Michigan Department of Transportation
Regional ITS Architectures and Deployment Plans

Bay Region

Final
Regional ITS Architecture

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AD	Archived Data
AHS	Automated Highway System
AMBER	America's Missing: Broadcast Emergency Response
ANSI	American National Standards Institute
APTS	Advanced Public Transportation Systems
ATIS	Advanced Travel Information System
ATMS	Advanced Traffic Management System
AVL	Automated Vehicle Location
AVSS	Advanced Vehicle Safety System
CCTV	Closed Circuit Television
CJIC	Criminal Justice Information Center
CRC	County Road Commission
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
DCM	Data Collection and Monitoring
DMS	Dynamic Message Sign
DNR	Department of Natural Resources
DPW	Department of Public Works
DSRC	Dedicated Short Range Communication
EM	Emergency Management
EMS	Emergency Medical Services
EOC	Emergency Operations Center
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
HRI	Highway Rail Intersection

LIST OF ACRONYMS

IDAS	ITS Deployment Analysis Software
IEEE	Institute of Electrical and Electronics Engineers
IMMS	Incident Management Message Sets
ISO	International Standards Organization
ISP	Information Service Provider
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
MAC	Medium Access Control
MC	Maintenance and Construction
MDOT	Michigan Department of Transportation
MDT	Mobile Data Terminal
MITSC	Michigan Intelligent Transportation Systems Center
MOU	Memorandum of Understanding
MSP	Michigan State Police
NEMA	National Emergency Management Association
NOAA	National Oceanic and Atmospheric Administration
NTCIP	National Transportation Communications for ITS Protocol
NWS	National Weather Service
RWIS	Roadway Weather Information System
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users
SDO	Standards Development Organization
STMF	Simple Transportation Management Framework
TCP/IP	Transmission Control Protocol/Internet Protocol
TEA-21	Transportation Equity Act for the 21st Century
TIP	Transportation Improvement Program
TMC	Transportation Management Center

LIST OF ACRONYMS

TOC	Traffic Operations Center
TSC	Transportation Service Centers
UDP/IP	User Datagram Protocol/Internet Protocol
USDOT	United States Department of Transportation
VIVDS	Vehicle Imaging Video Detection Systems
XML	Extensible Mark-up Language

1. INTRODUCTION

1.1 Project Overview

Development of a regional intelligent transportation system (ITS) architecture is one of the most important steps in planning for and implementing ITS in a region. ITS architectures provide a framework for implementing ITS projects, encourage interoperability and resource sharing among agencies, identify applicable standards to apply to projects, and allow for cohesive long-range planning among regional stakeholders. The ITS architecture allows stakeholders to plan for what they want their system to look like in the long-term, and then break out the system into smaller, more modular pieces that can be implemented over time as funding permits.

ITS architectures satisfy the conformity requirements first established in the Transportation Equity Act for the 21st Century (TEA-21) highway bill and continued in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) bill passed in 2005. In response to Section 5206(e) of TEA-21, the Federal Highway Administration (FHWA) issued a final rule and the Federal Transit Administration (FTA) issued a final policy that required regions implementing any ITS projects using federal funds to have an ITS architecture in place by April 2005. After this date, any ITS projects must show conformance with their regional ITS architecture in order to be eligible for funding from FHWA or FTA. Regions that had not yet deployed ITS were given four years to develop an ITS architecture after their first ITS project proceeded to final design.

In November 2006, the Michigan Department of Transportation (MDOT) began development of the Bay Regional ITS Architecture. The Regional ITS Architecture has the same geographic boundaries of the MDOT Bay Region. The Regional ITS Architecture focuses on a 20-year vision of ITS for the Bay Region. In addition, a separate ITS Deployment Plan was developed to identify and prioritize specific ITS projects recommended for the Region in order to implement the ITS architecture. The ITS Deployment Analysis Software (IDAS) was utilized to evaluate and prioritize the list of ITS projects outlined for the Bay Region.

The ITS Architecture and the ITS Deployment Plan were both developed with significant input from local, state, and federal officials. A series of four workshops were held to solicit input from stakeholders and ensure that the plans reflected the unique needs of the Region. Copies of the draft reports were provided to all stakeholders. The Regional ITS Architecture and Deployment Plan developed reflects an accurate snapshot of existing ITS deployments and future ITS plans in the Region. Needs and priorities of the Region will change over time and in order to remain effective this plan should be periodically reviewed and updated.

1.2 Document Overview

The Bay Regional ITS Architecture report is organized into five key sections:

Section 1 – Introduction

This section provides an overview of the National ITS Architecture requirements, the Bay Regional ITS Architecture, and the key features and stakeholders in the Bay Region.

Section 2 – Regional ITS Architecture Development Process

An overview of the key steps involved in developing the ITS architecture for the Bay Region is provided in this section. It includes a discussion of stakeholder involvement, architecture workshops, and the architecture development process.

Section 3 – Customization of the National ITS Architecture for the Bay Region

This section contains a summary of regional needs and details the customization of the National ITS Architecture to meet the ITS vision for the Bay Region. The market packages that were selected for the Region are included in this section and interconnects are presented, including the "sausage diagram" showing the relationships of the key subsystems and elements in the Region.

Section 4 – Application of the Regional ITS Architecture

Functional requirements and standards that apply to the Region, as indicated by the Regional ITS Architecture, are presented in Section 4. Operational concepts identifying stakeholder roles and responsibilities have been prepared and potential agreements to support the sharing of data and resources have been identified.

Section 5 – Use and Maintenance Plan for the Regional ITS Architecture

A use and maintenance plan will be developed for the Bay Regional ITS Architecture and included in this section in the Final Document. The plan will outline the procedure for updating the ITS architecture over time.

The Bay Regional ITS Architecture also contains five appendices:

- Appendix A – National ITS Architecture Market Package Definitions;
- Appendix B – Customized Market Packages;
- Appendix C – Element Functional Requirements;
- Appendix D – Stakeholder Database; and
- Appendix E – Architecture Maintenance Documentation Form.

1.3 Assessment

The Final Draft of the Bay Region ITS Architecture and Deployment Plan has been assessed based on twelve items derived from both the April 8, 2001 USDOT ITS Architecture and Standards Conformity Rule/Policy and from the architecture development process described in the *Regional ITS Architecture Guidance Document.* A listing of these items is shown in **Table 1**.

Table 1 - Summary of Architecture Assessment Categories

Content Criteria	Architecture Implementation Criteria
1. Architecture Scope	8. Implementation Plan (use)
2. Stakeholder Identification	9. Maintenance Plan
3. System Inventory	10. Agreements
4. Needs and Services	11. Standards Identification
5. Operational Concept	12. Project Sequencing
6. Functional Requirements	
7. Interfaces/Flows	

1.4 The Bay Region

1.4.1 Geographic Overview

The Bay Region is defined by the boundary of Lake Huron and Saginaw Bay to the east, the MDOT North Region to the north, the MDOT Grand Region to the west, and the MDOT University and Metro Region to the south, as shown in **Figure 1**. The Region encompasses all of the 13 counties of the MDOT Bay Region of Michigan.

The largest cities within the geographical boundaries of the Bay Region include Flint, Saginaw, Bay City, Midland, and Mt. Pleasant. When developing the stakeholder group, the project team coordinated with MDOT to invite the appropriate townships, cities, counties, State and Federal agencies, and area transit providers. The Bay-Metro Transit Authority, Flint-Mass Transportation Authority, and the Saginaw Transit Authority Regional Services are the primary transit providers that operate within the regional boundaries. The Bay-Metro Transit Authority provides fixed route and paratransit services within Bay County. The Flint-Mass Transportation Authority operates fixed route and paratransit services in and near Genesee County. The Saginaw Transit Authority Regional Services operates fixed route and paratransit for the urbanized Saginaw area. **Table 2** in Section 1.3.4 identifies the stakeholders that participated in the process.

When developing the architecture, a 20-year vision for ITS in the Region was documented. In the ITS Deployment Plan, the 20-year time frame will be broken down into smaller time periods to prioritize and sequence the projects. The naming convention used for elements in the Bay Regional ITS Architecture is consistent with the naming convention that was used in the Grand, North, Superior, and Southwest Regions and the Statewide ITS Architecture. This consistency provides seamless connections to those other architectures without requiring that they be specifically called out. Statewide initiatives, such as statewide commercial vehicle operations and the 511 traveler information service, are referenced in the Regional ITS Architecture, but will be addressed in further detail in the Statewide ITS Architecture.

1.4.2 Transportation Infrastructure

As illustrated in **Figure 1,** the Region is connected by several State and Federal highways. The primary roadway facilities include I-75, I-69, US 127, US 10, and M-46.

I-75 is the only interstate in Michigan that runs north-south north of Flint. I-75 connects Detroit with Lansing and continues north through Saginaw, Bay City, and on to Grayling in the North Region. I-69 runs east-west through the southern portion of the Bay Region. It connects Lansing in the University Region with Flint and continues east to Port Huron on the Lake Huron coastline in the Metro Region. US 127 is one of the major north-south roadways that connects Lansing in the University Region with Mt. Pleasant. US 127 continues north of Mt. Pleasant, running parallel with I-75 until they intersect just south of Grayling in the North Region. US 10 runs east-west through the Bay Region from US 127 on the west side to Midland and Bay City. M-46 is another east-west route that connects the Grand Region with Saginaw and continues east to Port Sanilac on the Lake Huron coastline.

Figure 1 - Bay Regional Boundaries

1.4.3 Bay Region ITS Plans

The Bay Region began the development of a Regional ITS Architecture in 2006 when MDOT contracted with a consultant to develop several regional ITS architectures and deployment plans in the State of Michigan. Version 5.1 of the National ITS Architecture was used in the architecture development.

It is important to recognize the initial deployment of ITS infrastructure in a region because as of April 2005, in order for a region to receive funding for ITS projects from the Highway Trust Fund, the United States Department of Transportation (USDOT) requires that the region have an ITS architecture developed. This requirement only applies to regions with existing ITS infrastructure deployed. For regions that do not have any ITS infrastructure deployed, the USDOT requires that they have an ITS architecture within four years of their first ITS project entering final design.

The Bay Region includes Genesee County, which approved a Regional ITS Architecture in December 2002. Genesee County has several deployments and those existing and planned ITS components are included in the Bay Region ITS Regional Architecture. The Bay Region also has several ITS components deployed outside of Genesee County. Examples of implementations in the Region include closed loop signal systems, portable dynamic message signs (DMS), and weigh-in-motion sensors. As the Bay Region pursues funding opportunities for proposed projects, it will be necessary to show that a project fits within the ITS architecture developed for the Region.

1.4.4 Stakeholders

Due to the fact that ITS often transcends traditional transportation infrastructure, it is important to involve non-traditional stakeholders in the architecture development and visioning process. Input from these stakeholders, both public and private, is a critical part of defining the interfaces, integration needs, and overall vision for ITS in a region.

Table 2 contains a listing of stakeholders in the Bay Region who have participated in the project workshops or provided input to the study team as to the needs and issues that should be considered as part of the Regional ITS Architecture. Other stakeholders that were invited to participate but were not able to attend were provided minutes of workshops and copies of reports to encourage their participation as much as possible. **Appendix D** contains a copy of the stakeholder database and workshop attendance records.

Table 2 - Bay Stakeholder Agencies and Contacts

Stakeholder Agency	Address	Contact
Bay City Area Transportation Study (BCATS) - Bay County	515 Center Avenue Bay City, Michigan 48708	Dave Engelhardt
Bay County Road Commission	2600 East Beaver Road Kawkawlin, Michigan 48631	James Lillo
Bay Metro Transit	1510 North Johnson Street Bay City, Michigan 48708	Eric Sprague
Bay Metro Transit	1510 North Johnson Street Bay City, Michigan 48708	Glenn Cardinali
ECMPDR (Regional Planning Commission)	3144 Davenport Avenue, Suite 200 Saginaw, Michigan 48602	Anamika Laad
FHWA - HAD -MT	400 Seventh Street, SW Washington, DC 20590	Tim Crothers
FHWA - Michigan	315 West Allegan, Suite 201 Lansing, Michigan 48933	Morrie Hoevel
Genesee County Metropolitan Planning Commission	1101 Beach Street Flint, Michigan 48502	Sharon Gregory
Genesee County Road Commission	211 West Oakley Street Flint, Michigan 48503	Kenneth Johnson
Genesee County Road Commission	211 West Oakley Street Flint, Michigan 48503	Christina Michael
Genesee County Road Commission	211 West Oakley Street Flint, Michigan 48503	Bonnie Wood
Gratiot County Road Commission	214 East Center Street Ithaca, Michigan 48847	Ray Welke
Local Agency Programs, MDOT - Lansing	425 West Ottawa Lansing, Michigan 48909	Jim D'Lamater
MDOT - Bay City TSC	2590 E. Wilder Road Bay City, Michigan 48706	Louis Taylor
MDOT - Bay Region	55 East Morley Drive Saginaw, Michigan 48601	Wendy Cloutier
MDOT - Bay Region	55 East Morley Drive Saginaw, Michigan 48601	Steve Palmer
MDOT - Bay Region	55 East Morley Drive Saginaw, Michigan 48601	Linda Burchell
MDOT - Bay Region	55 East Morley Drive Saginaw, Michigan 48601	Jay Reithel
MDOT - Cass City TSC	6867 East Cass City Road Cass City, Michigan 48726	Doug Wilson
MDOT - Central Maintenance	6333 Old Lansing Road Lansing, Michigan 48917	Tim Croze
MDOT - Davison TSC	9495 East Potter Road Davison, Michigan 48423	David Thorp
MDOT - ITS Program Office	425 W. Ottowa Street, Mail Code B235 Lansing, Michigan 48933	Greg Krueger
MDOT - Metro Region	18101 West Nine Mile Road Southfield, Michigan 48075	Collin Castle
MDOT - Metro Region	18101 West Nine Mile Road Southfield, Michigan 48075	Michelle Mueller
MDOT – MT. Pleasant TSC	1212 Corporate Drive Mt. Pleasant, Michigan 48858	Terry Palmer
MDOT – Planning	425 W. Ottowa Street, Mail Code B235 Lansing, Michigan 48933	Dave Schade
Saginaw County MPO	111 South Michigan Avenue Saginaw, Michigan 48602	Doug Bell
Saginaw County Road Commission	3020 Sheridan Avenue Saginaw, Michigan 48605	Bill Miller
Saginaw Metropolitan Area Transportation Study (SMATS) and SCMPC	615 Court Street Saginaw, Michigan 48602	Phil Grimaldi
Saginaw Transit Authority Regional Services	301 East Genesee, Suite 500 Saginaw, Michigan 48607	Bill Wright
Tuscola County Road Commission	1733 Mertz Road Caro, Michigan 48723	Michelle Zawerucha

2. REGIONAL ITS ARCHITECTURE DEVELOPMENT PROCESS

Development of the Regional ITS Architecture and Deployment Plan for the Bay Region relied heavily on stakeholder input to ensure that the architecture reflected local needs. A series of four workshops was held with stakeholders to gather input, and draft documents were made available to stakeholders for review and comment.

The process followed for the Bay Region was designed to ensure that stakeholders could provide input and review for the development of the Region's ITS Architecture and Deployment Plan. **Figure 2** illustrates the process followed.

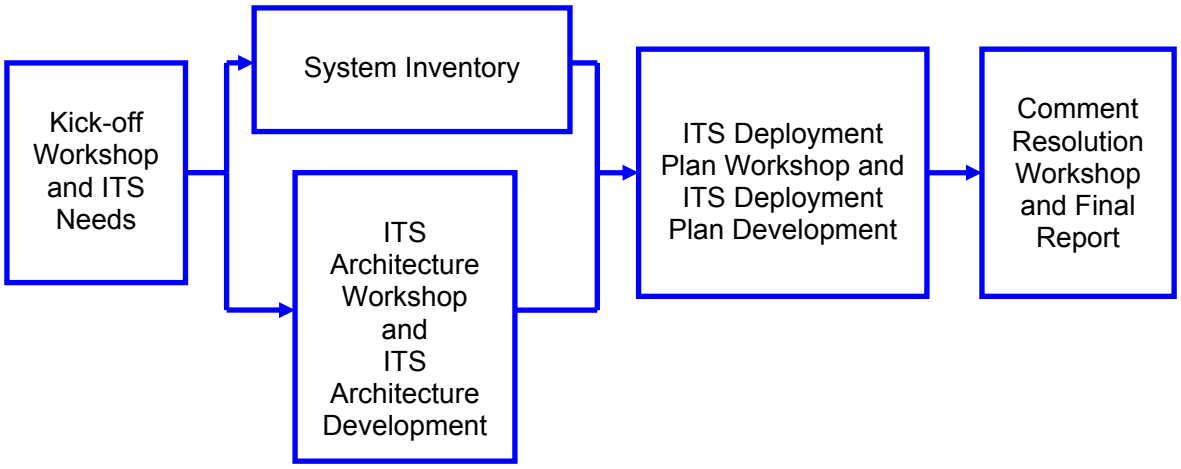

Figure 2 - Bay Regional ITS Architecture and Deployment Plan Development Process

A total of four workshops with stakeholders over a period of eleven months were used to develop the Bay Regional ITS Architecture and Deployment Plan. These workshops included:

- Kick-Off Workshop – December 7, 2006;
- Regional ITS Architecture Development Workshop – January 18, 2007;
- ITS Deployment Plan Workshop – August 3, 2007; and
- Comment Resolution Workshop – December 5, 2007.

Key components of the process are described below:

Task 1 – Kick-Off Workshop and ITS Needs: A stakeholder group was identified that included representatives from regional transportation, transit, and emergency management/public safety agencies. The group was invited to the project Kick-Off Workshop where ITS needs for the Region were identified.

Task 2 – System Inventory: Collecting information for the system inventory began at the Kick-Off Workshop through discussions with the stakeholders to determine existing and planned ITS elements in the Region. After the Kick-Off Workshop, follow-up calls were conducted with several local stakeholders to gather additional input.

Task 3 – ITS Architecture Workshop and ITS Architecture Development: The purpose of the Regional ITS Architecture Workshop was to review the system inventory with stakeholders and develop the Bay Regional ITS Architecture. Training on the National ITS Architecture was integrated into the workshop so that key elements of the architecture, such as market packages, could be explained prior to

the selection and editing of these elements. The result of the Regional ITS Architecture Workshop was an ITS Architecture for the Bay Region that included a system inventory, interconnect diagram, customized market packages, and relevant ITS standards. Following the workshop, a Draft Regional ITS Architecture document was prepared and sent to stakeholders for review and comment.

Task 4 – ITS Deployment Plan Workshop and ITS Deployment Plan Development: A draft project listing for the Region will be presented to stakeholders at the Regional ITS Deployment Plan Workshop. Stakeholders will be asked to provide input on the recommended projects, responsible agencies, associated costs, and deployment timeframe. Following the workshop, a Draft Regional ITS Deployment Plan document was prepared and sent to stakeholders for review and comment

Task 5 – Comment Resolution Workshop and Final Report: A Comment Resolution Workshop was held with stakeholders to review the Draft Regional ITS Architecture and the Draft Regional ITS Deployment Plan. Next steps for the Region were also discussed. Comments were incorporated and a final Regional ITS Architecture and Regional ITS Deployment Plan were developed.

3. CUSTOMIZATION OF THE NATIONAL ITS ARCHITECTURE FOR THE BAY REGION

3.1 Systems Inventory

An important initial step in the architecture development process is to establish an inventory of existing ITS elements. At the Kick-Off Workshop and through subsequent discussions with agency representatives, Bay Region stakeholders provided the team with information about existing and planned systems that would play a role in the Region's ITS architecture.

The National ITS Architecture has eight groups of ITS service areas. Existing, planned, and future systems in the Region were identified in the following service areas:

- ***Traffic Management*** – includes the Michigan Intelligent Transportation Systems Center (MITSC) located in Detroit as well as other existing and future TMCs and traffic operations centers (TOCs), detection systems, closed circuit television (CCTV) cameras, fixed and portable dynamic message signs, and other related technologies.
- ***Emergency Management*** – includes emergency operations/management centers, improved information sharing among traffic and emergency services, automated vehicle location (AVL) on emergency vehicles, traffic signal preemption for emergency vehicles, and wide-area alerts.
- ***Maintenance and Construction Management*** – includes work zone management, roadway maintenance and construction information, winter maintenance, and road weather detection systems.
- ***Public Transportation Management*** – includes transit and paratransit AVL, dispatch systems, transit travel information systems, electronic fare collection, and transit security.
- ***Commercial Vehicle Operations*** – includes coordination with Commercial Vehicle Information Systems and Networks (CVISN) efforts, and hazardous material (HAZMAT) management
- ***Traveler Information*** – includes broadcast traveler information such as 511, traveler information kiosks, and highway advisory radio (HAR).
- ***Archived Data Management*** – includes electronic data management and archiving systems.
- ***Vehicle Safety*** – includes collision avoidance and automated highway systems.

3.2 Regional Needs

Needs from the Region were identified by Stakeholders at the Kick-Off Workshop held in December of 2006. The needs identified provided guidance for determining which market packages should be included in the architecture. Stakeholders identified ITS needs for the Bay Region in the following areas:

- Traffic management;
- Emergency management;
- Maintenance and construction management;
- Public transportation management;
- Commercial vehicle operations;
- Traveler information; and
- Archived data management.

Section 3.4.3 contains additional information about the specific needs identified and relates those needs to the market packages that document the corresponding ITS service.

3.3 Element Customization

The inventory and needs documented at the Kick-Off Workshop are the starting point for developing an ITS architecture for the Bay Region. These ITS systems and components are used to customize the National ITS Architecture and create the architecture for the Bay Region.

When developing customized elements, the stakeholder group agreed not to create individual traffic, maintenance, and emergency management elements for all of the individual cities within the Bay Region. The smaller communities in the Region were documented as part of the local agency elements. This documentation allows the communities to be included in the Regional ITS Architecture, and therefore eligible to use federal monies on potential future ITS deployments.

3.3.1 Subsystems and Terminators

Each identified system or component in the Bay Region ITS inventory was mapped to a subsystem or terminator in the National ITS Architecture. Subsystems and terminators are the entities that represent systems in ITS.

Subsystems are the highest level building blocks of the physical architecture, and the National ITS Architecture groups them into four major classes: Centers, Field, Vehicles, and Travelers. Each of these major classes includes various components that represent a set of transportation functions (or processes). Each set of functions is grouped under one agency, jurisdiction, or location, and correspond to physical elements such as: traffic operations centers, traffic signals, or vehicles. **Figure 3** shows the National ITS Architecture subsystems. This figure, also known as the "sausage diagram," is a standard interconnect diagram, showing the relationships of the various subsystems within the architecture. A customized interconnect diagram for the Bay Region is shown in **Figure 4**. Communication functions between the subsystems are represented in the ovals. Fixed-point to fixed-point communications include not only twisted pair and fiber optic technologies, but also wireless technologies such as microwave and spread spectrum.

Terminators are the people, systems, other facilities, and environmental conditions outside of ITS that need to communicate or interface with ITS subsystems. Terminators help define the boundaries of the National ITS Architecture as well as a regional system. Examples of terminators include: drivers, weather information providers, and information service providers.

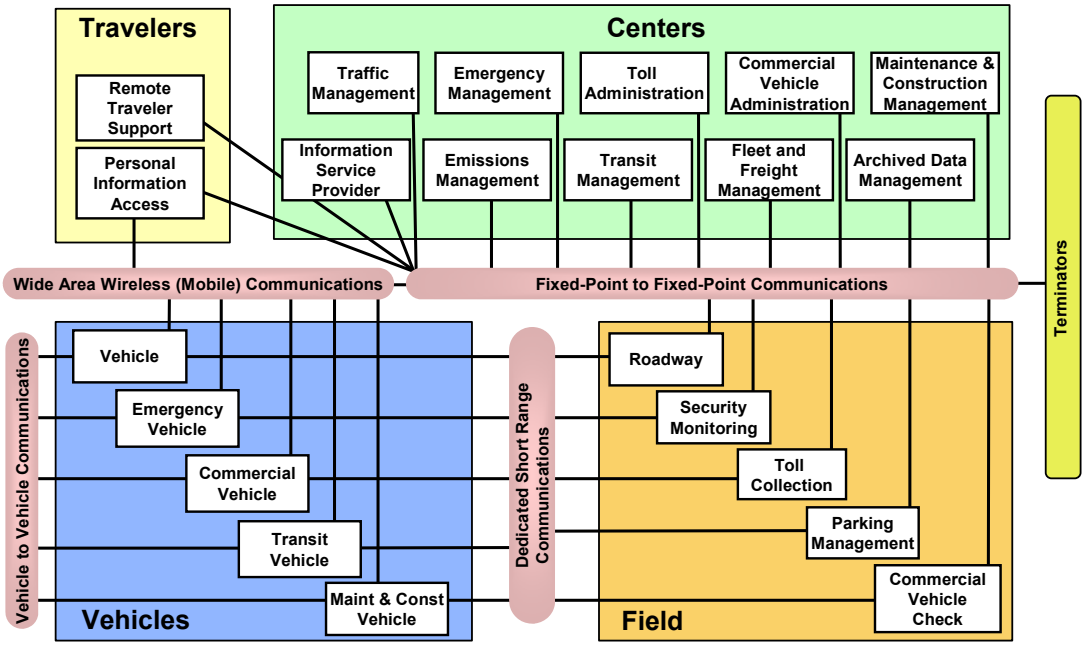

Figure 3 - National ITS Architecture Physical Subsystem Interconnect Diagram

3.3.2 ITS Inventory by Stakeholder

Each stakeholder is associated with one or more systems or elements (subsystems and terminators) that make up the transportation system in the Bay Region. A listing of stakeholders as identified in the architecture can be found in **Table 3** along with a description of the stakeholder. For example, rather than individually documenting each of the smaller local agencies in the Region, a single stakeholder was created for local agencies which represents the counties, cities, and towns not specifically called out in the architecture. **Table 4** sorts the inventory by stakeholder so that each stakeholder can easily identify and review all of the architecture elements associated with their agency. The table includes the status of the element. In many cases, an element classified as existing might still need to be enhanced to attain the service level desired by the Region.

Table 3 - Bay Region Stakeholder Descriptions

Stakeholder	Stakeholder Description
Bay Metro Transit Authority	Transit provider that operates fixed route and paratransit in Bay County.
Department of Homeland Security	The Department of Homeland Security is responsible for coordinating with multiple agencies to secure the nation's borders and protect the infrastructure and citizens.
DNR	Michigan Department of Natural Resources is responsible for the operations and maintenance of all Parks and Recreation facilities including infrastructure components on those properties. DNR utilizes some technologies to provide information to visitors at Parks and Recreation facilities.
Financial Institution	Banks involved in the transfer of funds for fare collection as well as for other fee based transportation services. Can handle the exchange of money for transit electronic fare collection or toll collection.
Flint-Mass Transportation Authority	Transit provider that operates fixed route and paratransit in and near Genesee County.
Local Agency	Local government includes municipalities, counties, and townships and covers all departments within those agencies that deal with traffic, public safety, emergency management, public works and school transportation agencies. Local Agencies include: Bay City, Bay CRC, City of Burton, City of Clio, City of Davison, City of Fenton, City of Flint, City of Flushing, City of Grand Blanc, City of Linden, City of Midland, City of Montrose, City of Mount Morris, City of Mt. Pleasant, City of Saginaw, City of Swartz Creek, Genesee CRC, Gratiot CRC, Isabella CRC, Midland CRC, Saginaw CRC.
MDOT	The Michigan Department of Transportation is responsible for the planning, design, construction, maintenance and operation for all aspects of a comprehensive integrated transportation system in the State of Michigan. Some of these roles are achieved through contract services with local agencies and private entities.
Media	Local media outlets. This can include television stations, newspapers, radio stations and their associated websites.
MSP	Michigan State Police is the state law enforcement agency that enforces traffic safety laws as well as commercial vehicle regulations.
NOAA	National Oceanic and Atmospheric Administration gathers weather information and issues severe weather warnings.
Other Agencies	This stakeholder represents a wide variety of agencies. The associated elements are groups of agencies or providers that do not have a primary stakeholder agency.
Other Elements	Other elements include potential obstacles, roadway environment and other vehicles.
Private Information Service Provider	Private sector business responsible for the gathering and distribution of traveler information. This service is typically provided on a subscription basis.
Private Operators	Private Operators manage privately owned resources that interconnect with public sector elements and sub-systems of the Regional Architecture.
Private Transportation Providers	Private transportation service providers such as taxis and shuttle services.
Rail Operators	Companies that operate trains and/or are responsible for the maintenance and operations of railroad tracks.
Regional Demand Response Transit Providers	Transit providers in the Bay region aside from Bay Metro Transit Authority, Flint-Mass Transportation Authority and Saginaw Transit Authority Regional Services that operate paratransit service in the region. The agencies include Caro Area Transit Authority, Midland Dial-A-Ride and Greater Lapeer Transit Authority.
Saginaw Transit Authority Regional Services	Transit provider that operates fixed route and paratransit for urbanized Saginaw area.
System Users	All of the users of the transportation system.

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Bay Metro Transit Authority	Bay Metro Transit Authority CCTV Surveillance	CCTV surveillance at the Bay Metro Transit Authority Center.	Planned
	Bay Metro Transit Authority Data Archive	The transit data archive for the Bay Metro Transit Authority. Used by FTA and MDOT Office of Public Transportation.	Planned
	Bay Metro Transit Authority Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of fixed route and paratransit vehicles operated by Bay Metro Transit Authority.	Existing
	Bay Metro Transit Authority Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Planned
	Bay Metro Transit Authority Kiosks	Kiosks for dissemination of transit traveler information. Kiosks can also be used for the purchase and recharging of electronic fare payment cards.	Planned
	Bay Metro Transit Authority Vehicles	Transit Vehicles owned by Bay Metro Transit Authority.	Existing
	Bay Metro Transit Authority Website	Website with information about fares and schedules. At this time the website is static.	Existing
Department of Homeland Security	Department of Homeland Security	Responsible for coordinating with multiple agencies to secure the nation's borders and protect the infrastructure and citizens.	Existing
DNR	DNR Weather Stations	Department of Natural Resources field equipment that collects weather data such as temperature and visibility.	Existing
Financial Institution	Financial Service Provider	Handles exchange of money for transit electronic payment collection.	Existing
	Service Agency	Agency responsible for payment of transit fares for medical transportation as part of government subsidized medical care. This includes Medicare and VA programs.	Existing
Flint-Mass Transportation Authority	Flint-Mass Transportation Authority CCTV Surveillance	CCTV surveillance at the Flint-Mass Transportation Authority Center.	Existing
	Flint-Mass Transportation Authority Data Archive	The transit data archive for the Flint-Mass Transportation Authority. Used by FTA and MDOT Office of Public Transportation.	Planned
	Flint-Mass Transportation Authority Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of fixed route and paratransit vehicles operated by Flint-Mass Transportation Authority.	Existing

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Flint-Mass Transportation Authority (continued)	Flint-Mass Transportation Authority Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Existing
	Flint-Mass Transportation Authority Kiosks	Kiosks for dissemination of transit traveler information. Kiosks can also be used for the purchase and recharging of electronic fare payment cards.	Planned
	Flint-Mass Transportation Authority Vehicles	Transit Vehicles owned by Flint-Mass Transportation Authority.	Existing
	Flint-Mass Transportation Authority Website	Website with information about fares and schedules. At this time the website is static.	Planned
Local Agency	Bay City Drawbridge Control Equipment	Roadside equipment located on Bay City drawbridges that close approaching roadways or stop traffic prior to the drawbridge opening to waterway traffic.	Planned
	Bay City Drawbridge Notification Equipment	Roadside equipment located on Bay City drawbridges that send notifications when the drawbridge is open for waterway traffic.	Planned
	City of Flint 911	911 Dispatch for the City of Flint. Central Dispatch is responsible for the dispatch of all Flint public safety vehicles (police and fire).	Existing
	County 911 Dispatch	Central Dispatch is responsible for the dispatch of all public safety vehicles (police and fire). After hours Central Dispatch will also dispatch the Street Department on-call emergency responder. Counties included are Clare, Gladwin, Arenac, Isabella, Midland, Bay, Gratiot, Saginaw, Huron, Tuscola, Sanilac, Genesee and Lapeer.	Existing
	County Road Commission	Contract agency managed by a county that oversees road maintenance and snow removal on local and MDOT facilities.	Existing
	County Road Commission Equipment Repair	Facility responsible for maintenance of County Road Commission vehicles.	Planned
	County Road Commission Maintenance Vehicles	County Road Commission vehicles used in maintenance operations.	Existing
	Fenton Police Department	Municipal police responsible for enforcement within the City of Fenton.	Existing
	Local Agency Airports	Municipal and county owned airports.	Existing

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Local Agency (continued)	Local Agency CCTV Cameras	Roadside equipment on local routes used for traffic condition monitoring and management of incidents.	Existing
	Local Agency DPW	Contract agency managed by a local municipality that oversees road maintenance and snow removal on local and MDOT facilities.	Existing
	Local Agency DPW Vehicles	Local Government vehicles used in maintenance operations.	Existing
	Local Agency Field Sensors	Roadway equipment on local routes used to detect vehicle volumes and/or speeds. This information is used in the operation of the traffic signal system and collected by the TOC.	Planned
	Local Agency Parking Management System	System operated by a local agency that monitors available vehicle parking at key parking facilities.	Planned
	Local Agency Public Safety Vehicles	Local law enforcement, fire and EMS vehicles. Includes the ITS equipment installed on the cruisers (AVL, MDTs, etc.).	Existing
	Local Agency Ride Sharing Program	System used for matching riders with similar origins and destinations to promote carpooling.	Planned
	Local Agency Speed Monitoring Equipment	Speed monitoring equipment owned and operated by a local agency. Includes radar, lidar, etc.	Planned
	Local Agency TOC	Local Traffic Operations Center responsible for municipal signal system operations.	Planned
	Local Agency Traffic Signals	Multiple traffic signals interconnected and operated by a Local Agency.	Existing
	Local Agency Website	Website for the Local Agencies.	Existing
	Local Emergency Operations Center	Central command and control facility responsible for carrying out the principles of emergency preparedness and emergency management, or disaster management functions at a strategic level in an emergency situation.	Planned
MDOT	Bay City Drawbridge Management Center	Central facility that monitors vehicle and waterway traffic and controls drawbridge traffic in Bay City.	Planned
	Maintenance and Construction Field Personnel	MDOT field forces that operate and maintain MDOT facilities.	Existing
	MDOT Animal Crossing Detection	Roadside equipment that monitors roadway for animal activity that could impact traffic.	Planned

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MDOT (continued)	MDOT Animal Crossing Warning System	In-vehicle and roadside equipment that can notify drivers about possible animal activity.	Planned
	MDOT Anti-Icing Field Equipment	Roadside equipment located along MDOT routes that collects weather data such as temperature and visibility.	Planned
	MDOT Bay Region Commercial Vehicle Parking Management System	System operated on MDOT routes that monitors available commercial vehicle parking at rest areas and other key locations.	Planned
	MDOT Bay Region Maintenance Management System	Central system used to track and plan maintenance on MDOT Bay Region vehicles.	Planned
	MDOT Bay Region Office	The Bay Region Office serves as a data collection and dissemination point for traffic information in the Bay Region. This includes coordination with other agencies such as public safety, emergency management, and transit.	Existing
	MDOT Bay Region Transportation Service Centers	MDOT field office that oversees road construction and maintenance on MDOT facilities. Most maintenance and snow removal in this region is achieved through contract agencies.	Planned
	MDOT CCTV Cameras	Roadside equipment located on local roadways used for traffic condition monitoring and management of incidents.	Planned
	MDOT Commercial Vehicle Permitting System	MDOT system for tracking and monitoring oversize and overweight permits for commercial vehicles.	Planned
	MDOT DMS	Roadside equipment on MDOT routes used to share traveler information with motorists through dynamic messaging.	Planned
	MDOT Drawbridge Control Equipment	Roadside equipment located on MDOT drawbridges that close approaching roadways or stop traffic prior to the drawbridge opening to waterway traffic.	Existing
	MDOT Drawbridge Management Center	Management of the waterways used by boats and ferries and the roadways used by vehicles.	Planned
	MDOT Drawbridge Notification Equipment	Roadside equipment located on MDOT drawbridges that send notifications when the drawbridge is open for waterway traffic.	Existing
	MDOT ESS	Environmental sensor stations located on MDOT routes that collect information about the roadways such as temperature and moisture levels.	Planned

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MDOT (continued)	MDOT Field Sensors	Roadway equipment located on MDOT roadways used to detect vehicle volumes and/or speeds. This information is used in the operation of the traffic signal system and collected by the TOC. MDOT field sensors include VIVDS and any other vehicle detection.	Planned
	MDOT Frost Tube Sensors	Roadside equipment located along MDOT routes that collect data from frost tube sensors.	Planned
	MDOT Grand Traverse County TOC	Transportation operations center located in the North Region for Grand Traverse County. It will be a joint facility with MDOT, Grand Traverse County, and Traverse City. Will include the freeway management system in the North Region as well as rural ITS deployments and municipal traffic operations.	Existing
	MDOT Maintenance Vehicles	Michigan Department of Transportation vehicles used in maintenance operations.	Existing
	MDOT MI Drive Website	Website for Michigan Department of Transportation.	Existing
	MDOT North Region TMC	MDOT traffic management center located in the North Region.	Planned
	MDOT Office of Communications	Michigan Department of Transportation responsible for the dissemination of traffic information to the media and public.	Existing
	MDOT Planning Division Data Warehouse	Archive that contains historical traffic data such as volume and speed information.	Existing
	MDOT Roadside Equipment for AHS	Equipment located along MDOT routes that allows communication between roadside devices and vehicles.	Planned
	MDOT Roadside Intersection Collision Avoidance Equipment	Equipment located along MDOT routes that communicates between multiple roadside devices and vehicles to alert of unsafe travel conditions or conditions conducive to crashes.	Planned
	MDOT Roadside Signing Equipment	Equipment located along MDOT routes that provide data through dynamic messaging or in-vehicle messaging.	Planned
	MDOT Security Monitoring Field Equipment	Roadside equipment located on MDOT routes that is used for monitoring key infrastructure elements from damage or attacks. These elements include structures such as bridges or dams.	Planned
	MDOT Service Patrol Dispatch	Provides efficient use of resources to assist motorists in need on MDOT facilities.	Planned

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MDOT (continued)	MDOT Service Patrol Vehicles	Fully equipped vehicles that provide motorist assistance to vehicles in need on MDOT facilities.	Planned
	MDOT Speed Monitoring Equipment	Speed monitoring equipment owned and operated by the Michigan Department of Transportation. Includes radar, lidar, etc.	Planned
	MDOT Statewide TMC - Lansing	MDOT traffic management center located in Lansing.	Planned
	MDOT Superior Region TMC	MDOT traffic management center located in the Superior Region.	Planned
	MDOT Traffic Signals	Multiple traffic signals interconnected and operated by MDOT.	Existing
	MDOT Traveler Information Database	MDOT maintained database for collecting and disseminating road condition data about construction and maintenance activities, incidents, and special events.	Planned
	MDOT Traveler Information Kiosks	Interactive kiosks that provides users the ability to request and received transportation information.	Planned
	MDOT Weigh-in-Motion	In-road equipment that monitors vehicle weights.	Existing
	MDOT West Michigan TMC	Co-located traffic management center in Traverse City. Responsible for the operation of the ITS equipment located in Traverse City and the surrounding areas in the North Region.	Planned
	MDOT Work Zone Safety Monitoring Equipment	Portable ITS equipment that can be used in work zones to more efficiently manage traffic and provide traveler information. Includes CCTV, vehicle detection, and/or DMS.	Planned
	Michigan 511 System	511 Traveler information system central server.	Planned
	Michigan 511 Voice Response System	Michigan 511 Interactive Voice Response system. This is the customer interface component of the 511 system.	Planned
	MITSC	MDOT traffic management center located in the Metro Region.	Existing
	Other MDOT Region TSC's	Local MDOT Transportation Service Centers outside of the Bay Region that oversee the operations and maintenance on MDOT facilities.	Existing
Media	Local Print and Broadcast Media	Local media that provide traffic or incident information to the public.	Existing

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
MSP	CJIC Database	Criminal Justice Information Center Database stores criminal justice data and can be accessed by multiple agencies.	Existing
	Michigan Intelligence Operations Center (MIOC)	Michigan Intelligence Operations Center. Provides 24-hour statewide information sharing among local, state, and federal public safety agencies and private sector organizations in order to facilitate the collection, analysis, and dissemination of intelligence relevant to terrorism and public safety.	Existing
	MSP District 3 - Saginaw	Michigan State Police dispatch for the Bay Region. Provides call-taking and dispatch for public safety agencies.	Existing
	MSP Headquarters - East Lansing	Michigan State Police headquarters that oversees operations of MSP.	Existing
	MSP Motor Carrier Division	Responsible for monitoring commercial vehicle regulations on MDOT routes.	Existing
	MSP Office of Highway Safety Planning	Manages crash data for MDOT routes.	Existing
	MSP Toll Free Winter Road Conditions Phone Number	Winter weather information operated from November through March to share winter weather conditions as received.	Existing
	MSP Vehicles	Public Safety vehicles owned and operated by Michigan State Police. Includes the ITS equipment installed on the cruisers (AVL, MDTs, etc.).	Existing
	MSP Winter Travel Advisory Website	Traveler Information website operated by Michigan State Police for dissemination of winter weather advisories.	Existing
NOAA	National Weather Service	Provides official US weather, marine, fire and aviation forecasts, warnings, meteorological products, climate forecasts, and information about meteorology.	Existing
	NWS Weather Stations	National Weather Service Field equipment that collects weather data such as temperature and visibility.	Existing
Other Agencies	MBS International Airport	Midland Bay City Saginaw International Airport is a municipal airport. Tri-owned by three municipalities.	Planned
	Multimodal Transportation Service Provider	Agency that offers services across multiple transportation modes.	Planned

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Other Elements (continued)	Private Concierge Provider	Private entities that provides customized services to the traveler. This service is usually subscription based.	Existing
	School Transportation Agencies	Agencies responsible for operating school bus fleets.	Existing
	Potential Obstacles	Obstacles that could interfere with the safe operation of vehicles.	Existing
	Roadway Environment	All objects and conditions in the vicinity of the traveler that can affect the operations of the traveler.	Existing
Private Information Service Provider	Private Sector ISP	Private entities that collect and disseminate traffic information.	Existing
	Private Sector Traveler Information Services	Website sponsored by a private entity. Often this information is provided through a subscription.	Existing
Private Operators	Contractor Smart Work Zone Equipment	Smart Work Zone Equipment owned by private contractor. Portable ITS equipment that can be used in work zones to more efficiently manage traffic and provide traveler information. Includes CCTV, vehicle detection, and/or DMS.	Existing
	Private Fleet Management Systems	A way to track and manage the contents private commercial vehicle fleets carry.	Existing
	Private Fleet Operators	Private companies that proactively manage and operate their fleet routing. Includes reactions to incidents and possible delays.	Existing
	Private Parking Operator	System operated on private property that monitors available commercial vehicle parking.	Existing
Private Transportation Providers	Private Transportation Providers	Private providers of transportation services in the Region such as taxis and intercity bus services.	Planned
Rail Operators	Rail Operator Wayside Equipment	Equipment located along the tracks including railroad crossing gates, bells, and lights as well as the interface to the traffic signal controller indicating the presence of a train.	Planned
Regional Demand Response Transit Providers	Regional Demand Response Transit Providers CCTV Surveillance	CCTV surveillance at the Regional Demand Response Transit Providers Center.	Planned
	Regional Demand Response Transit Providers Data Archive	The transit data archive for the Regional Demand Response Transit Providers. Used by FTA and MDOT Office of Public Transportation.	Planned

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
Regional Demand Response Transit Providers (continued)	Regional Demand Response Transit Providers Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of demand response vehicles operated by Regional Demand Response Transit Providers.	Existing
	Regional Demand Response Transit Providers Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Planned
	Regional Demand Response Transit Providers Vehicles	Transit Vehicles owned by Regional Demand Response Transit Authority.	Existing
	Regional Demand Response Transit Providers Website	Website with information about fares and schedules. At this time the website is static.	Existing
Saginaw Transit Authority Regional Services	STARS CCTV Surveillance	CCTV surveillance at the Saginaw Transit Authority Regional Services.	Planned
	STARS Data Archive	The transit data archive for the Saginaw Transit Authority Regional Services. Used by FTA and MDOT Office of Public Transportation.	Planned
	STARS Dispatch Center	Transit dispatch center responsible for the tracking, scheduling and dispatching of fixed route and paratransit vehicles operated by Saginaw Transit Authority Regional Services.	Existing
	STARS Electronic Fare Payment Card	Medium for collection of transit fares electronically.	Planned
	STARS Kiosks	Kiosks for dissemination of transit traveler information. Kiosks can also be used for the purchase and recharging of electronic fare payment cards.	Planned
	STARS Website	Website with information about fares and schedules. At this time the website is static.	Existing
System Users	Archived Data Users	Those who request information from the data archive systems.	Planned
	Commercial Vehicles	Privately owned commercial vehicles that travel throughout the Region. Included in the architecture to cover HAZMAT incident reporting.	Existing
	Driver	Individual operating a vehicle on roadways within the Region.	Existing
	Other Vehicles	Vehicles outside of the control of the driver.	Existing
	Private Travelers Personal Computing Devices	Computing devices that travelers use to access public information.	Existing

Table 4 - Bay Region Inventory of ITS Elements

Stakeholder	Element Name	Element Description	Status
System Users (continued)	Private Vehicles	Vehicles operated by the public.	Existing
	STARS Vehicles	Transit Vehicles owned by STARS.	Existing
	Traveler	Individual operating a vehicle on roadways within the Region.	Existing

3.3.3 Top Level Regional System Interconnect Diagram

A system interconnect diagram, or "sausage diagram" (shown previously in **Figure 3**), shows the systems and primary interconnects in the Region. The National ITS Architecture interconnect diagram has been customized for the Bay Region based on the system inventory and information gathered from the stakeholders. **Figure 4** summarizes the existing and planned ITS elements for the Bay Region in the context of a physical interconnect. Subsystems and elements specific to the Region are called out in the boxes surrounding the main interconnect diagram, and these are color-coded to the subsystem with which they are associated.

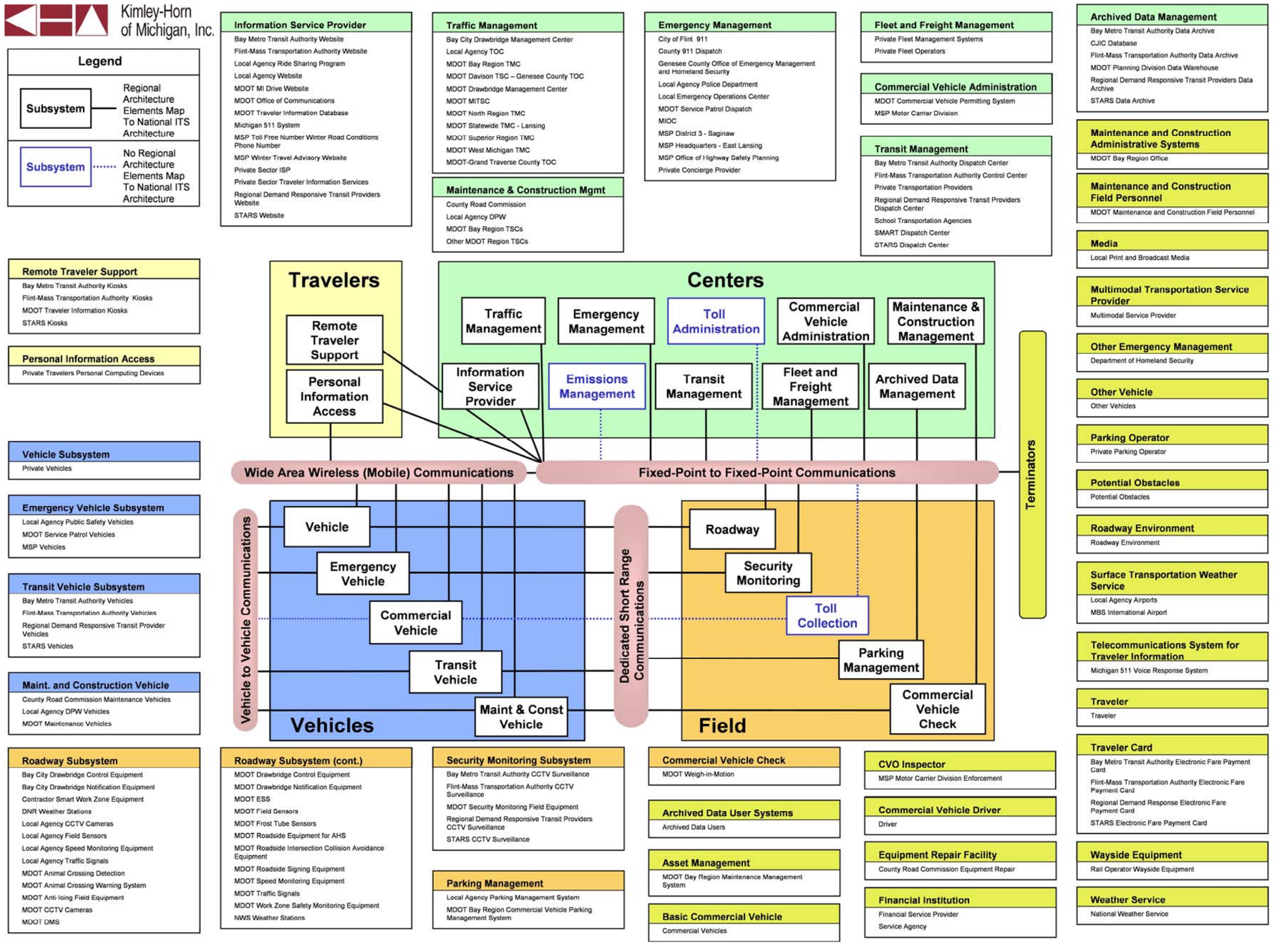

Figure 4 - Bay Regional System Interconnect Diagram

3.4 Market Packages

Upon completion of the system inventory, the next step in the development of the architecture was to identify the transportation services that are important to the Bay Region. In the National ITS Architecture, services are referred to as market packages. Market packages can include several stakeholders and elements that work together to provide a service in the Region. Examples of market packages from the National ITS Architecture include Network Surveillance, Traffic Information Dissemination, and Transit Vehicle Tracking. There are currently a total of 85 market packages identified in the National ITS Architecture Version 5.1. **Appendix A** provides definitions for each of the National ITS Architecture market packages.

The market packages are grouped together into eight ITS service areas: Traffic Management, Emergency Management, Maintenance and Construction Management, Public Transportation Management, Commercial Vehicle Operations, Traveler Information, Archived Data Management, and Vehicle Safety.

3.4.1 Selection and Prioritization of Regional Market Packages

In the Bay Region, the National ITS Architecture market packages were reviewed by the stakeholders and selected based on the relevance of the service that the market package could provide to the Region. Fifty-one market packages were selected for implementation in the Region. They are identified in **Table 5**. Stakeholders prioritized the selected market packages during the workshop, and the table organizes the market packages into service areas and priority groupings. These priorities are based on the stakeholders' opinion of need and do not necessarily represent the timeframe for funding of the deployments. These priorities can also be affected by several other factors such as existing infrastructure, dependency on other systems, and the maturity of the technology associated with the market package.

After selecting the market packages that were applicable for the Region, stakeholders customized each market package by reviewing the elements that could be included. This customization is discussed further in the following section.

Table 5 - Bay Region Market Package Prioritization by Functional Area

High Priority Market Packages	Medium Priority Market Packages	Low Priority Market Packages
Travel and Traffic Management		
ATMS01 Network Surveillance ATMS03 Surface Street Control ATMS06 Traffic Information Dissemination ATMS07 Regional Traffic Control ATMS08 Traffic Incident Management System ATMS20 Drawbridge Management	ATMS13 Standard Railroad Grade Crossing ATMS19 Speed Monitoring	ATMS02 Probe Surveillance ATMS09 Traffic Forecast and Demand Management ATMS16 Parking Facility Management ATMS17 Regional Parking Management
Emergency Management		
EM01 Emergency Call-Taking and Dispatch EM02 Emergency Routing EM06 Wide-Area Alert	EM03 Mayday Support EM04 Roadway Service Patrols	EM05 Transportation Infrastructure Protection EM08 Disaster Response and Recovery EM09 Evacuation and Reentry Management EM10 Disaster Traveler Information
Maintenance and Construction Management		
MC01 Maintenance and Construction Vehicle and Equipment Tracking MC03 Road Weather Data Collection MC04 Weather Information Processing and Distribution MC06 Winter Maintenance MC07 Roadway Maintenance and Construction	MC05 Roadway Automated Treatment MC08 Work Zone Management MC09 Work Zone Safety Monitoring	MC02 Maintenance and Construction Vehicle Maintenance MC10 Maintenance and Construction Activity Coordination
Public Transportation Management		
APTS1 Transit Vehicle Tracking APTS5 Transit Security	APTS2 Transit Fixed-Route Operations APTS3 Demand Response Transit Operations APTS4 Transit Passenger and Fare Management APTS6 Transit Maintenance APTS8 Transit Traveler Information	APTS7 Multi-modal Coordination
Commercial Vehicle Operations		
CVO06 Weigh-in-Motion	CVO04 CV Administration Process	CVO10 HAZMAT Management
Traveler Information		
ATIS1 Broadcast Traveler Information ATIS2 Interactive Traveler Information	ATIS4 Dynamic Route Guidance ATIS9 In Vehicle Signing	ATIS8 Dynamic Ridesharing

Table 5 - Bay Region Market Package Prioritization by Functional Area

High Priority Market Packages	Medium Priority Market Packages	Low Priority Market Packages
Archived Data Management		
AD1 ITS Data Mart AD3 ITS Virtual Data Warehouse		
Advanced Vehicle Safety System		
AVSS10 Intersection Collision Avoidance AVSS11 Automated Highway System		

3.4.2 Customized Market Packages

The market packages in the National ITS Architecture were customized to reflect the unique systems, subsystems, and terminators in the Bay Region. Each market package is shown graphically with the market package name, local agencies involved and desired data flows included. Market packages represent a service that will be deployed as an integrated capability.

Figure 5 is an example of an ATMS market package for Surface Street Control that has been customized for the Region. This market package shows the two subsystems, Traffic Management and Roadway, and the associated entities (Local Agency TOC and Local Agency Traffic Signals) for surface street control in the Region. Data flows between the subsystems indicate what information is being shared. The remainder of the market packages that were customized for the Bay Region is shown in **Appendix B**.

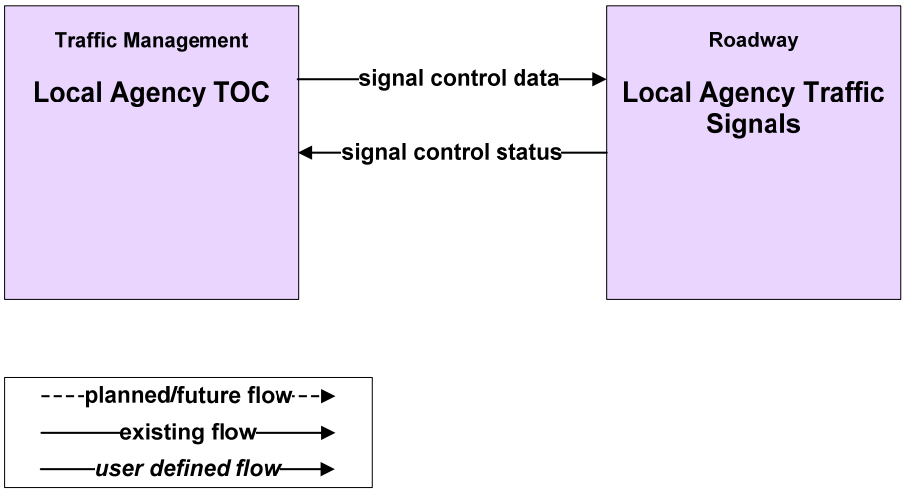

Figure 5 - Example Market Package Diagram: ATMS03 – Surface Street Control

3.4.3 Regional ITS Needs and Customized Market Packages

Input received from stakeholders at the Architecture Workshop provided valuable input for the market package customization process. The specific needs identified are included in **Table 6**. The table also identifies which market package corresponds to the particular ITS need.

Table 6 - Regional ITS Needs and Corresponding Market Packages

ITS Need	Market Package
Traffic Management and Traveler Information	
Need surveillance in Flint area to complement DMS installation	ATMS01 ATMS02
Need freeway management solution in Saginaw	ATMS01 ATMS06 ATMS07 ATMS08
Need improved communication with MSP about incidents when they occur	ATMS08
Need better information sharing through Media	ATMS06
Need real-time access to ATR locations	ATMS01
Need information directed towards tourist traffic and incident management freeways	ATMS06 ATMS08 ATIS01 ATIS02
Need system to handle recurring congestion and incidents at I-69/I-75	ATMS01 ATMS06 ATMS07 ATMS08
Need traffic management solutions for: ▪ Tourist traffic at I-75/US-10 interchange, M-25, Trumball ▪ Alternate routes to I-75: 84/13/25/Wilder in Bay City, M-13/US 23, M-54 in Flint ▪ Signal Coordination on M-46 in Saginaw	ATMS01 ATMS03 ATMS06 ATMS07 ATMS08 ATMS09
Need animal collision warning system on routes in several areas	ATMS01
Public Transportation Management	
Need system for sharing GPS information from Flint MTA with other agencies	APTS1 ATMS08
Need improved coordination between transit agencies in Tri-county area	APTS7
Emergency Management	
Need RWIS installations for fog and winter weather incident detection	MC03 MC04
Need improved incident management throughout region	ATMS08
Need safety solutions at high speed intersections in rural areas	ATMS19 AVSS10
Maintenance and Construction Management	
Need detection and surveillance in work zones	MC08
Need system to communicate construction and maintenance activities to the public	ATMS06 MC08 MC10 ATIS1 ATIS2
Need AVL technology to improve coordination during snowplow operation	MC01 MC06
Need coordination in tri-county area for snow removal for access to Midland-Bay-Saginaw Airport	MC01 MC06

Table 6 - Regional ITS Needs and Corresponding Market Packages

ITS Need	Market Package
Commercial Vehicle Management	
Need truck rollover systems that monitors the speed and weight of vehicles and disseminates warning messages if unsafe conditions exist	ATMS01 ATMS06 ATMS19
Need system to manage freight movement through region on I-69	CVO04
Archived Data Management	
Need improved access to historical ATR data and crash data	AD1 AD3

3.5 Architecture Interfaces

While it is important to identify the various systems and stakeholders that are part of a regional ITS, a primary purpose of the architecture is to identify the connectivity between transportation systems in the Bay Region. The system interconnect diagram shown previously in **Figure 4** showed the high-level relationships of the subsystems and terminators in the Bay Region and the associated local projects and systems. The customized market packages represent services that can be deployed as an integrated capability and the market package diagrams show the information flows between the subsystems and terminators that are most important to the operation of the market packages. How these systems interface with each other is an integral part of the overall ITS architecture.

3.5.1 Element Connections

There are a variety of elements identified as part of the Bay Regional ITS Architecture. These elements include traffic management centers, transit vehicles, dispatch systems, emergency management agencies, media outlets, and others—essentially, all of the existing and planned physical components that contribute to the regional ITS. Interfaces have been identified for each element in the Bay Region ITS Architecture and each element has been mapped to those other elements with which it must interface. The Turbo Architecture software can generate interconnect diagrams for each element in the Region that show which elements are connected to one another. **Figure 6** is an example of a context style interconnect diagram from the Turbo database output. This particular interconnect diagram is for Local Agency Public Safety Vehicles and is called a context diagram because it shows every element in the architecture that the vehicles connect to.

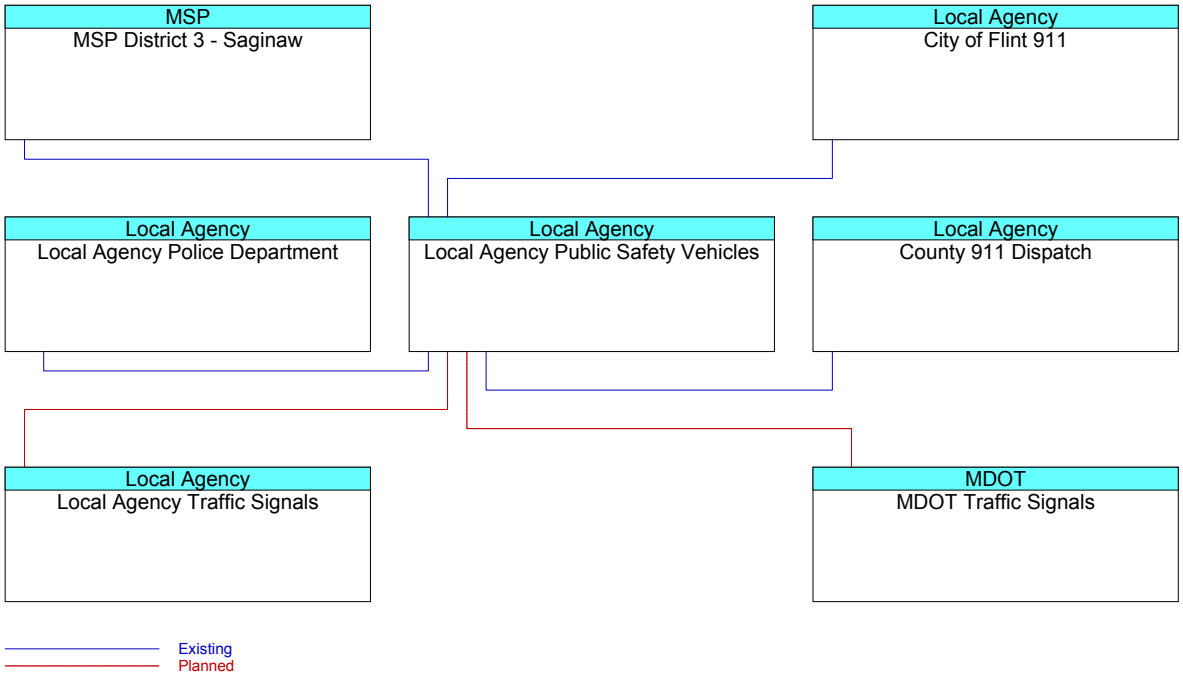

Figure 6 - Example Interconnect Diagram: Local Agency Public Safety Vehicles

3.5.2 Data Flows Between Elements

In the market package diagrams, flows between the subsystems and terminators define the specific information (data) that is exchanged between the elements and the direction of the exchange. The data flows could be requests for information, alerts and messages, status requests, broadcast advisories, event messages, confirmations, electronic credentials, and other key information requirements. Turbo Architecture can be used to output flow diagrams and can be filtered by market package for ease of interpretation; however, it is important to remember that custom data flows will not show up in diagrams that are filtered by market package. An example flow diagram for the Michigan State Police that has been filtered for EM01-1- Emergency Call Taking and Dispatch is shown in **Figure 7**.

The flow diagrams can vary greatly in complexity and, in turn, legibility. **Figure 8** shows a more complex flow diagram for EM02: Emergency Routing – Local Agency Public Safety.

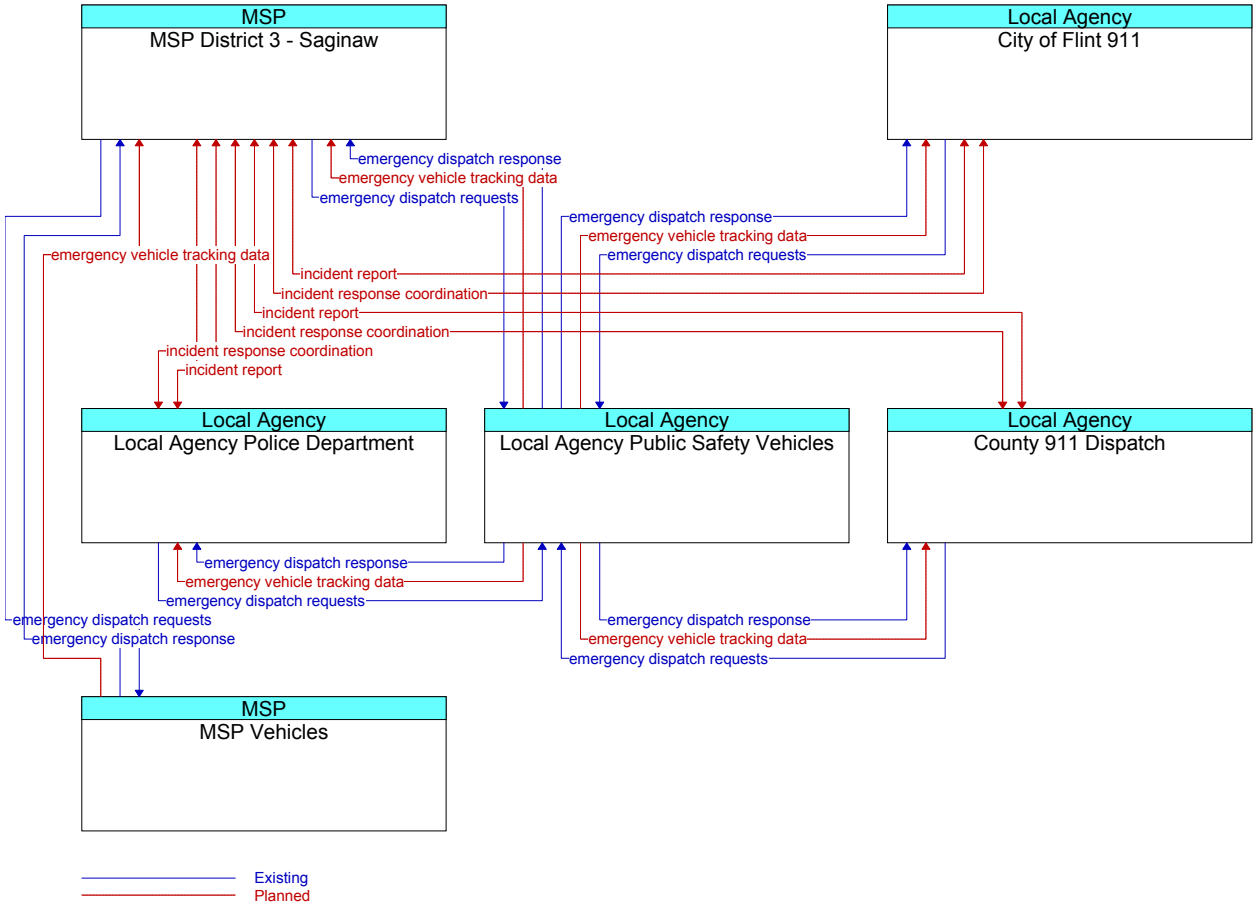

Figure 7 - Example Flow Diagram: EM01 – Michigan State Police

Figure 8 - Example Emergency Routing Diagram: EM02 – Local Agency Public Safety

In addition to market package style flow diagrams, Turbo Architecture has the ability to create flow diagrams that show only the connections between two or three specific elements or context diagrams that show all of the flows that involve an element. Filtering the diagrams to generate specific scenarios can be very useful during the project implementation process. For example, **Figure 9** shows the flows between the MDOT Bay Region Office and the MDOT Traveler Information Database. While this is a portion of the planned interactions, it could also be useful to use a context diagram for the element, as shown in **Figure 10** to view all of the other interactions so that the project can be designed with the future in mind. Context style flow diagrams can get very large and complicated for elements with lots of connections such as a TMC.

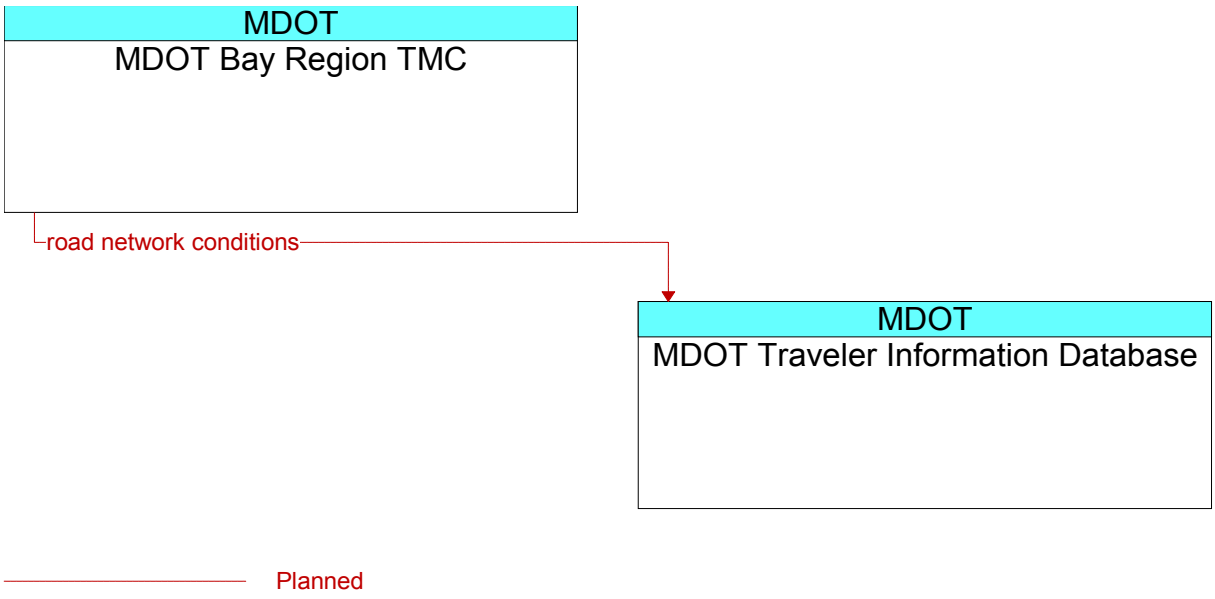

Figure 9 - Example Two Element Flow Diagram

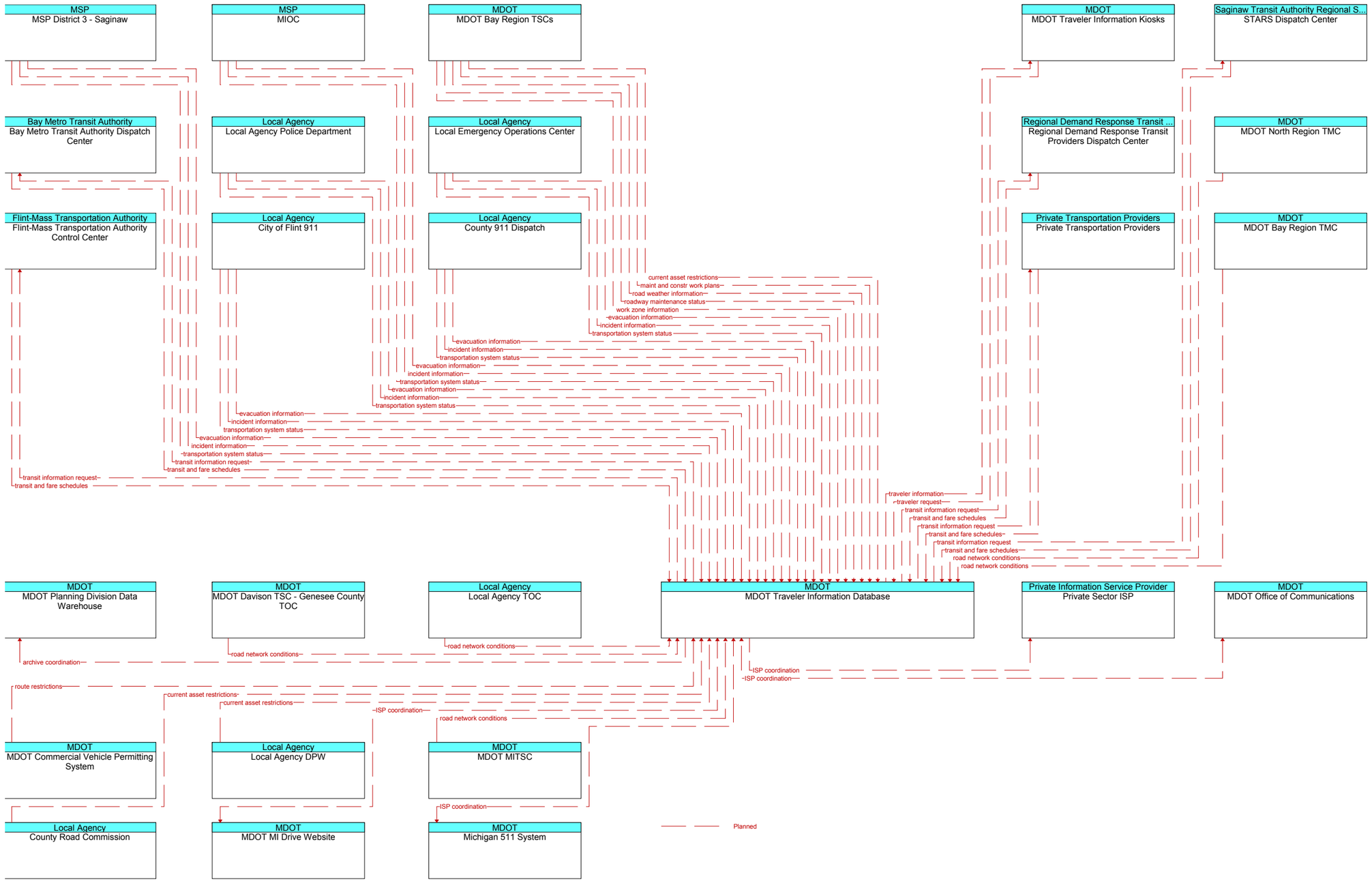

Figure 10 - Example Context Flow Diagram: MDOT Traveler Information Database

4. APPLICATION OF THE REGIONAL ITS ARCHITECTURE

Once a region has identified the desired components of ITS for their area and established which agencies and systems need to be connected, the structure of the National ITS Architecture assists with the region's planning and implementation. This section addresses the application of the Regional ITS Architecture in the Bay Region. The National ITS Architecture provides recommendations for standards and functional requirements that should be considered when implementing ITS elements. In addition, an operational concept has been developed for the Region and documents the roles and responsibilities of stakeholders in the operation of the regional ITS. The implementation of ITS in the Bay Region will likely require interagency agreements. Potential agreements have been identified based on the desired data flows identified in the Bay Region. The ITS Architecture and ITS Deployment Plan developed as part of this process will be incorporated into the existing planning process for the Region to ensure that the maximum benefit is realized from the development effort.

4.1 Functional Requirements

Functions are a description of what the system has to do. In the National ITS Architecture, functions are defined at several different levels, ranging from general subsystem descriptions through somewhat more specific equipment package descriptions to Process Specifications that include substantial detail. Guidance from the USDOT on developing a Regional ITS Architecture recommends that each Region determine the level of detail of the functional requirements for their Region. In the Bay Region, it is recommended that the development of detailed functional requirements such as the "shall" statements included in Process Specifications for a system be developed at the project level. These detailed "shall" statements identify all functions that a project or system needs to perform.

For the Bay Regional ITS Architecture, functional requirements have been identified at two levels. The customized market packages, discussed previously in Section 3.4.2, describe the services that ITS needs to provide in the Region and the architecture flows between the elements. These market packages and data flows describe what the systems in the Bay Region have to do and the data that needs to be shared among elements.

At a more detailed level, functional requirements for the Bay Region are described in terms of functions that each element in the architecture performs or will perform in the future. **Appendix C** contains a table that summarizes the functions by element.

4.2 Standards

Standards are an important tool that will allow efficient implementation of the elements in the Bay Regional ITS Architecture over time. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances, vendors change, and as new approaches evolve. The USDOT's ITS Joint Program Office is supporting Standards Development Organizations (SDOs) with an extensive, multi-year program of accelerated, consensus-based standards development to facilitate successful ITS deployment in the United States. **Table 7** identifies each of the ITS standards that could apply to the Bay Regional ITS Architecture. These standards are based on the physical subsystem architecture flows previously identified in Section 3.5.2.

Table 7 - Bay Region Applicable ITS Standards

SDO	Document ID	Title
ANSI	ANSI TS286	Commercial Vehicle Credentials
AASHTO/ITE/NEMA	NTCIP 1101	Simple Transportation Management Framework (STMF)
	NTCIP 1102	Octet Encoding Rules Base Protocol
	NTCIP 1103	Transportation Management Protocols
	NTCIP 1104	Center-to-Center Naming Convention Specification
	NTCIP 1105	CORBA Security Service Specification
	NTCIP 1106	CORBA Near-Real Time Data Service Specification
	NTCIP 1201	Global Object Definitions
	NTCIP 1202	Object Definitions for Actuated Traffic Signal Controller Units
	NTCIP 1203	Object Definitions for DMS
	NTCIP 1204	Environmental Sensor Station Interface Standard
	NTCIP 1205	Object Definitions for CCTV Camera Control
	NTCIP 1206	Object Definitions for Data Collection and Monitoring (DCM) Devices
	NTCIP 1208	Object Definitions for CCTV Switching
	NTCIP 1209	Data Element Definitions for Transportation Sensor Systems
	NTCIP 1210	Field Management Stations – Part 1: Object Definitions for Signal System Masters
	NTCIP 1211	Object Definitions for Signal Control and Prioritization
	NTCIP 1401	TCIP Common Public Transportation Objects
	NTCIP 1402	TCIP Incident Management Objects
	NTCIP 1403	TCIP Passenger Information Objects
	NTCIP 1404	TCIP Scheduling/Runcutting Objects
	NTCIP 1405	TCIP Spatial Representation Objects
	NTCIP 1406	TCIP On-Board Objects
	NTCIP 1407	TCIP Control Center Objects
	NTCIP 1408	TCIP Fare Collection Business Area Objects
	NTCIP 2101	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile
	NTCIP 2102	Point to Multi-Point Protocol Using Frequency Shift Keying Modem Subnetwork Profile
	NTCIP 2103	Point-to-Point Protocol Over RS-232 Subnetwork Profile
	NTCIP 2104	Ethernet Subnetwork Profile
	NTCIP 2201	Transportation Transport Profile
	NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile
	NTCIP 2301	STMF Application Profile
	NTCIP 2302	Trivial File Transfer Protocol Application Profile
	NTCIP 2303	File Transfer Protocol Application Profile
	NTCIP 2304	Application Profile for DATEX-ASN (AP-DATEX)
	NTCIP 2305	Application Profile for CORBA (AP-CORBA)
	NTCIP 2306	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications
	NTCIP 2501	Information Profile for DATEX
	NTCIP 2502	Information Profile for CORBA

Table 7 - Bay Region Applicable ITS Standards

SDO	Document ID	Title
ASTM	ASTM E2158-01	Standard Specification for Dedicated Short Range Communication (DSRC) Physical Layer using Microwave in the 902-928 MHz Band
	ASTM E2259-xx	Standard Specification for Metadata to Support Archived Data Management Systems
	ASTM PS 105-99	Standard Provisional Specification for DSRC Data Link Layer
IEEE	IEEE 1512.1-2003	Standard for Traffic Incident Management Message Sets for Use by EOCs
	IEEE 1512.2-2004	Standard for Public Safety Incident Management Message Sets (IMMS) for use by EOCs
	IEEE 1512.3-2002	Standard for Hazardous Material IMMS
	IEEE 1512-2000	Standard for Common IMMS for use by EOCs
	IEEE 1570-2002	Standard for Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection
	IEEE 1609.1	Resource Manager for DSRC 5.9 GHz
	IEEE 1609.2	Application Services (Layers 6,7) for DSRC 5.9 GHz
	IEEE 1609.3	Communications Services (Layers 4,5) for DSRC 5.9 GHz (Future Standard)
	IEEE 1609.4	Medium Access Control (MAC) Extension and the MAC Extension Management Entity for DSRC 5.9 GHz
	IEEE 802.11	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band DSRC MAC and Physical Layer Specifications
	IEEE 802.2	Logical Link (Layer 2) for DSRC 5.9 GHz
	IEEE P1512.4	Standard for Common Traffic Incident Management Message Sets for Use in Entities External to Centers
	IEEE Std 1455-1999	Standard for Message Sets for Vehicle/Roadside Communications
ISO	ISO 21210	Networking Services (Layer 3) for DSRC 5.9 GHz
SAE	ITE TM 1.03	Standard for Functional Level Traffic Management Data Dictionary
	ITE TM 2.01	Message Sets for External TMC Communication
	SAE J2266	Location Referencing Message Specification
	SAE J2313	On-Board Land Vehicle Mayday Reporting Interface
	SAE J2354	Message Set for Advanced Traveler Information System (ATIS)
	SAE J2369	Standard for ATIS Message Sets Delivered Over Reduced Bandwidth Media
	SAE J2540	Messages for Handling Strings and Look-Up Tables in ATIS Standards
	SAE J2540-1	Radio Data System Phrase Lists
	SAE J2540-2	International Traveler Information Systems Phrase Lists
	SAE J2540-3	National Names Phrase List

4.3 Operational Concepts

An operational concept documents each stakeholder's current and future roles and responsibilities across a range of transportation services, as grouped in the Operational Concepts section of Turbo Architecture, in the operation of the regional ITS. The services covered are:

- ***Arterial Management*** – The development of signal systems that react to changing traffic conditions and provide coordinated intersection timing over a corridor, an area, or multiple jurisdictions.
- ***Highway Management*** – The development of systems to monitor freeway (or tollway) traffic flow and roadway conditions, and provide strategies such as ramp metering or lane access control to improve the flow of traffic on the freeway. Includes systems to provide information to travelers on the roadway.
- ***Incident Management*** – The development of systems to provide rapid and effective response to incidents. Includes systems to detect and verify incidents, along with coordinated agency response to the incidents.
- ***Emergency Management*** – The development of systems to provide emergency call taking, public safety dispatch, and emergency operations center operations.
- ***Maintenance and Construction Management*** – The development of systems to manage the maintenance of roadways in the Region, including winter snow and ice clearance. Includes the managing of construction operations.
- ***Transit Management*** – The development of systems to more efficiently manage fleets of transit vehicles or transit rail. Includes systems to provide transit traveler information both pre-trip and during the trip.
- ***Electronic Payment*** – The development of electronic fare payment systems for use by transit and other agencies (e.g., parking).
- ***Commercial Vehicle Operations*** – The development of systems to facilitate the management of commercial vehicles (e.g., electronic clearance).
- ***Traveler Information*** – The development of systems to provide static and real time transportation information to travelers.
- ***Archived Data Management*** – The development of systems to collect transportation data for use in non-operational purposes (e.g., planning and research).
- ***Advanced Vehicle Safety*** – The development of systems to support private sector vehicle safety initiatives (e.g., intersection collision avoidance)

Table 8 identifies the roles and responsibilities of key stakeholders for a range of transportation services.

Table 8 - Bay Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Arterial Management	MDOT	Operate and maintain traffic signal systems on MDOT routes not managed by local agencies.
		Operate network surveillance equipment such as CCTV cameras and field sensors on MDOT routes not managed by local agencies.
		Provide traffic information reports to regional information service providers.
		Coordinate traffic information and control with Local Agency TOCs and other MDOT TMCs.
	Local Agency	Operate traffic signal systems on local routes.
		Operate network surveillance equipment such as CCTV cameras and field sensors on local routes to facilitate traffic signal operations.
		Provide traffic information reports to regional information service providers.
		Provide traffic information to regional agencies including transit, emergency management, maintenance and construction, and the media.
		Coordinate traffic information and control with MDOT West Michigan TMC and MDOT Bay Region Office.
		Coordinate traffic information with other local agencies.
		Coordinate HRI signal adjustments with private rail operators.
		Provide traffic signal preemption for emergency vehicles.
Highway Management	MDOT	Operate network surveillance equipment including CCTV cameras as well as DMS to convey traffic information to travelers on MDOT highway routes.
		Provide traffic information to regional information service providers.
		Provide traffic information to regional transportation agencies and the general public through traffic information devices primarily DMS.
Incident Management (Traffic)	MDOT	Perform network surveillance for detection and verification of incidents on MDOT routes.
		Provide incident information to travelers via traffic information devices on highways (e.g. DMS).
		Provide incident information to regional emergency responders, including the MSP and local agencies.
		Responsible for the coordination with other traffic operations centers and emergency management agencies for coordinated incident management.
		Responsible for the development, coordination, and execution of special traffic management strategies during an evacuation.
		Coordinate maintenance resources for incident response with MDOT TSC Construction and Maintenance Operations.

Table 8 - Bay Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Incident Management (Traffic) (continued)	Local Agency	Perform network surveillance for detection and verification of incidents on local routes.
		Provide incident information to regional emergency responders, including the MSP and MDOT.
		Coordinate maintenance resources for incident response with MDOT Grand Region TSCs and Local Agencies.
		Responsible for the coordination with other traffic operations centers and emergency management agencies for coordinated incident management.
Incident Management (Emergency)	MSP	Dispatch MSP vehicles for incidents on highways.
		Coordinate incident response with other public safety agencies (local police, fire, EMS, sheriff) as well as MDOT.
		Perform incident detection and verification for the highways within the region and provide this information to traffic and other public safety agencies.
	Local Agency	Receive emergency calls for incidents on local routes.
		Dispatch the local agency emergency vehicles to incidents, including the local agency police, fire, and EMS/rescue.
		Coordinate incident response with other public safety agencies (fire, EMS, ambulance, etc.).
		Coordinate public safety resources for incident response on local routes.
		Coordinate public safety resources for incident response on local routes.
		Perform incident detection and verification on local routes and provide this information to the local agency TOC.
Emergency Management	MSP	Dispatch MSP vehicles to incidents within their jurisdiction.
		Receive AMBER Alert and other wide area alert information from MSP Headquarters.
		Receive early warning information and threat information from the NWS and Local Agencies.
		Coordinate with regional emergency management providers, maintenance and construction providers, and regional traffic management providers for emergency plans and evacuation and reentry plans.
		Provide security monitoring of critical infrastructure for MDOT.
		Provide regional traffic, transit, emergency management, and maintenance operations with disaster information to disseminate to the traveling public.
	Local Agency	Participate in incident response, coordination, and reporting.
		Dispatch local agency fire/EMS/police vehicles.
		Perform incident detection and verification on local roadways.
		Receive AMBER Alert and other wide area alert information from MSP Headquarters.
		Respond to transit emergencies/alarms on-board transit vehicles or at the transit facilities of local transit agencies.

Table 8 - Bay Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Maintenance and Construction Management	MDOT	Receive requests for maintenance resources for incident response from regional emergency management agencies.
		Support coordinated response to incidents.
		Responsible for the tracking and dispatch MDOT maintenance vehicles.
		Receive vehicle location information from MDOT maintenance and construction vehicles.
		Receive vehicle maintenance conditions from MDOT maintenance and construction vehicle and coordinate fleet management with MDOT equipment repair facility.
		Collect road weather information with MDOT equipment and distribute it to regional traffic, maintenance, and transit agencies.
		Provide maintenance of state highways within the region, including pavement maintenance, winter maintenance, and construction activities.
		Manage work zones on all MDOT maintenance and construction activities, as well as monitor work zone safety with MDOT field devices and vehicles.
		Coordinate maintenance and construction activities with other regional maintenance and construction agencies.
		Distribute maintenance and construction plans and work zone information to regional information service providers, regional traffic operations, transit operations, emergency operations, rail operations, and the media.
		Perform maintenance of ITS field equipment owned by MDOT.
	Local Agency	Receive a request for maintenance resources for incident response from regional emergency management agencies.
		Coordinate maintenance resources for incidents with other regional maintenance providers.
		Receive vehicle location information from local agency DPW vehicles.
		Dispatch local agency maintenance vehicles.
	Private Operators	Provide maintenance of local routes and MDOT facilities (per contract), including pavement maintenance and construction activities.
Transit Management	Bay Metro Transit Authority	Provide fixed route bus service for Bay Metro Transit System.
		Provide paratransit bus service for the Bay Metro Transit System.
		Track and evaluate schedule performance on all Bay Metro Transit Authority fixed route and paratransit vehicles.
		Provide transit schedule and fare information to the Bay Metro Transit Authority website and private sector traveler information service providers.
		Provide a demand response transit plan from the agency website.

Table 8 - Bay Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Transit Management (continued)	Bay Metro Transit Authority (continued)	Provide transit passenger electronic fare payment on all Bay Metro Transit Authority fixed route and demand response transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all Bay Metro Transit Authority fixed route and demand response vehicles.
		Provide transit traveler information to the agency website, local private sector traveler information services, and the local public safety agency in addition to making it available on transit information kiosks.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from Bay Metro Transit System transit operations.
	Flint-Mass Transportation Authority	Provide fixed route bus service for Flint-Mass Transportation Authority.
		Provide paratransit bus service for the Flint-Mass Transportation Authority.
		Track and evaluate schedule performance on all Flint-Mass Transportation Authority fixed route and paratransit vehicles.
		Provide transit schedule and fare information to the Flint-Mass Transportation Authority website and private sector traveler information service providers.
		Provide a demand response transit plan from the agency website.
		Provide transit passenger electronic fare payment on all Flint-Mass Transportation Authority fixed route and demand response transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all Flint-Mass Transportation Authority fixed route and demand response vehicles.
		Coordinate transit service with other regional transit providers as well as regional intermodal terminals and the regional airport.
		Provide transit traveler information to the agency website, local private sector traveler information services, and the local public safety agency in addition to making it available on transit information kiosks.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from Flint-Mass Transportation Authority transit operations.

Table 8 - Bay Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Transit Management (continued)	Saginaw Transit Authority Regional Services	Provide fixed route bus service for Saginaw Transit Authority Regional Services.
		Provide paratransit bus service for the Saginaw Transit Authority Regional Services.
		Track and evaluate schedule performance on all Saginaw Transit Authority Regional Services fixed route and paratransit vehicles.
		Provide transit schedule and fare information to the Saginaw Transit Authority Regional Services website and private sector traveler information service providers.
		Provide a demand response transit plan from the agency website.
		Provide transit passenger electronic fare payment on all Saginaw Transit Authority Regional Services fixed route and demand response transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all Saginaw Transit Authority Regional Services fixed route and demand response vehicles.
		Coordinate transit service with other regional transit providers as well as regional intermodal terminals and the regional airport.
		Provide transit traveler information to the agency website, local private sector traveler information services, and the local public safety agency in addition to making it available on transit information kiosks.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from Saginaw Transit Authority Regional Services transit operations.
	Regional Demand Responsive Transit Providers	Track and evaluate schedule performance on all Regional Demand Responsive Transit Providers' demand response vehicles.
		Provide transit schedule and fare information to the Regional Demand Responsive Transit Providers website and private sector traveler information service providers.
		Provide demand response bus service for the Regional Demand Responsive Transit Providers.
		Provide a demand response transit plan from the agency website.
		Provide transit passenger electronic fare payment on all Regional Demand Responsive Transit Providers' transit vehicles.
		Provide transit security on all transit vehicles and at transit terminals through silent alarms and surveillance systems.
		Provide automated transit maintenance scheduling through automated vehicle conditions reports on all Regional Demand Responsive Transit Providers' demand response vehicles.

Table 8 - Bay Region Stakeholder Roles and Responsibilities

Transportation Service	Stakeholder	Roles/Responsibilities
Transit Management (continued)	Regional Demand Responsive Transit Providers (continued)	Coordinate transit service with other regional transit providers as well as regional intermodal terminals and the regional airport.
		Coordinate emergency plans with the local public safety agency and provide emergency transit services for evacuations, fires, and disasters (including re-entry).
		Collect and archive transit data from Regional Demand Responsive Transit Providers transit operations.
Commercial Vehicle Operations	MSP	Provide enforcement of regional permits for overheight/overweight or HAZMAT commercial vehicles.
		Provide first response to commercial vehicle incidents and coordinate for HAZMAT conditions/clean-up.
	MDOT	Provide automated weigh-in-motion inspections for private fleet operations (both commercial vehicles and rail).
		Provide regional permits (overheight/overweight and HAZMAT) to private fleet systems.
		Provide route restriction information to private fleet systems.
		Provide permit information to regional emergency management providers and regional enforcement agencies.
Traveler Information	MDOT	Collection, processing, storage, and broadcast dissemination for traffic, transit, maintenance and construction, and weather information to travelers via the 511 Traveler Information System.
		Provide traveler information to private travelers through in vehicle, personal computing devices or kiosks upon request.
		Provide traveler information to the media.
	MSP	Collect traffic information (road network conditions), work zone information, travel times, and weather information.
	Local Agency	Collect traffic information (road network conditions), work zone information, travel times, and weather information.
		Coordinate and share traveler information with all other traveler information providers within the Region.
Archived Data Management	MDOT	Collect and archive traffic information from regional traffic management providers and centers, emergency information from MSP and local agency police, and transit information from regional transit agencies for planning purposes.
		Coordinate with MDOT Transportation Planning Division.
	MSP	Collect and archive emergency and incident information from MSP and the region's emergency responders.

4.4 Potential Agreements

The Regional ITS Architecture for the Bay Region has identified many agency interfaces, information exchanges, and integration strategies that would be needed to provide the ITS services and systems identified by the stakeholders in the Region. Interfaces and data flows among public and private entities in the Region will require agreements among agencies that establish parameters for sharing agency information to support traffic management, incident management, provide traveler information, and perform other functions identified in the Regional ITS Architecture.

With the implementation of ITS technologies, integrating systems from one or more agencies, and the anticipated level of information exchange identified in the architecture, it is likely that formal agreements between agencies will be needed in the future. These agreements, while perhaps not requiring a financial commitment from agencies in the Region, should outline specific roles, responsibilities, data exchanges, levels of authority, and other facets of regional operations. Some agreements will also outline specific funding responsibilities, where appropriate and applicable.

Agreements should avoid being specific with regards to technology when possible. Technology is likely to change rapidly and changes to technology could require an update of the agreement if the agreement was not technology neutral. Focus of the agreement should be on the responsibilities of the agencies and the high level information that needs to be exchanged. Depending on the type of agreement being used, agencies should be prepared for the process to complete an agreement to take several months to years. Agencies must first reach consensus on what should be in an agreement and then proceed through the approval process. The approval process for formal agreements varies by agency and can often be quite lengthy, so it is recommended that agencies plan ahead to ensure that the agreement does not delay the project.

When implementing an agreement for ITS, it is recommended that as a first step any existing agreements are reviewed to determine whether they can be amended or modified to include the additional requirements that will come with deploying a system. If there are no existing agreements that can be modified or used for ITS implementation, then a new agreement will need to be developed. The formality and type of agreement used is a key consideration. If the arrangement will be in affect for an extended duration or involve any sort of long term maintenance, then written agreements should be used. Often during long term operations, staff may change and a verbal agreement between agency representatives may be forgotten by new staff.

Common agreement types and potential applications include:

- **Handshake Agreement:** Handshake agreements are often used in the early stage of a project. This type of informal agreement depends very much on relationships between agencies and may not be appropriate for long term operations where staff is likely to change.
- **Memorandum of Understanding (MOU):** A MOU demonstrates general consensus or willingness to participate as part of a particular project but is not typically very detailed.
- **Interagency and Intergovernmental Agreements:** These agreements between public agencies can be used for operation, maintenance, or funding of its projects and systems. They can include documentation on the responsibility of each agency, functions they will provide, and liability.
- **Funding Agreements:** Funding agreements document the funding arrangements for ITS projects. At a minimum, funding agreements include a detailed scope, services to be performed, and a detailed project budget.

- **Master Agreements:** Master agreements include standard contract language for an agency and serve as the main agreement between two entities which guides all business transactions. Use of a master agreement can allow an agency to do business with another agency or private entity without having to go through the often lengthy development of a formal agreement each time.

Table 9 provides a list of existing and potential agreements for the Bay Region based on the interfaces identified in the Regional ITS Architecture. It is important to note that as ITS services and systems are implemented in the Region, part of the planning and review process for those projects should include a review of potential agreements that would be needed for implementation or operations.

Table 9 - Bay Region Potential Agreements

Status	Agreement and Agencies	Agreement Description
Future	**Joint Operations/Shared Control Agreements (Public-Public or Public-Private)**	These agreements would allow joint operations or control of certain systems and equipment. The agreement should define such items as hours of operation and time of day/day of week when shared control would take effect, circumstances, or incidents when shared control would take effect, notification procedures between the agencies agreeing to shared control arrangements, overriding capabilities of owning agency, etc. Private agencies, such as information service providers that provide traffic reports, could also be part of this agreement.
Future	**Data Sharing and Usage (Public-Public)**	These agreements would define the parameters, guidelines, and policies for inter- and intra-agency ITS data sharing. This data sharing would support regional activities related to traffic management, incident management, traveler information, and other functions. The terms of this agreement should generally address such items as types of data and information to be shared, how the information will be used (traffic incident information to be shared, displayed on web site for travel information, distributed to private media, etc.), and parameters for data format, quality, security.
Future	**Data Sharing and Usage (Public-Private)**	These agreements would define the parameters, guidelines, and policies for private sector (such as the media or other information service providers) use of ITS data. This type of agreement is recommended to define terms of use for broadcasting public-agency information regarding traffic conditions, closures, restrictions, as well as video images. Agreements can also include requirements for the media to 'source' the information (i.e., using the providing agency's logo on all video images broadcast.
Future	**Mutual Aid Agreements (Public-Public)**	Mutual aid agreements often exist as either formal or informal arrangements. They are a routine practice among many public safety and emergency services agencies. Formal mutual aid agreements will become more important as agencies integrate systems and capabilities, particularly automated dispatch and notification. Formalized agreements should be considered as ITS or other electronic data sharing systems are implemented in the Region.

4.5 Phases of Implementation

The Regional ITS Architecture will be implemented over time through a series of projects led by both public sector and private sector agencies. Key foundation systems will need to be implemented in order to support other systems that have been identified in the Regional ITS Architecture. The deployment of all of the systems required to achieve the final Regional ITS Architecture build out will occur over many years.

A sequence of projects and their respective time frames will be identified in the Bay Regional ITS Deployment Plan. These projects will be sequenced over a 10-year period, with projects identified for deployment in 5- and 10- year timeframes.

Some of the key market packages that will provide the functions for the foundation systems in the Bay Region are listed below. Projects associated with these and other market packages identified for the Region will be included in the Bay Regional ITS Deployment Plan.

- Network Surveillance;
- Maintenance and Construction Vehicle Tracking;
- Weather Information Processing and Distribution;
- Surface Street Control;
- Traffic Information Dissemination; and
- Transit Vehicle Tracking

5. USE AND MAINTENANCE PLAN FOR THE REGIONAL ITS ARCHITECTURE

The ITS Architecture developed for the Bay Region addresses the Region's vision for ITS implementation at the time the plan was developed. Stakeholders invested a considerable amount of effort in the development of the Regional ITS Architecture and Regional ITS Deployment Plan. As the Region grows, needs will change, and, as technology progresses, new ITS opportunities will arise. Shifts in regional needs and focus as well as changes in the National ITS Architecture will necessitate that the Bay Region ITS Architecture be updated to remain a useful resource for the Region.

The following section outlines how the Region and its stakeholders can work with the MDOT ITS Program Office to ensure projects are in conformity and also provide updates as ITS evolves in the region.

5.1 Process for Determining Architecture Conformity

The Bay Regional ITS Architecture and Deployment Plan documents the customized market packages that were developed as part of the ITS architecture process. To satisfy federal requirements and remain eligible to use federal funds, a project must be accurately documented. To document the conformity of an ITS project with the regional architecture, MDOT's ITS Program Office will oversee the development of a regional architecture conformance form to guide project managers through the process. The project managers will be able to coordinate with the ITS Program Office and regional contact for additional assistance and guidance. The steps of the process are as follows:

- Identify the ITS components in the project;
- Identify the corresponding market packages(s) from the Regional ITS Architecture;
- Locate the component within the market package;
- Compare the connections to other agencies or elements documented in the ITS architecture as well as the information flows between them to the connections that will be part of the project;
- Assess the use of relevant standards; and
- Document any changes necessary to the ITS Architecture or the project to ensure there is conformance.

Identifying the ITS Components

ITS components can be fairly apparent in an ITS focused project such as CCTV or DMS deployments, but could also be included in other types of projects. For example, an arterial widening project could include the installation of signal system interconnect, signal upgrades, and the incorporation of the signals in the project limits into the MDOT's signal system. These are all ITS deployments and should be part of the ITS architecture.

Identifying the Corresponding Market Packages

If a project was included in Table 10 of the Deployment Plan, then the applicable market package(s) for that project are identified in a column. ITS projects are not required to be included in the ITS Deployment Plan in order to be eligible for federal funding; therefore, market packages might need to be identified without the assistance of an ITS Deployment Plan. In that case, the market packages selected and customized for the Bay Region are identified in **Table 5** of this document, detailed market package definitions are located in **Appendix A**, and customized market packages for the Bay Region are included in **Appendix B**.

Identifying the Component within the Market Package

The customized market packages for the Bay Region are located in **Appendix B**. Once the element is located on the market package, the evaluator may determine that the element name should be modified. For example, an element called the Local Agency TOC was included in the architecture, but at the time of deployment, City of Saginaw will more than likely decide to call the center by a specific name. This name change should be documented using the process outlined in Section 1.3.

Evaluating the Connections and Flows

The connections and architecture flows documented in the market package diagrams were selected based on the information available at the time the plan was developed. As the projects are designed, decisions will be made on the system layout that might differ from what is shown in the market package. These changes in the project should be documented in the ITS market packages using the process outlined in Section 1.3.

Relevant Standards

ITS Standards are documented guidelines or rules specifying the interconnections among elements and the characteristics of technologies and products to be used in ITS installations. Standards describe in detail what types of interfaces should exist between ITS components and how the components will exchange information and work together to deliver certain user services. The Bay Regional ITS Architecture highlights the relevant standards based on the region's needs. These standards should be reviewed as part of this conformity exercise. Where standards can be utilized, they should be noted. Where standards are not or could not be utilized, an explanation of why, also should be noted.

Documenting Required Changes

If any changes are needed to accommodate the project under review, Section 1.3 describes how those changes should be documented. Any changes will be incorporated during the next architecture update. Conformance will be accomplished by documenting how the market package(s) should be modified so that the connections and data flows are consistent with the project.

5.2 Maintenance Process

MDOT's ITS Program Office will be responsible for leading the maintenance of the Bay Regional ITS Architecture and Deployment Plan in coordination with the regional contact. Maintenance includes modifications to the plan as well as complete updates. **Table 10** summarizes the maintenance process agreed upon by stakeholders in the Region.

Table 10 - Regional ITS Architecture and Deployment Plan Maintenance Summary

Maintenance Details	Regional ITS Architecture		Regional ITS Deployment Plan	
	Modification	**Complete Update**	**Modification**	**Complete Update**
Timeframe for Updates	As needed	Every 5-7 years	As needed	Every 5-7 years
Scope of Update	Update market packages to satisfy architecture conformance requirements of projects or to document other changes that impact the ITS Architecture	Entire ITS Architecture	Update project status and add or remove projects as needed	Entire ITS Deployment Plan
Lead Agency	MDOT ITS Program Office*		MDOT ITS Program Office*	
Participants	Stakeholders impacted by market package modifications	Entire stakeholder group	Entire stakeholder group	
Results	Market package or other change(s) documented for next complete update	Updated Bay Regional ITS Architecture document, Appendices, and Turbo Architecture database	Updated project tables	Updated Bay Regional ITS Deployment Plan document

** Transit related projects will be supported by MDOT's Bureau of Passenger Transportation*

Modifications to the Regional ITS Architecture and Deployment Plan will often be necessitated by ITS projects that are receiving federal funding but do not conform to the Regional ITS Architecture. MDOT's ITS Program Office will take the lead in working with agencies that receive federal funding for ITS projects and will keep a record of any changes that are needed to the Regional ITS Architecture. Complete updates to the Regional ITS Architecture will occur approximately every five to seven years and will be led by the MDOT's ITS Program Office with support from the MDOT Bay Region and other key stakeholders. The entire stakeholder group that was engaged to develop this first Regional ITS Architecture will be reconvened for the complete updates.

5.3 Procedure for Submitting ITS Architecture Changes Between Scheduled Updates

Updates to the Bay Regional ITS Architecture will occur on a regular basis as described in Section 1.2 to maintain the architecture as a useful planning tool. Between complete plan updates, smaller modifications will likely be required to accommodate ITS projects in the Region. Section 1.1 contains step by step guidance for determining whether or not a project requires architecture modifications.

For situations where a change is required, an ITS Architecture Maintenance Documentation Form was developed and is included in **Appendix E**. This form should be completed and submitted to the MDOT ITS Program Office whenever a change to the Regional ITS Architecture or

Deployment Plan is proposed. Please note that MDOT's Bureau of Passenger Transportation also should be copied if the project has a transit related component.

The Maintenance Documentation form identifies three levels of modifications. They include:

- Level 1 – Basic changes that do not affect the structure of the architecture.
  Examples include: Changes to stakeholder or element name, element status, or data flow status.
- Level 2 – Structural changes that impact only one agency.
  Examples include: Addition of a new market package or modifications to an existing market package that affects only one agency.
- Level 3 – Structural changes that have the potential to impact multiple agencies.
  Examples include: Addition of a new market package or modifications to an existing market package that involves multiple agencies or incorporation of a new stakeholder into the architecture.

While documenting the proposed change, the project manager completing the change form should coordinate with any of the other agencies that may be impacted by the modification. This communication between agencies will simplify the process of performing a complete plan update. MDOT's ITS Program Office will review and accept the proposed changes. When a complete update is performed by MDOT's ITS Program Office, all of the documented changes will be incorporated into the regional ITS architecture. **Figure 11** graphically illustrates this process.

Figure 11 - Process for Documenting Architecture Performance