder. All of this can occur at highway speeds.

There are several different tag/reader technologies. The U.S. technologies are not compatible with those from Europe which are not compatible with those from Asia. The following is a list of the major applicable systems.

Current IAVE system components are developed in Europe using a standard of 5.8 GHz.

Current standards for the US are for the use of 900 MHz equipment, of which the standards differ from region to region in the US, although there are three main standards:

- California Title 21 (read-only communications, not 2-way), which defines the interface, protocol and functional requirements for tags to be used in California for ETC. Technically, this permits any vendor to manufacture a tag for use in California provided it meets this standard. It is noted the US state of Colorado is also implementing this standard.

- EZPass Interagency Group (IAG), which utilize proprietary tags manufactured by Mark IV along with compatible communication protocols. Two states previously not in the IAG, Illinois and Virginia have used the same tags and protocols as well, but recently these states have joined the organization as well, thus providing the ability for US drivers to travel throughout the northeastern US using one form of ETC. In the future, it will be likely possible to travel from Illinois to New York, Massachusetts or Virginia using EZPass.

- Individual state standards, including those in Florida (SunPass), Texas, Oklahoma, Georgia, South Carolina, Kansas, and Louisiana. Some of these are passive tags that do not require on-board power (battery). While cheaper to manufacture, the passive tags have less long-term capability than the active tags.

The U.S. has recently approved implementation of a DSRC standard at 5.9 GHz, which will serve as the basis for the next generation of technologies to be deployed for ETC as well as all other potential DSRC applications. The standard includes not just the radio frequency, but also the development of a standard communications protocol that accommodates ETC, electronic truck preclearance, communication between vehicles and roadside devices (for in-vehicle information, safety and warning systems), and vehicle-to-vehicle communications.

Transit Fare Cards

Automated systems to collect transit fares use "contact" fare cards that require the card to touch the reader, or "proximity" cards that need only to pass near the reader. The most common contact fare media are magnetic strip cards. The most common proximity cards use radio frequencies and are plastic.

A more recent development is a contact card that has memory and, in some cases, a microchip (also known as an integrated circuit). This application has great potential for transit use, but important technological considerations have yet to be resolved for everyday

use. More promise may lie with flash memory processors such as those used in many mobile phones.

Transit fare cards in principal work the same as electronic toll collection. They represent a pre-paid value that is deducted each time a user passes through some payment portal. Fare cards tend to require less real time coordination with a central system, and enforcement is usually immediate through physical barriers. There are several vendors of fare card systems that can provide a complete package to any agency.

Road Transport Related Personal Safety

In-Vehicle Safety

Much of this area is already handled by personal services through third party contractors. The GM OnStar system is the leading example. Either at the touch of a button, or automatically upon some other trigger (i.e., air bag deployment), the system establishes communications between the vehicle occupants and private sector monitoring service. The services can include anything from directing the driver to a movie to mayday services in the event of a crash.

Public Travel Security

The risk of being involved in a crime incident is at least twice as great in a transit system as in a private vehicle. Technologies used for transit security include:

- Closed-Circuit Television (CCTV)
- Call boxes/Emergency Phones Alarms
- Automated Ticketing Systems
- Automated Vehicle Location Systems

Weather / Environment Monitoring

Improved Road, Weather and Air Quality Information Systems

Accurate and updated weather and road condition information is absolutely critical for some regions. Road and Weather Information systems employ a variety of different types of technology to measure and detect a variety of different weather indicators. Such systems consist of a network of monitoring stations located along primary roads and identified trouble spots, for example bridges or mountainous regions.

The data required for such systems is collected by road and atmospheric sensors. **Road condition sensors** are in-pavement sensors that collect microclimate information and can work with de-icing systems in targeted trouble spots. Measures of road conditions include road surface temperature, condition (wet, dry, etc.), and amount of de-icing materials present.

Surface Sensors – Generally, pavement sensors are embedded into pavement so the top is flush with the surface. These devices can measure numerous conditions on the road surface. These conditions include road temperature, road moisture, what the form of that moisture is (snow/ice/water), the amount of de-icing chemical present on the roadway, and the freezing point of the chemical/water mix.

Subsurface Sensors – Subsurface sensors are generally installed 17 inches below a surface sensor. The small probes indicate when frost appears or disappears from the sub grade. This information is used in understanding the energy balance and for forecasting changing surface pavement temperatures.

Ground Penetrating Radar – Ground penetrating radar is being used for pavement thickness and condition evaluations and for mapping subsurface moisture content. This technology has been deployed using sensors attached to moving vehicles but has not been developed yet for continuous data collection applications.

Atmospheric sensors measure weather conditions at locations adjacent to the roadway. There are several different types of road and atmospheric sensors that measure different elements of roadway and climatic conditions. Atmospheric sensors detect air temperature and humidity, may detect onset and termination of precipitation, wind speed and direction measurement, some also detect visibility reading.
Atmospheric sensors are classified by the type of collected information such as air temperature, humidity, wind speed and direction, precipitation, and visibility.

Disaster Response Management and Coordination

Incident/Emergency Management Planning*

ITS is well suited for incident and emergency management. Accurate, timely information is vital to properly managing roadway incidents and emergencies. The ability to quickly provide the public the necessary information to maximize public safety, minimize delays, and reduce the potential for secondary incidents is key.

The technologies used within this domain have all been explained elsewhere in this document.

National Security

The issues at the borders often are the responsibility of non-transportation agencies. However, ITS can still be an asset at the border. The efforts generally fall into one of three categories.

Credentials – The sharing of electronic credentials to speed processing at the border is similar to the sharing of traveler information. It involves the sharing of data and real time wide area communications between several (often large) computer systems. This technology has already been addressed.

Inspections – Under the Freight domain the issue of inspections was discussed. The same technologies apply to inspecting vehicle contents and vehicles themselves at the border.

Toll Tags – whether the tags are used for actual tolling, or credentialing, this technology was discussed under the Electronic Payment domain.

Power and Communications

For every ITS technology considered for deployment, there is an issue of connecting the technology to power and communications back to a central location. Technologies cannot function without power and communications. So, in addition to the technology assessment presented, a discussion and recommendations are presented regarding electrical power and data-communication requirements for longer-term ITS deployments. The ultimate decision as to which technologies are deployed lies with the individual project design teams.

Wide-Area Communications

The communications infrastructure forms the backbone of all ITS projects/applications deployed. An intelligent transportation system is comprised of many elements — field components such as variable message signs (VMS), detector stations, ramp meters, and Closed Circuit Television (CCTV) cameras; central equipment such as computers, workstations and monitors; and the human element (i.e., system operators and maintenance personnel). For the system to function properly, it will be necessary for each of these components to exchange information efficiently and effectively with other system components. It is the communications network that provides the connecting link for information between system elements.

An area wide communications system can be designed using either hard-wired or wireless communication media. The most important factor in communication system design is the scope (coverage area or connection requirements) and the objective (planned ITS deployments) for the proposed communication system. The following are different technologies used in typical communication systems:

Hardwire technologies include:

- Cable (Twisted pair, Coaxial, and Fiber Optic)
- Lease telephone lines (Voice grade, Digital communications such as T1 lines)
- Switched Telecommunication services (Dial-up wireline)
- Cable TV providers

Wireless Communications include:

- Radio networks
- Spread spectrum radio
- Point to point microwave
- Air path optics
- Satellite

	Advantages	Disadvantages
Hardwire:	• Network may already be in place • System redundancy often built in • If lease lines, no maintenance • Very reliable • Large bandwidths available	• Network may not be in place • May be expensive to install in remote locations • Relatively simple design compared to Wireless • May require repeaters

Wireless:

- No need for physical medium
- Lower installation cost
- Easily spans natural barriers
- Provides communications where ROW is not available
- Flexible implementation
- Commercial off-the-shelf equipment available

- Less reliable
- Relatively complex design compared to Hardwire
- Limited choice of operating frequencies
- Line of sight constraints for some technologies (900 MHz, Microwave, Spread spectrum Radio
- Limited bandwidth
- Monthly cost for cellular service
- May require repeaters

Wireline Options

Technology	Advantages	Disadvantages
Twisted Pair Cable	• Easy to maintain • Least expensive • Highly reliable • Proven technology	• Limited bandwidth • Minimal video capability • Conduit or overhead wiring required • High cost to install
Coax Cable	• Easy to maintain • High data capacity • Video capability • Highly reliable • Proven technology	• Conduit or overhead wiring required • High cost to install
Fiber Optics	• Very high data capacity • Video capability • Excellent noise immunity • Highly reliable • Proven technology	• Complex to maintain • Conduit or overhead wiring required • High cost to purchase and install

Wireless Options

Technology	Advantages	Disadvantages
Spread Spectrum Radio	• No physical connection required • No FCC license required • Low potential for being interfered with or being	• Complex to maintain • Line of sight required • Limited video capability

	interfered by other users • Easy to install (noise immunity) • Moderate reliability (in GRSM)	
Microwave Radio	• No physical connection required • High bandwidth • Video capability • Moderate reliability (in GRSM)	• Complex to maintain • FCC license required • Line of sight required
Satellite	• No physical connection required • Cost independent of distance – ideal for long distance transmissions • Has video capability • Moderate reliability (in GRSM)	• Complex to maintain • High monthly leasing cost • Large antenna required at each site
Cellular Telephone	• Relatively easy to install • Currently used in GRSM • Moderate reliability (in GRSM)	• Poor reception possible in some locations

Power Requirements

ITS devices require power. Power is required to operate the device, whether it is to raise or lower a gate, or display a message on a variable message sign (VMS). Power is also required to operate the communications equipment. In order for an ITS device to operate it must have power.

The amount of power required depends upon the device. A device such as a traffic monitoring station has low power consumption whereas a variable message sign will have higher power consumption. The amount of power required is directly related to whether a device can operate using batteries and solar power or must be connected to the utility grid.

ELECTRICAL POWER

Power from the Utility Company

Connection to the electric utility grid is the general means to provide a consistent source of power. The longer the distances the power lines are run the larger the required electrical cable. Typically a higher voltage than required by the ITS devices would be supplied by the cable. At each device a step down transformer would be placed to reduce the voltage to either 120 or 240VAC.

Power from Batteries and Solar Cells

Devices requiring a low amount of power, or power for only short time periods, may be powered by banks of batteries. The device, depending upon its power requirements, may be

able to be powered by a bank of gel cell batteries. The battery bank is kept in a charged state by a solar cell array.

Any use of a battery bank and solar cells will require a site evaluation. The number and size of batteries required to power the device must be ascertained. In addition, the number, and size of the solar cells, as well as whether the cells will receive an adequate amount of sunlight to maintain the charge on the batteries must be determined.

References

Great Smokey Mountains ITS Architecture Working Paper #3
Martha Morecock-Eddy

http://www.calccit.org/itsdecision/serv_and_tech/list.html

A3A18: TRB Committee on Traffic Signal Systems
Traffic Signal Systems - *Addressing Diverse Technologies and Complex User Needs*
Darcy Bullock, Purdue University, Tom Urbanik, Texas A&M University

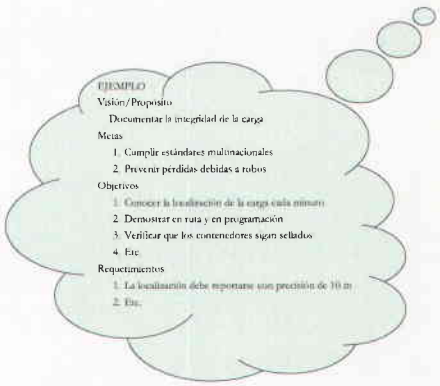
Mexico National ITS Architecture
ITS Project Development Explanation

Three training posters were provided to SCT to allow for easy production and dissemination of explanations of what the ITS Architecture is, and how it should be used. These are not intended to replace more in depth training classes, only to provide a guide for field staff to follow as they begin working with the ITS Architecture.

The third poster is on how to use the Mexican National ITS Architecture to properly develop a project.

Project Concept

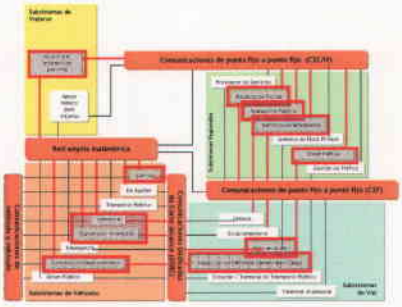
The first step is to develop the project concept. It is literally just developing an idea of what you want to accomplish and how you initially believe you will accomplish this project. There is no need for a lot of detail at this point. A one or two paragraph description of the project and the problem it will try to solve. The description should include the following:



- Problem description
- Project concept
- Proposed location
- Major components
- Major stakeholders/participants

Application to the Regional ITS Architecture

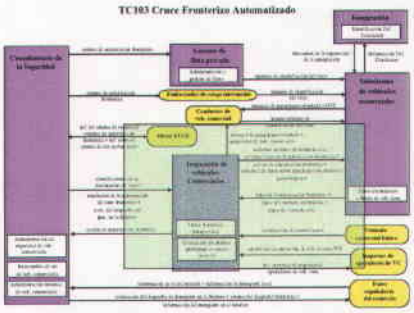
The next step is to use the chorizo diagram to identify the various systems and communications that this project should consider. If a regional ITS Architecture does not exist, you can use the National ITS Architecture. The general approach is as follows:



- Consider each and every box on the ITS Architecture diagram.
    - Is there any existing systems with which this project should coordinate?
    - Is there any planned system with which this project should coordinate?
- Consider the communications type
    - Wireless – existing or planned
    - Landline – existing or planned
- Any owner of an identified system or communications should be added to the stakeholders list

    - Confirm status of their systems
    - Examine joint opportunities
- Modify and add to the project concept to represent the identified opportunities and issues

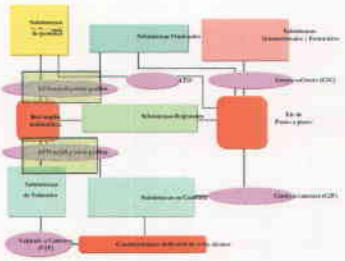
Project Architecture



At this point, the project owners need to start identifying some details about the project. The service diagrams are used to explicitly identify systems and data elements that should be addressed in this project – either in this phase, or in future phases. It is important to identify all components, even if you know they will not be completed in this initial project. Other systems will use the project architecture from this effort to identify what they will do in their next project, so the more that is identified now, the more likely those features will be added to new projects. The individual components are as follows:

- Go to the service diagrams in Appendix A of the Mexican National IT'S Architecture document. Identify all services that apply to this project based on the service description and the previous project work. There will likely be only one or two.
- For each service diagram, identify the functions/services (e.g., "TMC dispatch") that apply to this project (existing and planned) and the data elements (e.g,, "traffic data") that need to be exchanged between the various systems.
- The result can be a modified service diagram(s) with only the elements that apply (existing and future shown differently) along with a textual description of the analysis.
- This analysis and diagram(s) still includes different agencies or companies that have a potential role in this project.

Identify Standards



Now that the data elements have been defined, and the general approach to communications, the necessary standards can be identified. The standards don't have to be officially sanctioned – they can be legacy standards. For example, if there is an existing large traffic management center that has real time traffic data available, but only in a format created ten years ago, because this is an important source of data for the new project, the new project will have to work with the legacy standard. The standards are not enforced upon the project at this moment. They are only identified as an input to the future design work. As the communications (in particular) may not yet be determined, there may be several identified standards at this point. The work for this step is as follows:

- For each data element identified in the previous step, check for existing data standards
- For each data element identified in the previous step, check for regional, national, and international standards that could be applied.
- For each method of communications, identify the standards that will likely apply.

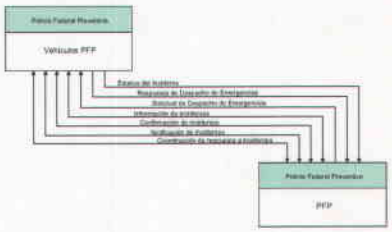
Concept of Operations

At this point, considerable effort has been put into this project concept. Some of the elements of the Systems Engineering approach have already been completed, though not necessarily specifically identified. The basic elements of the Systems Engineering process are specifically identified in this step of the process. They are collectively called the "Concept of Operations". The elements are as follows:

- Inventory
  - The systems that are part of this project were already identified in several of the previous steps. Here, they are specifically identified as existing systems.
  - Future or planned systems should also be identified, especially if there is a likely timeframe around each.
- Needs, Goals, and Objectives
  - While describing the project problems and goals, the basic needs have been discussed. Here, they need to be specifically identified.
  - The goals flow from the needs. That is, for each need (e.g., improve incident response time) there should be several goals (e.g., quicker incident identification, better determination of closest resource, etc.)
- Operations
  - Each participating agency or company should have its role in the project defined. This may include such items as the following:
    - New operational responsibilities
    - Who will maintain the new equipment
    - Who will pay for communications
    - Agreements on data sharing – what will be shared and when
- Requirements
  - Each goal should have one or more requirements associated with the goal. These are done in two levels. First, high level requirements are developed. There may only be a few high level requirements for the project, depending on its size. For example, building on the incident management example, "the public shall have a simple number to call to report an incident".

- For each high level requirement, detailed requirements are then developed. The detailed requirements will trace exactly to the design, so they must be more specific, and verifiable. For example:
  - "Call boxes shall be installed at no more than one every two miles"
  - "A three or four digit cellular number shall be available for public use"

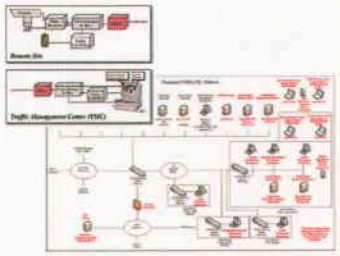
Design



You have just identified why this project is important, what problems it will solve, and who needs to participate. You have also begun to identify how the project will solve these problems. Now you need to start identifying the details of how this project will be accomplished. The design can be multiple projects, or a component of a larger project. There may be an initial design followed by a detailed design, or the entire effort may be a subset of a larger design/build project. All of the steps in the design process need to build from the requirements identified in the previous step. Each requirement should translate to several design elements. The goals is that at the end of the design phase, the product should be a document that any vendor could use to develop the final system.

Depending on the complexity and size of the project, the following elements may or may not be included. There may also be other design efforts that are not identified here but are still necessary to provide a bid package for the eventual vendor. These general design elements are as follows:

- Data elements – system interfaces
  - This is one of the most critical steps that uses all of the information gathered to date from the ITS Architecture efforts. The exact data needs to be identified and developed.
  - More detail is needed on the previously identified data elements. "Traffic data" should become something similar to "one minute travel speeds for each detector".
  - The standards are then applied to develop more detail. For example, "speed in kph, followed by ten digit detector number, followed by time and date".
  - Explicit design instructions are then created. For example, "bits 1-8 are for speed in kph to the tenths place, etc."
- Communications
  - Previously, there may have been one or more alternatives identified for communications. The first step is to analyze the communications to determine which best meets the needs and requirements



    - Then standards are applied from the communications. This applies to both physical construction as well as electronic standards
    - Explicit design instructions are then created
- Physical design
    - These are the more traditional elements. Plan sheets on where to install a pole and how to install it.
    - Actual hardware is specified at this point. Either model name, or detailed performance requirements that the vendor will have to meet.
    - Agency standards are applied where applicable
- The final product is a complete bid package that can be used to procure the system.

For all design efforts, there MUST be traceability to all of the requirements. Any changes that occur (e.g., a technology is not available) must be identified and the requirements changed to reflect this decision.

Procurement and Implementation

The procurement method is typically dependent on the agency rules. The implementation does not directly use the ITS Architecture, though any problems identified during the implementation need to be communicated and addressed in that context, so that future projects can benefit from the experience.

National Mexico ITS Architecture
Immediate Action Plan

The action plan identified in Chapter 10 went through a wide variety of steps and actions that are required in order to have a successful ITS program in Mexico. This included addressing concept of operations, funding, agreements, project program, as well as other issues.

The following is a step by step 24 month detailed action plan. The focus is just on the next 24 months, as the longer term was discussed in length in Chapter 8. Everything discussed in this paper is consistent with the current chapters of the final report.

Month 1

Hire an ITS Manager.

One of the biggest institutional issues has been a lack of staff for ITS. While those involved in the project have been very dedicated, the ITS Architecture remains a small portion of their responsibilities. In order for the program to advance, staff must be hired that are completely dedicated to ITS. Over the longer term, the office can, and should, grow. But the first position that needs to be hired is a champion and a leader. Someone who is dedicated to ITS and has the advancement of ITS in Mexico as their sole responsibility.

Hire an ITS Consultant – create the RFP

The objective here is to have some support staff and expertise that can be tapped to assist the ITS Manager. Over the first two years, Mexico needs a consultant that can help them maintain, and improve the ITS Architecture, as well as provide guidance on writing and reviewing tasks within the ITS office. Over the long term, a large well staffed ITS Office within SCT is likely the best way to advance ITS within Mexico. But it will take a few years to build up the staff and give them some experience.

During this month, staff should begin writing the RFP for the support consultant. Much of this will be through contacting other agencies that have done similar RFPs and assemble the necessary pieces. The timing should be sufficient that the ITS Manager can be hired before the RFP is completed. If this person will be responsible for administering and using this contract, they should have a voice in its content.

Month 2

Hire an ITS Consultant – advertise the RFP

By the end of the second month, the RFP should be advertised. This contract should only be for two years with the possibility of adding one additional year. The limit should be to allow the ITS industry to begin flourishing. With a more robust industry, there may be better candidates for support in two years.

The contract should be designed as a task order. Very specific pieces will be defined by the ITS Manager, scoped, and priced before any work begins. This will give the ITS

Manager greater control over the consultant's work, and allow SCT to more efficiently manage the consultant.

Identify corridors and groups
One of the first responsibilities of the ITS Manager, is to identify who the active players are within the industry. This can be individuals, agencies, projects, or committees. It is important that existing work be encouraged and supported, and the ITS Manager look for areas where he/she can get a lot of support – financial, administrative, use of existing agreements, etc. This will focus primarily within Mexico, but operations and initiatives along the US border are also a high priority.

This task should become an ongoing task. New groups form on a recurring basis. Old groups sometimes get mired in problems and other times are coming out of problems and looking to expand. Every month a day should be set aside to looking for partners and opportunities and examining past performance with other groups. It is not critical to create extensive metrics, but each relationship should be examined on a recurring basis. It is also critical to continue an active role with the US counterparts (at least bi-weekly discussions). This is to give them confidence in Mexico and build relationships. All of this will make future joint efforts much easier to develop and execute.

Hire an ITS Administrative Assistant
The ITS Manager will begin coordinating a wide variety of activities. He/she will need some administrative help dedicated to ITS to help coordinate these activities. The person should be above a secretary level. They should be able to provide assistance in coordinating and controlling contracts and agreements.

Month 3
Hire an ITS Consultant – award and contract
While this is a fairly aggressive schedule, a contractor needs to be brought on board as soon as possible. The contractor should certainly be selected in this month, but all parties should strive to get a signed agreement within this month. Much of the additional work depends on the ITS Manager having some support staff to accomplish each task.

Examine Procurement Issues
The ITS Manager should begin examining the methods and hurdles necessary to procure new services. Legal and administrative staff should be included in these discussions to determine where there is some flexibility with current procedures, and where new procedures are necessary.

Distribute ITS Architecture Information
The ITS Manager should use this as an opportunity to both inform various groups within Mexico about ITS and the ITS Architecture, as well as inform them about the new ITS Office and its role. The Architecture document and posters should be distributed to several agencies and staff within each state and major metropolitan area.

State ITS Plans – initial study

The ITS Manager must work with SCT and others to create a system where each state and/or metropolitan area is required to create an ITS plan – if they wish to receive future federal ITS money. The initial plans do not have to be cumbersome. A ten-twenty page document discussing which ITS projects the region is interested in would be sufficient. While legislation will not happen this quickly, SCT rules or policies may be enacted that create this requirement (at least of the SCT offices).

Month 4

Develop an ITS Architecture Training Class

One of the first tasks of the consultant is to develop a training class on ITS and the Mexico National ITS Architecture. It is important that the various ITS parties become aware of the Systems Engineering process, and the ITS Architecture, so that future projects can benefit from this coordination.

State ITS Plan – requirements

The requirements and details of state ITS plans needs to be developed. This can be a combination of the ITS Manager and the Consultant. Information related to these plans needs to be worked into the training.

Pesaje Facil

The ITS Manager can begin working within SCT to identify the first few candidate locations for this test project.

Month 5

Suggest New Projects

At this point, the ITS Manager has had enough discussions with other agencies and personnel that new projects can be identified. Many of these will be projects others were already considering, and may be at more advanced stages. New projects should be worked into the initial program and individual schedules identified.

Implement an ITS Architecture Training Class

The consultant should start going to each state and/or metropolitan area and provide training on the ITS Architecture and the ITS Statewide Plans. This process is expected to take up to one year.

Examine Agency Business Plans

The ITS Manager and others within SCT should have identified other agencies and groups on which they will depend for information, or actions. Within the federal Mexican administration, each agency should begin its own review of business practices, so that automation required by ITS systems can be built into their new business practices.

It is estimated that this process will take a considerable amount of time. Some agencies may begin quickly, while others may take awhile. This activity can be expected to last at least one year and likely more. It should be considered an ongoing task for the remainder of the action plan. As individual reports are finalized, the ITS Office should take appropriate action.

Pesaje Facil
The ITS Manager and the consultant can begin design work on the Pesaje Facil project. This would include vendor specifications as well as detailed design drawings for the candidate locations. Design can be expected to take 2-3 months.

Info Viaje
The ITS Manager and the consultant can begin defining the Info Viaje project. By this time, critical existing systems should be identified and some preliminary discussions can be completed about the technical information available. The consultant can provide preliminary information about what kind of computer system is available, and what kind of staffing is required for the computer system. The geographic limits can also be determined (will it be in one test location, or nationwide?).

Months 6-9
Hire Additional Technical Staff
During this period, the ITS Program Manager can determine the likely direction projects will take in the coming 1-2 years, and have a better idea of the kind of technical skills that are required to assist the office.

Establish an ITS Standards Organization
ITS Standards are critical to achieving greater inter-operability. Mexico needs an independent organization that establishes ITS Standards for the entire country. A University or trade organization can be most helpful. International groups such as ITE are a good starting point, but Mexico should be able to adapt the international standards to something more appropriate for Mexico itself.

This process should take 4-6 months, and should be continuous thereafter.

Allow States to Develop ITS Plans
As regions and states complete the training class on the ITS Architecture, they should begin developing their regional/statewide ITS Plan. As the training is expected to take up to one year, the plans also will be developed over the next twelve to fifteen months. The plans should not be more than a three month effort at the beginning.

Pesaje Facil
SCT can begin procuring installations of Pesaje Facil. Either one initial test implementation, or up to four or five initial installations would be appropriate. The number depends more on the comfort level of the ITS Program Manager – whether he/she feels comfortable overseeing more than one installation.

Info Viaje
The design process can begin for Info Viaje. This includes completing the systems engineering process started in Month 5, and completing the design of the software and hardware components.

E-Carga
This is the most complex of the three early winner projects. The systems engineering process should be followed in identifying what can be done and what the agencies are able to complete. Much of this may depend on the agency business plans, as to what capabilities they even posses.

Months 10-12
Start Assembling State Plans
As the state plans are completed, the ITS Program Office must assemble the plans and keep track of their contents. This includes adding and deleting projects to the national program, looking for adjacent cooperation opportunities, and sending information back to the states on how they can improve their plan and begin implementing the plan.

This is expected to be a core function of the ITS Program Office. This responsibility will be ongoing for the near term.

Pesaje Facil
Whatever test site(s) were chosen in the previous quarter, the facilities need to be constructed and installed and begin operations.

Info Viaje
Any remaining design issues should be completed, and the initial procurement should begin. Depending on the design, this could be a hardware purchase, a hardware and software purchase, or a contract for someone to build and operate.

E-Carga
During this phase, the ITS Program Manager and the consultant should select the functions that they wish to accomplish with this project, and determine if a second consultant will be required to design the system. This is mostly a continuation of the systems engineering process. The biggest decision will be in the eventual procurement method.

Months 13-18
Ongoing Activities
- Coordinating with Mexican agencies
- Coordinating with US border agencies on joint efforts
- Training
- Reviewing State ITS Plans
- Working with new standards organization
- Agency business plan reviews

Pesaje Facil
With the new operations, the ITS Program Office and the consultant should review the results closely. This will allow for some changes in design or operations that can be worked into the next phase of construction and operations.

Depending on how well the systems are operating, either SCT can proceed with additional procurement, or the consultant can go back to the design level to make improvements.

The contract with the developer should allow for SCT to either use them for additional enhancements, or to cut the relationship and allow a new developer to come in and complete some enhancements. This will give SCT flexibility to either continue with a good developer, or drop them and try someone else.

Info Viaje
The system should be built and operational within this period. Again, it is important that the initial operations is reviewed and checked against the design to ensure a quality product was provided, and to determine where additional changes are expected. It is common that with new operational centers that the owners don't always understand what they are getting until they start using it. It should be expected that the owner will want some changes and enhancements after first operating the system.

E-Carga
During this period, the system should be designed. Depending on the complexity of the final system, and whether a new consultant was required to complete the design, will determine how far the project has proceeded.

Months 19-24
Ongoing Activities
- Coordinating with Mexican agencies
- Coordinating with US border agencies on joint efforts
- Training
- Reviewing State ITS Plans
- Working with new standards organization
- Agency business plan reviews

Pesaje Facil
SCT should be in the process of installing a second round of systems and continuing the operations.

Info Viaje
The owners of the system and the ITS Program Manager should collectively be determining what new features or data sources should be considered next. The second phase design or design procurement should start near the end of this period.

E-Carga
Again, depending on who is doing the design, either a prototype system should be ready, or the designer should be working throughout this period to develop a prototype deployment.

ITS Architecture Update

The ITS Program Manager and the consultant should take a look back at the last two years and begin the process for updating the national ITS Architecture. This includes adding new services that were not previously included, dropping some services, and preparing new training materials with any changes. The Update should begin around month 21 and may not be complete until several months after this period.