Prepared For

DOTD

LOUISIANA DEPARTMENT OF TRANSPORTATION & DEVELOPMENT

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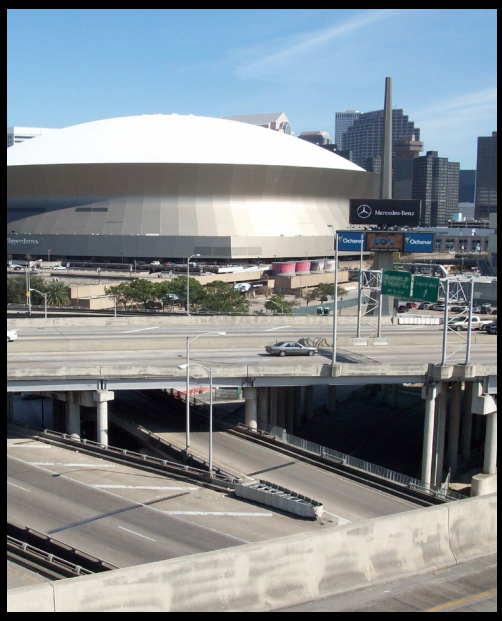

Louisiana Statewide ITS Architecture

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LOUISIANA STATEWIDE ITS ARCHITECTURE

September 13, 2016

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Executive Summary

The purpose of this document is to update the Statewide Intelligent Transportation Systems (ITS) Architecture plan for the State of Louisiana. This document will describe the ITS envisioned for the entire State of Louisiana, outlining programs and projects critical for implementation, operation and management of the Statewide ITS infrastructure. The concept of operations for the Statewide and regional management of traffic will be addressed. The stakeholders and their operational roles and responsibilities are also described in the document. The various systems envisioned and frameworks for policies, programs, and projects that will facilitate advanced transportation management in the State of Louisiana are listed below:

- Traveler information
- Freeway management
- Arterial management
- Incident management
- Travel demand management
- Public transportation management
- Electronic payment and congestion pricing
- Commercial vehicle operations
- Emergency management
- Information management
- Work zone ITS
- Infrastructure monitoring and security
- Future TMC development
- Future motorist assistance patrol (MAP) deployment
- Maintenance of ITS devices
- Advanced vehicle systems

Technological advancements and the evolving needs of users means changes have to be made to this framework to ensure it is current and meets the needs of the State. Anticipated changes include implementing innovative programs and projects that leverage state-of-the-art technology, to successfully meet the challenges in transportation safety, mobility and environmental stewardship.

The framework described in this document is based on the National ITS Architecture. The desired user services and service packages have also been described. In addition, the data exchanges required between stakeholders or institutions, and equipment required to meet identified user needs identified have been presented in flow context diagrams or interconnect

context diagrams. The context diagrams were developed using the Turbo Architecture software package developed by the federal government to aid in the development of ITS Architectures.

Currently, Louisiana has implemented regional ITS architectures with traffic management centers to manage local traffic in Baton Rouge, Houma, New Orleans, and Shreveport. These TMCs provide coverage at least during the morning and evening rush hours. New Orleans TMC operates 24 hours a day 7 days a week. There is also a Statewide TMC located in Baton Rouge which provides traffic monitoring and management for corridors outside the coverage areas of the regional TMCs and also after hour's coverage for the regional TMCs. The Statewide TMC provides coverage as needed and also operates 24 hours a day, 7 days a week .

1 INTRODUCTION

1.1 INTRODUCTION

Intelligent Transportation Systems (ITS) is the use of advanced technology and communications and management strategies to address transportation related issues such as mobility, safety and traveler information to increase the efficiency and effectiveness of the transportation systems and investments. An ITS architecture defines a framework to describe, plan and implement ITS for an advanced transportation management system. This Statewide ITS Architecture is therefore a roadmap for the development, implementation and management of an advanced transportation systems in Louisiana. This document describes ITS related programs and projects that the Louisiana Department of Transportation and Development (LADOTD) and the stakeholders[1] will pursue to operate, manage and maintain the transportation system in the State.

1.2 FEDERAL REGULATIONS AND GUIDANCE

The U.S. Federal Government enacted a rule that requires all regions that want to benefit from federal funding to have in place a regional ITS architecture. Federal Highway Administration (FHWA) Final Rule 940 Part 11 Paragraph 940.9 (a) states that:

> *"A regional ITS architecture shall be developed to guide the development of ITS projects and programs and be consistent with ITS strategies and projects contained in applicable transportation plans. The National ITS Architecture shall be used as a resource in the development of the regional ITS architecture. The regional ITS architecture shall be on a scale commensurate with the scope of ITS investment in the region. Provision should be made to include participation from the following agencies, as appropriate, in the development of the regional ITS architecture: Highway agencies; public safety agencies (e.g., police, fire, emergency/medical); transit operators; Federal lands agencies; State motor carrier agencies; and other operating agencies necessary to fully address regional ITS integration."*

While the rule does not require a Statewide ITS architecture, having a Statewide ITS architecture allows for a uniform systematic approach to addressing the state's ITS needs and is encouraged. With this in mind, the Statewide ITS Architecture for Louisiana follows the guidelines for regional ITS architectures as outlined in the rule.

[1] Section 4.20 has a description of all stakeholders impacted by the Statewide ITS Architecture. Active participants in the development of this document included LADOTD, LTRC, LSP, the MPOs and FHWA.

1.3 ITS ARCHITECTURE DEVELOPMENT IN LOUISIANA

The stakeholders in the Louisiana Statewide ITS Architecture envision a system that enhances productivity of all citizens by providing seamless end-to-end multimodal transportation. This can be achieved through an efficient transportation system that leverages the benefits of ITS infrastructure to meet needs for mobility, safety, security and economic productivity. The initial Steering Committee[2] set up for the development of the Statewide ITS Architecture established the following guiding principles:

1. Major traveler delays on freeways and major arterial routes will be minimized through rapid detection, response and clearance of all reported incidents.
2. Citizens will be able to reach safe locations during emergency evacuations sooner through the continuous monitoring and management of traffic and communication of best route information to evacuees.
3. Travelers will be able to avoid delays on freeways and major arterial routes through the availability of accurate information on work zone, construction area, and incident locations in a wide variety of different ways, both pre-trip and en-route.
4. Travelers will be able to make informed decisions about trip need, time, route, and mode because they will be able to access accurate information about current traffic conditions and public transit options.
5. Accidents in work zone areas and at high-accident locations will be reduced through advance warnings and effective speed control measures.
6. Traveler delay on major arterial routes will be minimized through use of traffic signal control strategies that respond to changing traffic conditions.
7. Louisiana's industries will realize lower transportation costs.
8. Quality of life will be improved because travel will become more predictable and less stressful.

The Statewide ITS plan when it was first articulated had the following goals outlined for ITS deployment in Louisiana:

- Minimizing traveler delays on freeways and major arterials routes through rapid detection, response, and clearance of all reported incidents;
- Expediting emergency evacuations by continuously monitoring and communicating best routes information to evacuees;

[2] *Louisiana Statewide ITS Implementation and Telecommunications Plan (2002)*

- Empowering users to make smarter travel decisions both pre-trip and en-route; monitoring and managing traffic to ensure reliable and predictable travel times;
- Enhancing safety in work zone areas and locations with abnormal crash frequency through targeted ITS deployment.

In addition to the above, the Louisiana Department of Transportation (LADOTD) included the following additional goals[3]:

- Improved administrative efficiency, operational safety, and productivity for commercial vehicles, and
- Amber Alert

While various systems and programs have been deployed to meet these goals, the evolving nature of transportation issues and the continuous advancements in technology require that the systems in place are periodically reviewed and adapted to meet the needs of the public. This continuous evolution presents new opportunities and challenges with legacy systems and cutting edge technology which have to be evaluated for performance in meeting the desired objectives. This periodic review of programs and services enables investments of limited resources to be efficient and effective. **Table 1** summarizes the Statewide objectives and their relationship to planning.

Table 1: Relationship to Planning

Number	Name	Description	Performance Measure Category[4]	Performance Measure
1	Improved Transportation Network Safety	Continually improve the safety of the Statewide transportation system for all users, and reduce the number of crashes and other incidents associated with work zone and high accident location areas.	Crashes	Crashes/MVM
			Incident Clearance Time	Time
2	Improved Traffic Management	Reduce recurring and non-recurring delay for travelers in the State. Generally the goal is to reduce travel time variability.	Delay	Vehicle Hours of Travel (VHT)

[3] *Louisiana DOTD 5-Year ITS Strategic Business Plan (2010)*

[4] The Performance Measure Category and Performance Measure were not provided in the Louisiana DOTD 5-Year ITS Strategic Business Plan (October 2010)

Number	Name	Description	Performance Measure Category[4]	Performance Measure
3	Reduced Non-Recurring Congestion	To minimize the effects of unexpected crashes or incidents, bad weather, construction and irregular congestion causes. Major traveler delays on freeways and major arterial routes will be minimized through rapid detection, response, and clearance of all reported incidents.	Travel Time Reliability	Planning Time Index, Buffer Time Index
4	Effective Dissemination of Traffic Information	Increase the number of people receiving accurate traveler information.	Delay	Vehicle Hours of Travel (VHT)
5	Improved Emergency Management	Citizens will be able to reach safe locations during emergency evacuations sooner through the continuous monitoring and management of traffic and communication of best route information to evacuees.	Delay	Vehicle Hours of Travel (VHT)
6	More Efficient Modal Utilization	Increase the number of people receiving transit schedule information.	Modal Connectivity	Connectivity, Wait Time
7	Improved Administrative Efficiency, Operational Safety, and Productivity for Commercial Vehicles	Decrease state resources expended on routine administrative tasks, increase revenues as a result of improved compliance, reduce motor carrier regulatory compliance cost, reduce commercial vehicle crash rate and cost effectiveness of inspections through better targeting of unsafe and illegal carriers.	Freight Travel Time	Hours
8	Amber Alert	Amber Alerts are issued to alert the general public of a child abduction. Amber Alerts are issued via radio, TV, email, SMS Text and DMS.	Delay	Minutes

This update to the Statewide ITS Architecture has been developed through a collaborative effort between the Statewide stakeholders involved in Louisiana's transportation system to address current and emerging transportation needs. This architecture therefore represents a shared vision of how various agencies and the regions will work together sharing information and resources to provide a safe and efficient transportation system.

2 ACRONYMS AND DEFINITIONS

AASHTO – American Association of State Highway and Transportation Officials

ASC – Actuated Traffic Signal Controller

ASD – Aftermarket Safety Device

ATIS – Advanced Traveler Information Systems

ATMS – Advanced Transportation Management System

AV – Autonomous Vehicle

AVL – Automated Vehicle Location System

AVTT – Autonomous Vehicle Technology Team

CAD – Computer Aided Dispatch

CCTV – Closed Circuit Television

CDMA – Code Division Multiple Access

CEA – Cooperative Endeavor Agreement

CFR – Code of Federal Regulations

CMU – Conflict Monitor Units

CORBA – Common Object Request Broker Architecture

CRPC – Capital Region Planning Commission

CV – Connected Vehicle

CVISN – Commercial Vehicle Information Systems Network

CVRIA – Connected Vehicle Reference Implementation Architecture

DCM – Data Collection and Monitoring

DEQ – Department of Environmental Quality

DMS – Dynamic Message Signs

DOTD – Department of Transportation and Development

DPW – Department of Public Works

DSRC – Dedicated Short-Range Communication

DTOE – District Traffic Operations Engineer

ELMS – Electrical and Lighting Management Systems

EMS – Emergency Medical Service

ESS – Environmental Sensor Stations

FAA – Federal Aviation Administration

FHWA – Federal Highway Administration

FMCSA – Federal Motor Carrier Safety Administration

FMS – Field Management Stations

FTA – Federal Transit Administration

GNOEC - Greater New Orleans Expressway Commission

GOHSEP – Governor's Office of Homeland Security and Emergency Preparedness

GSM – Global System for Mobile Communication

HAR – Highway Advisory Radio

HAZMAT – Hazardous Materials

HOV – High Occupancy Vehicle

HRI – High-rail Intersection

IP – Internet Protocol

ITS – Intelligent Transportation Systems

LADOTD – Louisiana Department of Transportation and Development

LONI – Louisiana Optical Network Initiative

LSP – Louisiana State Police

LTRC – Louisiana Transportation Research Center

MAP – Motorist Assistance Patrol

MPO – Metropolitan Planning Organization

MS/ETMCC – Message Sets for External Traffic Management Center Communications

MTP – Metropolitan Transportation Plan

MUTCD – Manual on Uniform Traffic Control Devices

NHTSA – National Highway Traffic Safety Administration

NORPC – New Orleans Regional Planning Commission

NTCIP – National Transportation Communications for Intelligent Transportation System

PRISM – Performance and Registration Information Systems Management

O & M – Operations and Maintenance

OEM – Original Equipment Manufacturer

OHSEP – Office of Homeland Security and Emergency Preparedness

OPAC – Optimized Policies for Adaptive Control

PCMS – Portable Changeable Message Signs

PDA – Personal Digital Assistant

RHODES – Real-time Hierarchical Optimized Distributed Effective System

RR – Roles and Responsibilities

RSE – Roadside Equipment

RTMC – Regional Traffic Management Center

RWIS – Road Weather Information System

SAE – Society of Automotive Engineers

SCATS – Sydney Coordinated Adaptive Traffic System

SCOOT – Split Cycle Offset Optimization Technique

SCP – Signal Control and Prioritization

SDO – Standards Development Organizations

SSL – Signal System Local

SSM – Signal System Master

TDM – Travel Demand Management

TIM – Traffic Incident Management

TIP – Transportation Improvement Program

TMA – Transportation Management Area

TMC – Traffic Management Center (a.k.a. Transportation Management Center)

TMDD – Traffic Management Data Dictionary

TMP – Transportation Management Plan

USDOT – United States Department of Transportation

TSS – Transportation Sensor Systems

UAS – Unmanned Aerial Systems

UAV – Unmanned Aerial Vehicles

V2D – Vehicle-To-Device

V2I – Vehicle-To-Infrastructure

V2V – Vehicle-To-Vehicle

VD – Vehicle Detection

VDMS – Video Distribution Management System

VDS – Video Distribution System

VHT – Vehicle Hours Traveled

VII – Vehicle Infrastructure Integration

VMT – Vehicle Miles Traveled

WIM – Weigh-in-Motion

XML – Extensive Markup Language

3 ARCHITECTURE SCOPE

3.1 BACKGROUND

The State of Louisiana is located in the southern region of the United States and bordered by Texas to the west, Arkansas to the north, Mississippi to the east, and the Gulf of Mexico to the south. The population of the State based on a 2012 estimate is 4,601,893. Of the 1,831,057 workers 16 years of age and older in the state, 78.1% drive (cars, trucks or vans) alone to work, 13.6% carpool, 2.4% use public transportation, 2.2% walk, 2.1% work from home and 1.6% use other means. The population of the State of Louisiana in 2030 is projected to be in the range of 5,161,800 to 8,813,420.

Louisiana's highway network ranks 30th largest in the nation, and has the 11th largest state highway system[5]. The highway network is comprised of over 60,000 miles of roadway and 13,000 bridges under the jurisdiction of federal, state or local government entity. This network handles about 41 billion miles of travel annually, and the higher proportion of this travel occurs on rural roads and highways. The principal highway corridors in the State of Louisiana are listed in **Table 2**. In the last decade, the highway system has expanded by less than 1% however demand on the system grew by 11%.

Table 2: Principal Highway Corridors in Louisiana

Interstates	United States (U.S.) Routes	
Interstate 10	U. S. Route 11	U. S. Route 190
Interstate 12	U. S. Route 51	U. S. Route 371
Interstate 20	U. S. Route 61	U. S. Route 425
Interstate 49	U. S. Route 63	
Interstate 55	U. S. Route 65	
Interstate 59	U. S. Route 71	
Interstate 110	U. S. Route 79	
Interstate 210	U. S. Route 80	
Interstate 220	U. S. Route 84	

[5] http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Multimodal/Transportation_Plan/Pages/default.aspx (accessed 6/13/2016)

Interstates	United States (U.S.) Routes	
Interstate 310	U. S. Route 90	
Interstate 510	U. S. Route 165	
Interstate 610	U. S. Route 167	
Interstate 910[6]	U. S. Route 171	

The State is subdivided into 64 parishes and the largest parish by population is East Baton Rouge Parish. There are also nine metropolitan statistical areas (MSAs). Each of these MSAs has a regional ITS architecture existing, planned or proposed. Below is a list of the MSAs ordered from the largest to the smallest:

1. New Orleans-Metairie-Kenner
2. Baton Rouge
3. Shreveport-Bossier City
4. Lafayette
5. Houma-Bayou Cane-Thibodaux
6. Lake Charles
7. Monroe
8. Alexandria
9. Hammond

Furthermore, there are eight metropolitan planning organizations (MPOs) in the urbanized areas that are responsible for transportation planning. MPOs are required for any urbanized area with a population of more than 50,000 people. A transportation management area (TMA) is required in an urbanized area with a population of over 200,000 people. All the urbanized areas of the State have regional ITS architectures existing with devices deployed or proposed for development (see **Figure 1**). The New Orleans regional ITS architecture which also covered the Northsore area (including Hammond) is being modified and a new Northshore ITS architecture is under development and devices will be operated from the Statewide TMC. The boundaries of these regional ITS architectures usually fall within each respective metropolitan planning organization's (MPOs) boundary. The limits may exceed MPO boundaries in instances where

[6] The New Orleans Westbank Expressway (US 90B) was designated by AASHTO in 1990 to be I-910. However, it was never signed because of the future I-49. To date, its signing as I-910 is still on hold.

additional coverages for critical corridors are required. Where no local regional TMC is available, the field devices are managed and controlled from the Statewide Traffic Management Center. The LADOTD District Offices and Louisiana State Police (LSP) are critical agencies for highway operations, incident and emergency management. **Figure 2** and **Figure 3** show the DOTD Districts and LSP Troop jurisdictions respectively.

3.2 GEOGRAPHIC SCOPE

The Statewide ITS architecture will provide the framework for the deployment of field devices, systems and personnel to facilitate the active manage of traffic in the state to improve traveler mobility, reduce traffic congestion, reduce emissions and improve safety. Therefore the Statewide ITS architecture is intended to guide implementation and operation of ITS infrastructure throughout the state. While the intent of the Statewide ITS architecture is to ensure a uniform systematic approach to ITS deployments, the regional ITS architectures are based specifically on the needs of each region. Furthermore, the Statewide ITS architecture will focus on ITS infrastructure to address needs within corridors that bridge the areas covered under the regional ITS architectures. Since ITS deployments are capital intensive and impractical to provide coverage for every mile of the entire state highway system. The Statewide ITS deployments are therefore focused on corridors that yield high return on the investment. These critical corridors include Interstates, freeways, expressways, and major arterials with very high vehicular and truck volumes. Special attention is given to roadways with the following characteristics:

- ✓ Experience significant recurring and non-recurring congestion
- ✓ Experience a high number of crashes (abnormal crashes)
- ✓ Serve as evacuation routes during emergencies
- ✓ Serve as major freight route within and through the state
- ✓ Provide connections to intermodal facilities

In future, the Louisiana Statewide ITS architecture could interface with other adjoining statewide or regional ITS architectures (Arkansas, Mississippi and Texas) to enable seamless ITS coverage for motorists traveling across state lines.

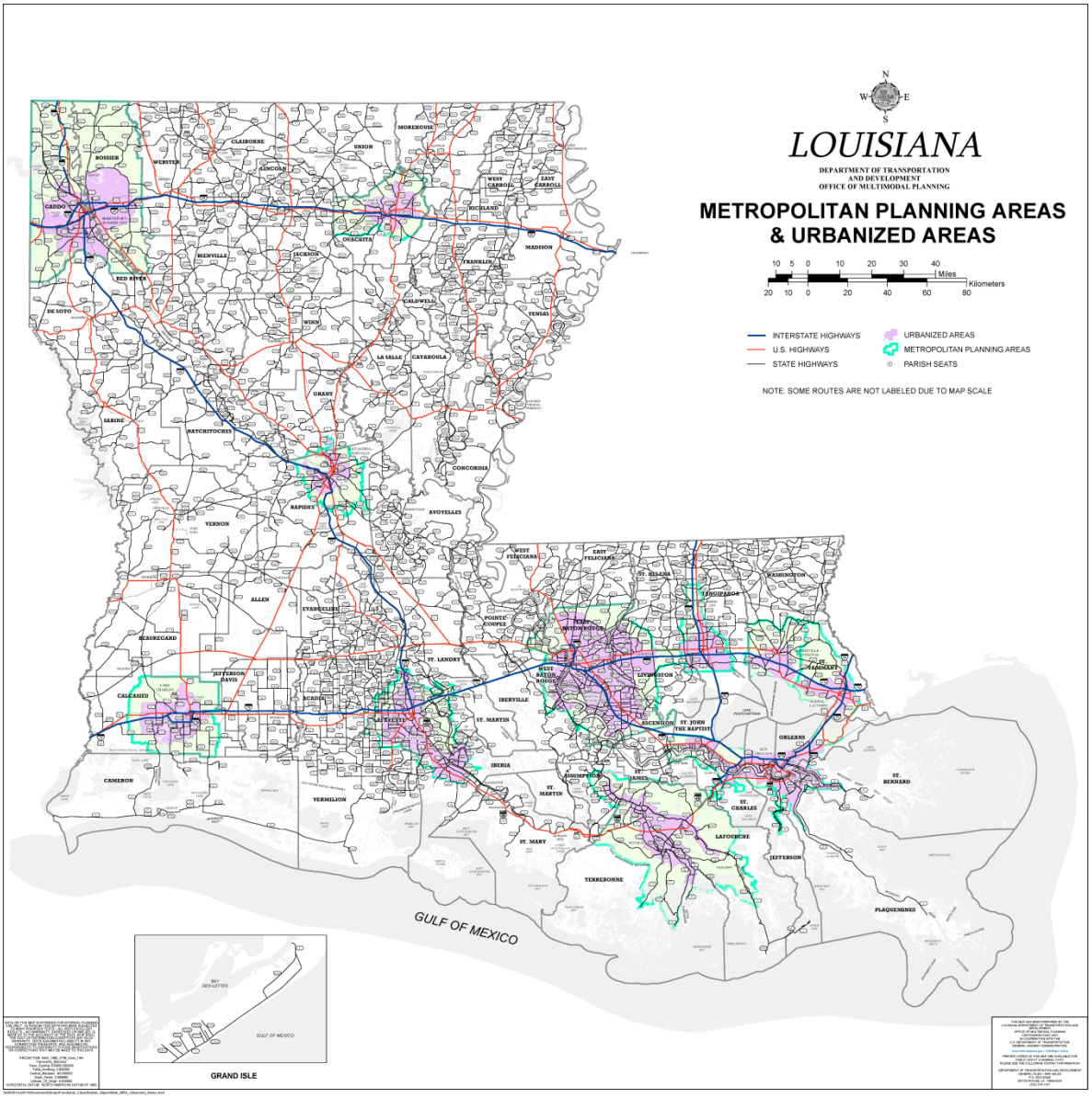
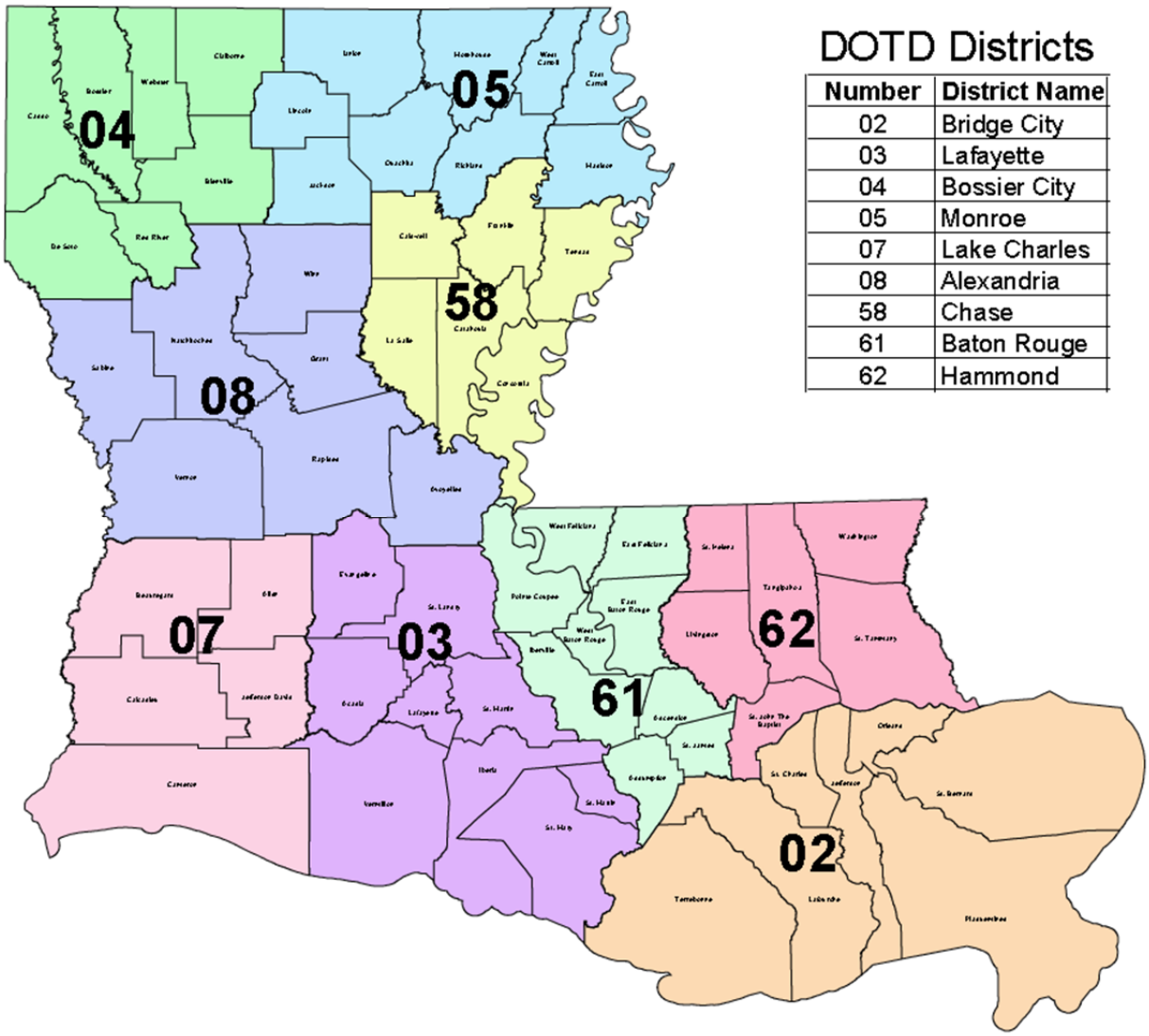


Figure 1: Urbanized Areas of Louisiana



DOTD Districts

Number	District Name
02	Bridge City
03	Lafayette
04	Bossier City
05	Monroe
07	Lake Charles
08	Alexandria
58	Chase
61	Baton Rouge
62	Hammond

Figure 2: DOTD Districts

Figure 3: Louisiana State Police Troop Locations

3.3 SERVICE SCOPE

The vision and goals of the Statewide ITS Architecture define the concept of operations and the requirements which in turn define the scope of functions that need to be deployed to enhance transportation operations and safety. In order to achieve the desired goals listed in **Section 1.1**, all the major facets of ITS systems desired in Louisiana must be assessed and developed. These systems include but are not limited to the following:

- Traveler information
- Freeway management
- Arterial management
- Incident management
- Travel demand management
- Public transportation management
- Electronic payment and congestion pricing
- Commercial vehicle operations

- Emergency management
- Information management
- Work Zone ITS
- Infrastructure monitoring and security
- Traffic Management Centers (TMCs)
- Motorist Assistance Patrol (MAP)
- Maintenance of ITS devices
- Advanced vehicle systems

3.4 TIME FRAME

The time frame proposed for the Statewide ITS Architecture is 10 years. However it is expected that the document will undergo periodic reviews during this period to revise programs and proposed projects to address evolving user needs and better leverage state-of-the-art technology to meet those needs in the State.

3.5 MAINTAINER

The Louisiana Department of Transportation and Development (LADOTD) will maintain the Statewide ITS Architecture.

4 OPERATIONAL CONCEPT

4.1 INTRODUCTION

The operational concept defines what the Statewide ITS architecture will do from a user perspective and the roles and responsibilities of each stakeholder. Advancements in technology especially in the areas of telematics and communications facilitates the development of ITS. While the user needs may not change much, the means by which services are delivered may undergo significant changes over the anticipated time frame of the Statewide ITS architecture. The purpose of this section is to discuss the state-of-the-art in ITS technologies, including the services available under the National ITS Architecture framework that may be used to address existing and emerging user needs.

4.2 OPERATIONAL REGIMES

Louisiana is prone to hurricane emergencies because of its proximity to the Gulf of Mexico. Other natural emergencies include ice and flooding. There are also many industrial plants and refineries that pose hazards related to fires, explosions and chemical leaks. Other disasters may be artificially induced such as terrorism. The Statewide ITS architecture is required to meet these diverse operational challenges and help deliver an efficient transportation system to meet the mobility demands for extreme events or the daily socio-economic activities.

Because of these contingency three distinct operational regimes have been identified and these are normal, major incident and emergency operations. Each stakeholder has operational roles and responsibilities based on the range of services required to achieve the desired objectives in each scenario. The stakeholder roles and responsibilities will be defined for the various operational regimes. The key differences in the three operational regimes (normal, major incident and emergency operations) are the scale and urgency of resource allocation to alleviate congestion, manage incidents, and the lead agency responsible for operations.

4.2.1 Normal Operation

The Normal Operation regime describes normal traffic conditions and the predominant concern is recurring traffic during rush hour. Occasionally, minor incidents may happen which may cause additional delays because of reduced lane capacity, however the roadway remains passable. The agency with primary operational responsibility is DOTD with support from LSP or Local Public Safety Agencies.

4.2.2 Major Incident

The Major Incident regime describes a scenario where there is major incident or public event which requires extended closure of roadway. Examples of major incidents include chemical spills, bridge collapse, flooding, or a major sporting event. The impacts of a major incident extend over a wider geographic area than minor incidents that occur under “normal operation.”

The agency with primary operational responsibility will be LSP with support from DOTD and other Local Public Safety Agencies.

4.2.3 Emergency Operation

Emergency operation is typically activated by GOHSEP and involves major events such as hurricane hazard or other public safety related issue that mandates massive evacuation. This operational regime has system-wide impacts on the transportation network. GOHSEP will determine the emergency action level which in turn defines operational responses from DOTD and LSP. DOTD will designate evacuation routes and be responsible for road network status monitoring and information communication to support evacuations. LSP will be responsible for diversions, traffic control and incident management. The agency with primary operational responsibility is GOHSEP.

4.3 TRAVELER INFORMATION

Traveler information consists of transportation network monitoring and the methods used to obtain and disseminate information to travelers. Traveler information may include traffic conditions such as congestion, incidents, roadway weather conditions, travel time, AMBER alerts, transit schedules or status, construction or work zones information.

Traveler information is very important because it empowers users to make smart decisions about travel. Accurate information about network status, congestion, incidents, travel time and modal choices enables travelers to make pre-trip and en-route decisions about the best modal choice, routes, and departure times to meet their mobility needs. Drivers who use alternate routes to avoid congested roadways or locations with incidents help to reduce the duration of congestion and reduce excessive vehicle emissions associated with congestion. From a safety perspective, drivers can avoid hazardous or threatening situations when informed of adverse weather conditions. At the very least, if drivers are informed about incidents and congestion downstream, it removes the uncertainty and the anxiety associated with traveling in congested corridors.

An effective traveler information system depends on accurate real-time information of the transportation network status successfully reaching users. This requires an efficient network surveillance system that monitors for instance vehicle speeds and rapidly detect anomaly in the traffic flow, incidents, and evaluate the impacts and facilitates rapid deployment of mitigation measures. A proactive approach to traffic management includes predictive tools that can help traffic operators estimate traffic conditions in advance and provide traveler information to support smarter travel – this is also referred to as active management. This capability is critical especially during emergencies or evacuations to enable rapid evacuation of people from unsafe zones to areas of refuge. The importance of traveler information during such emergencies cannot be overemphasized. There are many ways to detect and collect traffic data to actively monitor the roadway and this has been discussed in **Section 6.1.4**.

The available methods for traveler information include dynamic message signs (DMS), highway advisory radios (HAR), the internet, smartphone apps, text messages, 511 systems, mobile GPS devices, media (radio and television) and information service providers (ISP). The options to disseminate information to travelers en-route are limited since they must not adversely affect the task of driving and compromise safety. Louisiana currently has available all the options listed above to broadcast or disseminate traffic, transit, maintenance, construction, and weather information that affect travel.

4.3.1 National ITS Traveler Information

The National ITS Architecture describes many services that are applicable to traveler information. These services are put into packages (i.e., service packages) which can include various subsystems, equipment, information flows, people, etc. Brief descriptions of the service packages are provided in **Table 3**.

Table 3: Traveler Information Service Packages

Service Package Name	Service Package	Service Package Description
Broadcast Traveler Information	ATIS01	This service package collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, roadway maintenance and construction information, air quality and weather information, and broadcasts the information to travelers using technologies such as FM subcarrier, satellite radio, cellular data broadcasts, and Internet web casts. The information may be provided directly to travelers or provided to merchants and other traveler service providers so that they can better inform their customers of travel conditions. Different from the service package ATMS06 - Traffic Information Dissemination, which provides localized HAR and DMS information capabilities, ATIS01 provides a wide area digital broadcast service. Successful deployment of this service package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.
Disaster Traveler Information	EM10	This service package uses ITS to provide disaster-related traveler information to the general public, including evacuation and reentry information and other information concerning the operation of the transportation system during a disaster. This service package collects information from multiple sources including traffic, transit, public safety, emergency management, shelter provider, and travel service provider organizations. The collected information is processed and the public is provided with real-time disaster and evacuation information using ITS traveler information systems. A disaster will stress the surface transportation system since it may damage transportation facilities at the same time that it places unique demands on these facilities to support public evacuation and provide access for emergency responders. Similarly, a disaster may interrupt or degrade the operation of many traveler information systems at the same time that safety-critical information must be provided to the traveling public. This service package keeps the public informed in these scenarios, using all available means to provide information about the disaster area including damage to the transportation system, detours and closures in effect, special traffic restrictions and allowances, special transit schedules, and real-time information on traffic conditions and transit system performance in and around the disaster. This service package also provides emergency information to assist the public with evacuations when necessary. Information on mandatory and voluntary evacuation zones, evacuation times, and instructions are provided. Available evacuation routes and destinations

Service Package Name	Service Package	Service Package Description
		and current and anticipated travel conditions along those routes are provided so evacuees are prepared and know their destination and preferred evacuation route. Information on available transit services and traveler services (shelters, medical services, hotels, restaurants, gas stations, etc.) is also provided. In addition to general evacuation information, this service package provides specific evacuation trip planning information that is tailored for the evacuee based on origin, selected destination, and evacuee-specified evacuation requirements and route parameters. This service package augments the ATIS service packages that provide traveler information on a day-to-day basis for the surface transportation system. This service package provides focus on the special requirements for traveler information dissemination in disaster situations.
Early Warning System	EM07	This service package monitors and detects potential, looming, and actual disasters including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and acts of terrorism including nuclear, chemical, biological, and radiological weapons attacks). The service package monitors alerting and advisory systems, ITS sensors and surveillance systems, field reports, and emergency call-taking systems to identify emergencies and notifies all responding agencies of detected emergencies.
Interactive Traveler Information	ATIS02	This service package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, roadway maintenance and construction, transit services, ride share/ride match, parking management, detours and pricing information. Although the Internet is the predominate network used for traveler information dissemination, a range of two-way wide-area wireless and fixed-point to fixed-point communications systems may be used to support the required data communications between the traveler and Information Service Provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone via a 511-like portal and web pages via kiosk, personal digital assistant, personal computer, and a variety of in-vehicle devices. This service package also allows value-added resellers to collect transportation information that can be aggregated and be available to their personal devices or remote traveler systems to better inform their customers of transportation conditions. Successful deployment of this service package relies on availability of real-time transportation data from roadway instrumentation, transit, probe vehicles or other means. A traveler may also input personal preferences and identification information via a “traveler card” that can convey information to the system about the traveler as well as receive updates from the system so the card can be updated over time.
ISP Based Trip Planning and Route Guidance	ATIS05	This service package offers the user trip planning and en-route guidance services. It generates a trip plan, including a multimodal route and associated service information (e.g., parking information), based on traveler preferences and constraints. Routes may be based on static information or reflect real time network conditions. Unlike ATIS3 and ATIS4, where the user equipment determines the route, the route determination functions are performed in the Information Service Provider Subsystem in this service package. The trip plan may be confirmed by the traveler and advanced payment and reservations for transit and alternate mode (e.g., airline, rail, and ferry) trip segments, and ancillary services (e.g., parking reservations) are accepted and processed. The confirmed trip plan may include specific routing information that can be supplied to the traveler as general directions or as turn-by-turn route guidance depending on the level of user equipment.

Service Package Name	Service Package	Service Package Description
Traffic Information Dissemination	ATMS06	This service package provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic and road conditions, closure and detour information, travel restrictions, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. Careful placement of the roadway equipment provides the information at points in the network where the drivers have recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), Transit Management, Emergency Management, and Information Service Providers. A link to the Maintenance and Construction Management subsystem allows real time information on road/bridge closures and restrictions due to maintenance and construction activities to be disseminated. The sharing of transportation operations data described in this service package also supports other services like ATMS09-Traffic Decision Support and Demand Management.
Travel Services Information and Reservation	ATIS07	This service package provides travel information and reservation services to the user. These additional traveler services may be provided using the same basic user equipment used for Interactive Traveler Information. This service package provides multiple ways for accessing information either while en route in a vehicle using wide-area wireless communications or pre-trip via fixed-point to fixed-point connections.
Weather Information Processing and Distribution	MC04	This service package processes and distributes the environmental information collected from the Road Weather Data Collection service package. This service package uses the environmental data to detect environmental hazards such as icy road conditions, high winds, dense fog, etc. so system operators and decision support systems can make decision on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination service package, and aid operators in scheduling work activity.
Wide-Area Alert	EM06	This service package uses ITS driver and traveler information systems to alert the public in emergency situations such as child abductions, severe weather events, civil emergencies, and other situations that pose a threat to life and property. The alert includes information and instructions for transportation system operators and the traveling public, improving public safety and enlisting the public's help in some scenarios. The ITS technologies will supplement and support other emergency and homeland security alert systems such as the Emergency Alert System (EAS). When an emergency situation is reported and verified and the terms and conditions for system activation are satisfied, a designated agency broadcasts emergency information to traffic agencies, transit agencies, information service providers, toll operators, and others that operate ITS systems. The ITS systems, in turn, provide the alert information to transportation system operators and the traveling public using ITS technologies such as dynamic message signs, highway advisory radios, in-vehicle displays, transit displays, 511 traveler information systems, and traveler information web sites.

4.4 FREEWAY MANAGEMENT

According to the FHWA *Freeway Management and Operations Handbook*[7], freeway management and operations is the "implementation of policies, strategies and technologies to improve freeway performance." The primary goals of freeway management are to reduce congestion, improve mobility and enhance safety for all users. Congestion results when the capacity of the freeway is less than the demand. Congestion can be described as recurrent or non-recurrent congestion. Recurrent congestion is typically associated with demand exceeding available capacity. The congestion that occurs during morning and evening rush hour are typical examples of recurrent congestion. Non-recurrent congestion occurs when the capacity of the roadway is reduced temporarily because of an incident or environmental factors. While recurrent congestion often follows a known temporal pattern, non-recurrent congestion is more random in nature.

There are many tools that are used to manage freeways. These include travel demand management, use of technology for detection and verification of incidents, motorist information systems, emergency response, lane controls, ramp meters, high occupancy vehicle (HOV) lanes, high occupancy toll (HOT) lanes for congestion pricing, motorist assistance patrol (MAP), etc. The mix of strategies depends on the capabilities available based on the infrastructure in place and cooperation between different agencies or stakeholders. The national ITS architecture has several service packages for freeway management and a summary is presented in **Table 4**.

Louisiana is prone to emergencies from hurricanes, which can be predicted in advance. However, where it makes landfall cannot be predicted with certainty. This threat to public safety triggers a massive hurricane evacuation of residents especially from coastal areas. The primary mode most people use to evacuate is by driving, and often some residents do not leave until the danger is imminent. Contraflow is one of the strategies typically activated on the freeway system to help meet the inflated vehicular demand on the freeway system. It takes the planned efforts of many agencies using ITS equipment, roadside staff, and temporary traffic control to effectively implement contra flow.

Table 4: Service Packages for Freeway Management

Service Package Name	Service Package	Service Package Description
Dynamic Lane Management and Shoulder Use	ATMS23	This service package provides for active management of travel lanes along a roadway. The package includes the field equipment, physical overhead lane signs and associated control electronics that are used to manage and control specific lanes and/or the shoulders. This equipment can be used to change the lane configuration on the roadway according to traffic

[7] http://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/fmoh_complete_all.pdf (Accessed 2/25/2015)

Service Package Name	Service Package	Service Package Description
		demand and lane destination along a typical roadway section or on approach to or access from a border crossing, multimodal crossing or intermodal freight depot. This package can be used to allow temporary or interim use of shoulders as travel lanes. The equipment can be used to electronically reconfigure intersections and interchanges and manage right-of-way dynamically including merges. Also, lanes can be designated for use by special vehicles only, such as buses, high occupancy vehicles (HOVs), vehicles attending a special event, etc. Prohibitions or restrictions of types of vehicles from using particular lanes can be implemented. The lane management system can be centrally monitored and controlled by a traffic management center or it can be autonomous. This service also can include automated enforcement equipment that notifies the enforcement agency of violators of the lane controls. Dynamic lane management and shoulder use is an Active Traffic Management (ATM) strategy and is typically used in conjunction with other ATM strategies (such as ATMS22-Variable Speed Limits and ATMS24-Dynamic Roadway Warning).
HOV Lane Management	ATMS05	This service package manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.
Network Surveillance	ATMS01	This service package includes traffic detectors, other surveillance equipment, the supporting field equipment, and fixed-point to fixed-point communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this service package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.
Roadway Closure Management	ATMS21	This service package closes roadways to vehicular traffic when driving conditions are unsafe, maintenance must be performed, and other scenarios where access to the roadway must be prohibited. The service package includes automatic or remotely controlled gates or barriers that control access to roadway segments including ramps and traffic lanes. Remote control systems allow the gates to be controlled from a central location or from a vehicle at the gate/barrier location, improving system efficiency and reducing personnel exposure to unsafe conditions during severe weather and other situations where roads must be closed. Surveillance systems allow operating personnel to visually verify the safe activation of the closure system and driver information systems (e.g., DMS) provide closure information to motorists in the vicinity of the closure. The equipment managed by this service package includes the control and monitoring systems, the field devices (e.g., gates, warning lights, DMS, CCTV cameras) at the closure location(s), and the information systems that notify other systems of a closure. This service package covers general road closure applications; specific closure systems that are used at railroad grade crossings, drawbridges, reversible lanes, etc. are covered by other ATMS service packages.
Roadway Service Patrols	EM04	This service package supports roadway service patrol vehicles that monitor roads that aid motorists, offering rapid response to minor incidents (flat tire, accidents, out of gas) to minimize disruption to the traffic stream. If problems are detected, the roadway service patrol vehicles will

Service Package Name	Service Package	Service Package Description
		provide assistance to the motorist (e.g., push a vehicle to the shoulder or median). The service package monitors service patrol vehicle locations and supports vehicle dispatch to identified incident locations. Incident information collected by the service patrol is shared with traffic, maintenance and construction, and traveler information systems.
Speed Warning and Enforcement	ATMS19	This service package monitors vehicle speeds and supports warning drivers when their speed is excessive. Also the service includes notifications to an enforcement agency to enforce the speed limit of the roadway. Speed monitoring can be made via spot speed or average speed measurements. Roadside equipment can display the speed of passing vehicles and/or suggest a safe driving speed. Environmental conditions and vehicle characteristics may be monitored and factored into the safe speed advisories that are provided to the motorist. For example, warnings can be generated recognizing the limitations of a given vehicle for the geometry of the roadway such as rollover risk for tall vehicles. This service focuses on monitoring of vehicle speeds and enforcement of the speed limit while the variable speed limits service (covered in ATMS22-Variable Speed Limits service package) focuses on varying the posted speed limits to create more uniform speeds along a roadway, to promote safer driving during adverse conditions (such as fog) and/or to reduce air pollution.
Traffic Incident Management System	ATMS08	This service package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The service package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as rail operations and event promoters. Information from these diverse sources is collected and correlated by this service package to detect and verify incidents and implement an appropriate response. This service package supports traffic operations personnel in developing an appropriate response in coordination with emergency management, maintenance and construction management, and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications or resource coordination between center subsystems. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination service package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information service packages. The roadside equipment used to detect and verify incidents also allows the operator to monitor incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.
Traffic Metering	ATMS04	This service package provides central monitoring and control, communications, and field equipment that support metering of traffic. It supports the complete range of metering strategies including ramp, interchange, and mainline metering. This package incorporates the instrumentation included in the Network Surveillance service package (traffic sensors are used to measure traffic flow and queues) to support traffic monitoring so responsive and adaptive metering strategies can be implemented. Also included is configurable field equipment to provide information to drivers approaching a meter, such as advance warning of the meter, its operational status (whether it is currently on or not, how many cars per green are allowed, etc.), lane usage at the meter (including a bypass lane for HOVs) and existing queue at the meter.
Variable Speed Limits	ATMS22	This service package sets variable speed limits along a roadway to create more uniform speeds, to promote safer driving during adverse conditions (such as fog), and/or to reduce air pollution. Also known as speed harmonization, this service monitors traffic and environmental conditions along the roadway. Based on the measured data, the system calculates and sets

Service Package Name	Service Package	Service Package Description
		suitable speed limits, usually by lane. Equipment over and along the roadway displays the speed limits and additional information such as basic safety rules and current traffic information. The system can be centrally monitored and controlled by a traffic management center or it can be autonomous. This service establishes variable speed limits and communicates the speed limits to drivers. Speed warnings and enforcement of speeds limits, including variable speed limits, is covered in the ATMS19-Automated Speed Warning and Enforcement service package. Variable speed limits are an Active Traffic Management (ATM) strategy and are typically used in conjunction with other ATM strategies (such as ATMS23-Dynamic Lane Management and Shoulder Use and ATMS24-Dynamic Roadway Warning).

4.5 ARTERIAL MANAGEMENT

Arterial management mitigates delays and provides safe routes for daily commute. A well-managed arterial can support integrated corridor management (ICM) and increase mobility, reduce delays, reduce emissions into the environment, and improve safety. The techniques for corridor management include traffic detection and monitoring, advanced traffic signal control and access management. Signals on the arterial require advance detection, intersection monitoring and communication to support adaptive signal operations. Special timing plans for intersection control can be implemented in real-time to support for instance traffic that is diverted to the arterial because of an incident on a freeway or during emergency evacuation.

The intersections are locations where conflicting movements share common space and therefore require traffic signal systems to assign right of way to ensure safety and reduce delays. Many traffic signal systems are pre-timed and therefore not responsive to demand and contribute to congestion and delays. Adaptive signal control systems are traffic signal systems with detectors and controllers that can modify cycle time, splits and offset to meet the demand in real-time. There are many choices of adaptive controllers available and include Split Cycle Offset Optimization Technique (SCOOT), Sydney Coordinated Adaptive Traffic System (SCATS), Real-time Hierarchical Optimized Distributed Effective System (RHODES), Optimized Policies for Adaptive Control (OPAC) “Virtual Fixed Cycle” and ACS Lite. The benefits of adaptive traffic signal systems include improvements in travel time reliability by progressively tunneling vehicles through green lights with minimum stops and reduce delays. Minimizing congestion reduces cost to businesses and consumers and improves the environment through lesser environmental emissions. Adaptive traffic systems rely on advanced detection to assign green light optimally to reduce delays. **Table 5** summarizes the service packages available for arterial management from the national ITS architecture.

Table 5: Service Packages for Arterial Management

Service Package Name	Service Package	Service Package Description
Dynamic Lane Management and Shoulder Use	ATMS23	This service package provides for active management of travel lanes along a roadway. The package includes the field equipment, physical overhead lane signs and associated control electronics that are used to manage and control specific lanes and/or the shoulders. This equipment can be used to change the lane configuration on the roadway according to traffic demand and lane destination along a typical roadway section or on approach to or access from a border crossing, multimodal crossing or intermodal freight depot. This package can be used to allow temporary or interim use of shoulders as travel lanes. The equipment can be used to electronically reconfigure intersections and interchanges and manage right-of-way dynamically including merges. Also, lanes can be designated for use by special vehicles only, such as buses, high occupancy vehicles (HOVs), vehicles attending a special event, etc. Prohibitions or restrictions of types of vehicles from using particular lanes can be implemented. The lane management system can be centrally monitored and controlled by a traffic management center or it can be autonomous. This service also can include automated enforcement equipment that notifies the enforcement agency of violators of the lane controls. Dynamic lane management and shoulder use is an Active Traffic Management (ATM) strategy and is typically used in conjunction with other ATM strategies (such as ATMS22-Variable Speed Limits and ATMS24-Dynamic Roadway Warning).
Intersection Collision Avoidance	AVSS10	This service package will determine the probability of an intersection collision and provide timely warnings to approaching vehicles so that avoidance actions can be taken. This service package builds on the Intersection Safety Warning field and in-vehicle equipment and adds equipment in the vehicle that can take control of the vehicle to avoid intersection violations and potential collisions. The same sensors and communications equipment in the roadway infrastructure are used to assess vehicle locations and speeds near an intersection. This information is determined and communicated to the approaching vehicle using a short range communications system. The vehicle uses this information to develop control actions which alter the vehicle's speed and steering control and potentially activate its pre-crash safety system.
Intersection Safety Warning	AVSS05	This service package monitors vehicles approaching an intersection and warns drivers when hazardous conditions are detected. The service package detects impending violations (e.g., red-light violations) and potential conflicts between vehicles occupying or approaching the intersection (e.g., situations where a left turn would be unsafe because of approaching traffic). When a potentially hazardous condition is detected, a warning is communicated to the involved vehicles using short range communications and/or signs/signals in the intersection.
Mixed Use Warning Systems	ATMS26	This service package supports the sensing and warning systems used to interact with pedestrians, bicyclists, and other vehicles that operate on the main vehicle roadways, or on pathways which intersect the main vehicle roadways. These systems could allow automated warning or active protection for this class of users.
Network Surveillance	ATMS01	This service package includes traffic detectors, other surveillance equipment, the supporting field equipment, and fixed-point to fixed-point communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this service package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and

Service Package Name	Service Package	Service Package Description
		made available to users and the Information Service Provider Subsystem.
Reversible Lane Management	ATMS18	This service package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this service package includes sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This service package also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.
Roadside Lighting System Control	ATMS12	This service package includes systems that manage electrical lighting systems by monitoring operational conditions and using the lighting controls to vary the amount of light provided along the roadside. These systems allow a center to control lights based on traffic conditions, time-of-day, and the occurrence of incidents. Such systems can increase the safety of a roadway segment by increasing lighting and conserve energy at times when conditions warrant a reduction in the amount of lighting.
Speed Warning and Enforcement	ATMS19	This service package monitors vehicle speeds and supports warning drivers when their speed is excessive. Also the service includes notifications to an enforcement agency to enforce the speed limit of the roadway. Speed monitoring can be made via spot speed or average speed measurements. Roadside equipment can display the speed of passing vehicles and/or suggest a safe driving speed. Environmental conditions and vehicle characteristics may be monitored and factored into the safe speed advisories that are provided to the motorist. For example, warnings can be generated recognizing the limitations of a given vehicle for the geometry of the roadway such as rollover risk for tall vehicles. This service focuses on monitoring of vehicle speeds and enforcement of the speed limit while the variable speed limits service (covered in ATMS22-Variable Speed Limits service package) focuses on varying the posted speed limits to create more uniform speeds along a roadway, to promote safer driving during adverse conditions (such as fog) and/or to reduce air pollution.
Traffic Signal Control	ATMS03	This service package provides the central control and monitoring equipment, communication links, and the signal control equipment that support traffic control at signalized intersections. A range of traffic signal control systems are represented by this service package ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. This service package is generally an intra-jurisdictional package. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would also be represented by this package. Coordination of traffic signal systems using real-time communications is covered in the ATMS07-Regional Traffic Management service package. This service package is consistent with typical traffic signal control systems.

4.6 INCIDENT MANAGEMENT

A traffic incident is any random event that causes a reduction in roadway capacity and leads to congestion and in some instances secondary incidents. Crashes, debris on roadway, and bridge or pavement failures are examples of incidents. Stranded motorist on the side of the roadway can be a traffic incident if rubber necking occurs. Traffic incident management (TIM) is the

development of systems for rapid detection, verification, response and clearance of an incident. TIM poses many challenges because of the randomness (spatial and temporal) associated with incidents and the tremendous impact it has on the transportation system and users. Incidents can lead to loss of life and significant property damage. FHWA has estimated that 20% of all crashes are secondary incidents due to congestion from an earlier incident. Secondary incidents can sometimes be more costly than the initial incident and this therefore underscores the need for a robust and coordinated effort to rapidly detect and remove incidents and restore roadway to normal use.

The agencies that typically work on roadway incidents depending on the nature may include law enforcement, fire and rescue, emergency medical services, public safety communications, department of transportation, emergency management, towing and recovery, hazardous material contractors and traffic information media. Transportation agencies are typically responsible for planning and implementation of mitigation measures. Where traffic management centers (TMCs) and field devices are available these can help with incident detection, verification, MAP dispatch, traffic management (traveler information, detour routes), incident clearance and roadway repair needs.

Another area where incident management is crucial is its impact on travel time reliability. Traffic incidents as well as other disruptions to normal flow of traffic are contributing factors to the total congestion on the roadway. An incident that occurs during peak travel time can generate about four times more delay than one that occurs off peak. Research done by FHWA shows that the variability and uncertainty affects travel time reliability and this has significant economic cost for movement of freight and goods. The federal government emphasizes the importance of performance measures (e.g., travel time reliability, planning time index, buffer index, etc.) and efficient incident management is critical to the performance measure. A key component of the incident management process is the ability to estimate the duration of the incident. Accurate prediction of expected incident duration helps traffic managers provide reliable information to travelers, use proper traffic control measures, and evaluate the effectiveness of the incident management strategies. **Table 6** shows the national ITS architecture service packages available for incident management.

Table 6: Service Packages for Incident Management

Service Package Name	Service Package	Service Package Description
Disaster Response and Recovery	EM08	This service package enhances the ability of the surface transportation system to respond to and recover from disasters. It addresses the most severe incidents that require an extraordinary response from outside the local community. All types of disasters are addressed including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and national security emergencies such as nuclear, chemical, biological, and radiological weapons attacks). The service package supports coordination of emergency response plans, including general plans developed before a disaster as well as specific tactical plans with short time horizon that

Service Package Name	Service Package	Service Package Description
		are developed as part of a disaster response. The service package provides enhanced access to the scene for response personnel and resources, provides better information about the transportation system in the vicinity of the disaster, and maintains situation awareness regarding the disaster itself. In addition, this service package tracks and coordinates the transportation resources - the transportation professionals, equipment, and materials - that constitute a portion of the disaster response. The service package identifies the key points of integration between transportation systems and the public safety, emergency management, public health, and other allied organizations that form the overall disaster response. In this service package, the Emergency Management subsystem represents the federal, regional, state, and local Emergency Operations Centers and the Incident Commands that are established to respond to the disaster. The interface between the Emergency Management Subsystem and the other center subsystems provides situation awareness and resource coordination among transportation and other allied response agencies. In its role, traffic management implements special traffic control strategies and detours and restrictions to effectively manage traffic in and around the disaster. Maintenance and construction provides damage assessment of road network facilities and manages service restoration. Transit management provides a similar assessment of status for transit facilities and modifies transit operations to meet the special demands of the disaster. As immediate public safety concerns are addressed and disaster response transitions into recovery, this service package supports transition back to normal transportation system operation, recovering resources, managing on-going transportation facility repair, supporting data collection and revised plan coordination, and other recovery activities. This service package builds on the basic traffic incident response service that is provided by ATMS08, the Traffic Incident Management service package. This service package addresses the additional complexities and coordination requirements that are associated with the most severe incidents that warrant an extraordinary response from outside the local jurisdictions and require special measures such as the activation of one or more emergency operations centers. Many users of the National ITS Architecture will want to consider both ATMS08 and this service package since every region is concerned with both day-to-day management of traffic-related incidents and occasional management of disasters that require extraordinary response. Disaster Response and Recovery is also supported by EM10, the "Disaster Traveler Information" service package that keeps the public informed during a disaster response. See that service package for more information.
HAZMAT Management	CVO10	This service package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.
Traffic Incident Management System	ATMS08	This service package manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The service package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers as well as rail operations and event promoters. Information from these diverse sources is collected and correlated by this service package to detect and verify incidents and implement an appropriate response. This service package supports traffic operations personnel in developing an appropriate response in coordination with emergency

Service Package Name	Service Package	Service Package Description
		management, maintenance and construction management, and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications or resource coordination between center subsystems. Incident response also includes presentation of information to affected travelers using the Traffic Information Dissemination service package and dissemination of incident information to travelers through the Broadcast Traveler Information or Interactive Traveler Information service packages. The roadside equipment used to detect and verify incidents also allows the operator to monitor incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other allied response agencies and field service personnel.

4.7 TRAVEL DEMAND MANAGEMENT

Travel demand is outpacing available capacity on roadway system especially on urban roadways. The adage “we cannot build our way out of congestion” still rings true and underscores the fact that adding capacity by building more lanes is not effective. Moreover, it is not always feasible to build new lanes especially in urbanized areas where there is no space or the cost is prohibitive to acquire right of way. Therefore, effective management strategies to support travel demand are required.

Travel demand management started as a strategy to address challenges with energy conservation, environmental protection, and traffic congestion. The initial approach used for travel demand management focused on services by public agencies to employers. The services used were carpooling, vanpooling, public transit, and commuter bus to get employees to work. The contemporary model for travel demand management has evolved to include broader objectives that address mode choice, time choice, location choice, and route choice. This new approach, unlike the former, addresses travel demand for both commute and non-commute periods.

The contemporary approach to travel demand management seeks to optimize system performance at all times. The success of this approach depends on the options presented to travelers pre-trip and en-route. Pre-trip traveler information about incidents, route travel times etc. facilitate decision making about the trip, time of departure and route choice based on the prevailing network conditions.

Intelligent transportation systems contribute immensely to travel demand management. Appropriate investment in ITS can enable real-time assessment of transportation system performance and disseminate up-to-the-minute information to travelers who can access them through personal electronic devices. Information can be processed and distributed in more useful options to empower users to make smarter travel choices. For instance reliable information about travel times between two alternate routes, expected delay, and parking

availability will enable a user make optimal transportation decisions. An integral part of travel demand management is integrated corridor management.

4.7.1 Integrated Corridor Management

Integrated corridor management (ICM) leverages all available capacity across all modes of travel to move people and goods along a corridor. This requires the use of real-time system information, predictive tools, and decision support systems to balance demand across different transportation assets. ITS enables integrated corridor management when travelers are empowered with information they need and can take advantage of underused capacity on parallel routes or change modes of travel. ITS can foster more dynamic and fluid travel decisions with high reliability. Messages can be posted on DMS or pushed to smartphone apps for traveler information. Stakeholders within the catchment of the corridor can share information and collaborate operationally to optimize transportation. An integrated approach may require rerouting traffic, changing operational parameters (signal timing, ramp closures, etc) and or mode shift. ICM facilitates access to excess capacity in a mode or route and can help minimize congestion. This in turn will reduce delays and improve air quality because of fewer emissions. There are several corridors in urbanized areas that lend themselves to ICM techniques to enhance mobility and optimize use of transportation assets. There are also critical corridors in Louisiana such as elevated expressways/bridges (a few examples include but not limited to the Pontchartrain Expressway, Bonnet Carre Spillway, Atchafalaya Basin, and bridges across the Mississippi River) that can benefit from ICM techniques to better manage congestion and incidents. **Table 7** summarizes the service packages available for travel demand management in the national ITS architecture.

Table 7: Service Packages for Travel Demand Management

Service Package Name	Service Package	Service Package Description
Demand Response Transit Operations	APTS03	This service package performs automated dispatch and system monitoring for demand responsive transit services. This service performs scheduling activities as well as operator assignment. In addition, this service package performs similar functions to support dynamic features of flexible-route transit services. This package monitors the current status of the transit fleet and supports allocation of these fleet resources to service incoming requests for transit service while also considering traffic conditions. The Transit Management Subsystem provides the necessary data processing and information display to assist the transit operator in making optimal use of the transit fleet. This service includes the capability for a traveler request for personalized transit services to be made through the Information Service Provider (ISP) Subsystem. The ISP may either be operated by a transit management center or be independently owned and operated by a separate service provider. In the first scenario, the traveler makes a direct request to a specific paratransit service. In the second scenario, a third party service provider determines that the paratransit service is a viable means of satisfying a traveler request and makes a reservation for the traveler.
Dynamic Lane Management and	ATMS23	This service package provides for active management of travel lanes along a roadway. The package includes the field equipment, physical overhead lane signs and associated control

Service Package Name	Service Package	Service Package Description
Shoulder Use		electronics that are used to manage and control specific lanes and/or the shoulders. This equipment can be used to change the lane configuration on the roadway according to traffic demand and lane destination along a typical roadway section or on approach to or access from a border crossing, multimodal crossing or intermodal freight depot. This package can be used to allow temporary or interim use of shoulders as travel lanes. The equipment can be used to electronically reconfigure intersections and interchanges and manage right-of-way dynamically including merges. Also, lanes can be designated for use by special vehicles only, such as buses, high occupancy vehicles (HOVs), vehicles attending a special event, etc. Prohibitions or restrictions of types of vehicles from using particular lanes can be implemented. The lane management system can be centrally monitored and controlled by a traffic management center or it can be autonomous. This service also can include automated enforcement equipment that notifies the enforcement agency of violators of the lane controls. Dynamic lane management and shoulder use is an Active Traffic Management (ATM) strategy and is typically used in conjunction with other ATM strategies (such as ATMS22-Variable Speed Limits and ATMS24-Dynamic Roadway Warning).
Dynamic Ridesharing	ATIS08	This service package provides dynamic ridesharing/ride matching services to travelers. This service could allow near real time ridesharing reservations to be made through the same basic user equipment used for Interactive Traveler Information. This ridesharing/ride matching capability also includes arranging connections to transit or other multimodal services.
Parking Facility Management	ATMS16	This service package provides enhanced monitoring and management of parking facilities. It assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This service package collects current parking status, shares this data with Information Service Providers and Traffic Management, and collects parking fees using the same in-vehicle equipment utilized for electronic toll collection or contact or proximity traveler cards used for electronic payment. Two other service packages, APTS04: Transit Fare Collection Management and ATMS10: Electronic Toll Collection also provide electronic payment services. These three service packages in combination provide an integrated electronic payment system for transportation services.
Regional Parking Management	ATMS17	This service package supports communication and coordination between equipped parking facilities and also supports regional coordination between parking facilities and traffic and transit management systems. This service package also shares information with transit management systems and information service providers to support multimodal travel planning, including parking reservation capabilities. Information including current parking availability, system status, and operating strategies are shared to enable local parking facility management that supports regional transportation strategies.
Reversible Lane Management	ATMS18	This service package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this service package includes sensory functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This service package also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and

Service Package Name	Service Package	Service Package Description
		special events.
Traffic Metering	ATMS04	This service package provides central monitoring and control, communications, and field equipment that support metering of traffic. It supports the complete range of metering strategies including ramp, interchange, and mainline metering. This package incorporates the instrumentation included in the Network Surveillance service package (traffic sensors are used to measure traffic flow and queues) to support traffic monitoring so responsive and adaptive metering strategies can be implemented. Also included is configurable field equipment to provide information to drivers approaching a meter, such as advance warning of the meter, its operational status (whether it is currently on or not, how many cars per green are allowed, etc.), lane usage at the meter (including a bypass lane for HOVs) and existing queue at the meter.
Transit Signal Priority	APTS09	This service package determines the need for transit priority on routes and at certain intersections and requests transit vehicle priority at these locations. The signal priority may result from limited local coordination between the transit vehicle and the individual intersection for signal priority or may result from coordination between transit management and traffic management centers. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network.
Transportation Decision Support and Demand Management	ATMS09	This service package recommends courses of action to traffic operations personnel based on an assessment of current and forecast road network performance. Recommendations may include predefined incident response plans and regional surface street and freeway control strategies that correct network imbalances. Where applicable, this service package also recommends transit, parking, and toll strategies to influence traveler route and mode choices to support travel demand management (TDM) programs and policies managing both traffic and the environment. TDM recommendations are coordinated with transit, parking, and toll administration centers to support regional implementation of TDM strategies. Incident response and congestion management recommendations are implemented by the local traffic management center and coordinated with other regional centers by other service packages (see ATMS07-Regional Traffic Management and ATMS08-Traffic Incident Management). All recommendations are based on historical evaluation, real-time assessment, and forecast of the roadway network performance based on predicted travel demand patterns. Traffic data is collected from sensors and surveillance equipment as well as other transportation management centers (see ATIS06-Transportation Operations Data Sharing). Forecasted traffic loads are derived from historical data and route plans supplied by the Information Service Provider Subsystem. This service package also collects air quality, parking availability, transit usage, and vehicle occupancy data to support TDM, where applicable.
Transportation Operations Data Sharing	ATIS06	This service package makes real-time transportation operations data available to transportation system operators. The Information Service Provider collects, processes, and stores current information on traffic and travel conditions and other information about the current state of the transportation network and makes this information available to transportation system operators, facilitating the exchange of qualified, real-time information between agencies. Using the provided information, transportation system operators can manage their individual systems based on an overall view of the regional transportation system. The regional transportation operations data resource represented by the Information Service Provider may be implemented as a web application that provides a web-based access to system operators, an enterprise database that provides a network interface to remote center applications, or any implementation that supports regional sharing of real-

Service Package Name	Service Package	Service Package Description
		time transportation operations data.

4.8 PUBLIC TRANSPORTATION MANAGEMENT

Public transportation or transit systems serve all demographics in urban areas by providing mobility and increasing accessibility. For children, the elderly, the blind or others with disabilities that preclude them from driving, it becomes the principal means of mobility. When patronized, public transit reduces automobile trips and traffic congestion, makes work accessible to many and fosters livable communities. There are various public transit options available that can be implemented depending on the population density. Potential applications include regional commuter rail, light rail, express bus and paratransit.

ITS technologies can enhance transit operations and user experience such as providing real-time transit information, enabling users to request for and pay for transit services electronically. Trip planning software can be used to help travelers plan trips and customize these trips to their needs based on the available transit options. Transit operators can track transit vehicles and provide up-to-the-minute information on the status of transit systems. Computer aided dispatch systems can monitor transit vehicle location and dispatch transit to meet demand and improve headways for schedule adherence. Transit signal priority can be implemented in collaboration with local traffic management agencies to ensure on-time arrival of transit vehicles thereby reducing delay for those who use transit. The reliability of transit arrival times will further encourage transit use and facilitate travel demand management. Paratransit systems can benefit from automatic vehicle location systems since dispatchers can efficiently respond to user calls and provide service in a shorter period of time by dispatching the appropriate vehicle. This will enhance mobility and make paratransit use more efficient. Transit users can also be informed about incidents and any delays in the system and can empower users to choose alternate modes and save money and time. **Table 8** summarizes the service packages for advanced public transportation systems in the national ITS architecture.

Table 8: Service Packages for Advanced Public Transportation Management

Service Package Name	Service Package	Service Package Description
Demand Response Transit Operations	APTS03	This service package performs automated dispatch and system monitoring for demand responsive transit services. This service performs scheduling activities as well as operator assignment. In addition, this service package performs similar functions to support dynamic features of flexible-route transit services. This package monitors the current status of the transit fleet and supports allocation of these fleet resources to service incoming requests for transit service while also considering traffic conditions. The Transit Management Subsystem provides

Service Package Name	Service Package	Service Package Description
		the necessary data processing and information display to assist the transit operator in making optimal use of the transit fleet. This service includes the capability for a traveler request for personalized transit services to be made through the Information Service Provider (ISP) Subsystem. The ISP may either be operated by a transit management center or be independently owned and operated by a separate service provider. In the first scenario, the traveler makes a direct request to a specific paratransit service. In the second scenario, a third party service provider determines that the paratransit service is a viable means of satisfying a traveler request and makes a reservation for the traveler.
Interactive Traveler Information	ATIS02	This service package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, roadway maintenance and construction, transit services, ride share/ride match, parking management, detours and pricing information. Although the Internet is the predominate network used for traveler information dissemination, a range of two-way wide-area wireless and fixed-point to fixed-point communications systems may be used to support the required data communications between the traveler and Information Service Provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone via a 511-like portal and web pages via kiosk, personal digital assistant, personal computer, and a variety of in-vehicle devices. This service package also allows value-added resellers to collect transportation information that can be aggregated and be available to their personal devices or remote traveler systems to better inform their customers of transportation conditions. Successful deployment of this service package relies on availability of real-time transportation data from roadway instrumentation, transit, probe vehicles or other means. A traveler may also input personal preferences and identification information via a “traveler card” that can convey information to the system about the traveler as well as receive updates from the system so the card can be updated over time.
ISP Based Trip Planning and Route Guidance	ATIS05	This service package offers the user trip planning and en-route guidance services. It generates a trip plan, including a multimodal route and associated service information (e.g., parking information), based on traveler preferences and constraints. Routes may be based on static information or reflect real time network conditions. Unlike ATIS3 and ATIS4, where the user equipment determines the route, the route determination functions are performed in the Information Service Provider Subsystem in this service package. The trip plan may be confirmed by the traveler and advanced payment and reservations for transit and alternate mode (e.g., airline, rail, and ferry) trip segments, and ancillary services (e.g., parking reservations) are accepted and processed. The confirmed trip plan may include specific routing information that can be supplied to the traveler as general directions or as turn-by-turn route guidance depending on the level of user equipment.
Transit Fare Collection Management	APTS04	This service package manages transit fare collection on-board transit vehicles and at transit stops using electronic means. It allows transit users to use a traveler card or other electronic payment device. Readers located either in the infrastructure or on-board the transit vehicles enable electronic fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem. Two other service packages, ATMS10: Electronic Toll Collection and ATMS16: Parking Facility Management, also provide electronic payment services. These three service packages in combination provide an integrated electronic payment system for transportation services.
Transit Fixed-Route Operations	APTS02	This service package performs automated dispatch and system monitoring for fixed-route and flexible-route transit services. This service performs scheduling activities including the creation of schedules, blocks and runs, as well as operator assignment. This service determines the

Service Package Name	Service Package	Service Package Description
		transit vehicle trip performance against the schedule using AVL data and provides information displays at the Transit Management Subsystem. Static and real time transit data is exchanged with Information Service Providers where it is integrated with that from other transportation modes (e.g. rail, ferry, air) to provide the public with integrated and personalized dynamic schedules.
Transit Fleet Management	APTS06	This service package supports automatic transit maintenance scheduling and monitoring. On-board condition sensors monitor system status and transmit critical status information to the Transit Management Subsystem. Hardware and software in the Transit Management Subsystem processes this data and schedules preventative and corrective maintenance. The service package also supports the day to day management of the transit fleet inventory, including the assignment of specific transit vehicles to blocks.
Transit Passenger Counting	APTS10	This service package counts the number of passengers entering and exiting a transit vehicle using sensors mounted on the vehicle and communicates the collected passenger data back to the management center. The collected data can be used to calculate reliable ridership figures and measure passenger load information at particular stops.
Transit Security	APTS05	This service package provides for the physical security of transit passengers and transit vehicle operators. On-board equipment is deployed to perform surveillance and sensor monitoring in order to warn of potentially hazardous situations. The surveillance equipment includes video (e.g., CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g., metal detectors). Transit user or transit vehicle operator activated alarms are provided on-board. Public areas (e.g., transit stops, park and ride lots, stations) are also monitored with similar surveillance and sensor equipment and provided with transit user activated alarms. In addition this service package provides surveillance and sensor monitoring of non-public areas of transit facilities (e.g., transit yards) and transit infrastructure such as bridges, tunnels, and transit railways or bus rapid transit (BRT) guideways. The surveillance equipment includes video and/or audio systems. The sensor equipment includes threat sensors and object detection sensors as described above as well as, intrusion or motion detection sensors and infrastructure integrity monitoring (e.g., rail track continuity checking or bridge structural integrity monitoring). The surveillance and sensor information is transmitted to the Emergency Management Subsystem, as are transit user activated alarms in public secure areas. On-board alarms, activated by transit users or transit vehicle operators are transmitted to both the Emergency Management Subsystem and the Transit Management Subsystem, indicating two possible approaches to implementing this service package. In addition the service package supports remote transit vehicle disabling by the Transit Management Subsystem and transit vehicle operator authentication.
Transit Signal Priority	APTS09	This service package determines the need for transit priority on routes and at certain intersections and requests transit vehicle priority at these locations. The signal priority may result from limited local coordination between the transit vehicle and the individual intersection for signal priority or may result from coordination between transit management and traffic management centers. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network.
Transit Traveler	APTS08	This service package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop annunciation,

Service Package Name	Service Package	Service Package Description
Information		imminent arrival signs, and real-time transit schedule displays that are of general interest to transit users. Systems that provide custom transit trip itineraries and other tailored transit information services are also represented by this service package.
Transit Vehicle Tracking	APTS01	This service package monitors current transit vehicle location using an Automated Vehicle Location System. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. Fixed route transit systems may also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the Information Service Provider.

4.9 ELECTRONIC PAYMENT & CONGESTION PRICING

Electronic toll passes or transponders consist of in-vehicle devices that can be read by transceivers as vehicles travel through a toll facility for the appropriate financial transactions. Advancement in technology has made open-road tolling possible, where drivers can continue driving at freeway speed and pay tolls without stopping. Portable DSRC transponders or image based tolling (license plate recognition) can be used for payment at free flow speed. Image based systems take photographs of the license plate and use image analysis techniques to identify the vehicle by its license plate. This approach is known to have a 98 percent level of reliability which can be further reduced if license plate is damaged, dirty or ambient light is unfavorable. FHWA listed the following requirements for the success of electronic fare collection systems[8]: additional cameras may be required to capture both front and rear license plates and independent verification of images; a system controller near the toll location will require full uninterruptible power and fiber optic communications to the field devices. Electronic payment especially open toll lanes help to alleviate congestion and reduce emissions from vehicles. **Table 9** shows the national ITS service package for electronic tolling.

4.9.1 Electronic Payment Services

As tolling technology has evolved and become more economically feasible, the need for human based toll collection has become less prevalent. Technology based tolling allows for more efficient system performance, reducing delay by removing the "stopping" to pay toll. Full electronic tolling has not been implemented due to several challenges especially the lack of

[8] Technologies that Enable Congestion Pricing – A Primer. Published by US Department of Transportation Federal Highway Administration.

standardized transponders for integrated cross jurisdiction fare collections. Compatibility and interoperability are critical for planned toll systems. The challenges with legacy systems must be addressed in relation to new and emerging technology. Interoperable systems must be considered on a statewide level and also between multiple states. It also requires institutional and jurisdictional issues to be carefully considered to ensure compatibility and interoperability.

4.9.2 High Occupancy Tolling

High occupancy toll (HOT) lanes is a management strategy that combines HOV and pricing strategies to allow vehicles that do not meet HOV requirements to pay a toll to access HOV lanes. This management approach makes reliable travel available for those willing to pay a price for it. It frees up space on other lanes and improves the efficiency of HOV lanes. The excess capacity on HOV can be used to attract additional revenue to maintain the transportation infrastructure. The fee system may vary with traffic demand to ensure acceptable level of service on the HOT lanes. HOT lanes depend on electronic payment systems to eliminate delays associated with tollbooths. Vehicles with special tags or transponders pay toll on a periodic, say monthly, basis.

Table 9: Service Package for Electronic Tolling

Service Package Name	Service Package	Service Package Description
Electronic Toll Collection	ATMS10	This service package provides toll operators with the ability to collect tolls electronically and detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Field-Vehicle Communication between the roadway equipment and the vehicle is required as well as Fixed Point-Fixed Point interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Toll violations are identified and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional, and ultimately national interoperability for these services. Two other service packages, APTS04: Transit Fare Collection Management and ATMS16: Parking Facility Management also provide electronic payment services. These three service packages in combination provide an integrated electronic payment system for transportation services. The vehicle equipment and roadside readers that these systems utilize can also be used to collect road use statistics for highway authorities. This data can be collected as a natural by-product of the toll collection process or collected by separate readers that are dedicated to probe data collection.

4.10 COMMERCIAL VEHICLE OPERATIONS

The domestic freight ton-miles traveled by trucks in the United States is projected to increase by 53% in 30 years[9]. The economy relies on efficient movement of goods and services. Commercial vehicles are required to have appropriate credentials, evidence of meeting specified qualifications, in order to operate on the interstate system, carry hazardous materials, or operate vehicles over standard legal weight or size. ITS technologies facilitate freight movement by streamlining the permitting and documentation process and improve the safety and security of motor carriers and the transportation system. Commercial vehicle operations (CVO) ITS technologies include weigh-in-motion (WIM) sensors, commercial vehicle information systems network (CVISN), and performance and registration information system management (PRISM). CVISN and PRISM are programs managed by the Federal Motor Carrier Safety Administration (FMCSA), and both have the objective of improving motor carrier safety through information exchange. PRISM is used for enforcement purposes to ensure that commercial vehicles with unfavorable safety ratings cannot be registered under new International Registration Plan (IRP) license plates, or a motor carrier that is prohibited from operating in interstate commerce by the FMCSA. The PRISM program enables accurate identification of high-risk carriers and more efficient roadside inspections. CVISN provides an infrastructure to enable government agencies, motor carrier industry, and other stakeholders in CVO safety to exchange information and transact business electronically. The goal of the CVISN program is to improve safety and efficiency of commercial vehicle operations. The PRISM and CVISN programs are complementary and both are geared towards improving motor carrier safety. When implemented together the programs work synergistically and use limited resources for targeted enforcement by focusing on high risk carriers and vehicles.

According to the Louisiana ITS Strategic Business Plan, the main goals for commercial vehicle operations in Louisiana are to improve administrative efficiency, operational safety and productivity. CVO is critical to the growth of the economy in Louisiana. **Table 10** provides a summary of the service packages for commercial vehicle operations in the national ITS architecture.

4.10.1 Weigh-in-Motion

Commercial vehicle axle load enforcement is critical to the structural integrity of pavements and bridges and has a direct impact on cost of maintaining these facilities. Overloaded trucks cause accelerated damage to the physical roadway infrastructure, shorten the life of the infrastructure, and increase the life cycle cost. Overloaded trucks also pose a serious safety hazard to all road users since braking and steering are compromised by the excess weight and there is an increased risk for a tire blowout.

[9] http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3640 (accessed 9/19/2013)

Weigh-in-motion (WIM) technology allows the axle loads of heavy vehicles to be weighed at highway speed without stopping. This enforcement approach allows only trucks that have loads approaching a set threshold to be pulled over for axle load inspection while other trucks that are not in violation may continue on their journey. The selective pre-screening approach is effective in reducing delays by targeting enforcement at potential axle load violations.

4.10.2 Virtual Weigh-in-Motion

A virtual weigh station refers to a roadside enforcement facility that is used to screen trucks for weight enforcement by relaying axle and gross vehicular weight information to enforcement agencies that may be located downstream. The information may include photographs of the truck in violation for identification. The main difference between virtual weigh-in-motion and permanent weigh-in-motion stations is that the former does not require continuous staffing and is typically monitored from a remote location. The virtual site may be monitored from a nearby fixed WIM site or from an enforcement agency vehicle located downstream and equipped with a laptop and requisite communication. Virtual WIM can complement fixed sites when deployed on secondary routes that are used to bypass fixed sites by carriers or drivers that are in violation. Also in instances where cost and environmental factors will preclude construction of a fixed site, such as urban areas, virtual weigh stations can be a more feasible option.

4.10.3 Hazardous Material

Transportation of Hazardous Materials (HAZMAT) is important because of the potential health impacts from incidents or the security concerns in the hands of terrorists. Incidents involving HAZMATs can lead to extensive traffic delays depending on the toxicity of the material and the cleanup required. CVSIN provides an avenue to track HAZMAT movement and flag any deviations from assigned routes. In Louisiana, the Louisiana State Police (LSP) emergency operations in association with the Department of Environmental Quality (DEQ) handle HAZMAT related incidents.

4.10.4 Incident Management and Alternative Routing

The dispatchers and drivers of commercial vehicles need advance knowledge of route conditions pre-trip and en-route. With many manufacturing plants and other industrial plants eliminating warehousing and relying on timely delivery of goods, travel time reliability is critical. Any change in expected travel time because of incidents or work zones must be communicated to drivers with reliable alternate routing to enable them deliver goods on time.

Table 10: Service Packages for Commercial Vehicle Operations

Service Package Name	Service Package	Service Package Description
Carrier Operations and Fleet	CVO01	This service package provides the capabilities to manage a fleet of commercial vehicles. The Fleet and Freight Management subsystem provides the route for a commercial vehicle by

Service Package Name	Service Package	Service Package Description
Management		either utilizing an in-house routing software package or an Information Service Provider. Routes generated by either approach are constrained by hazardous materials and other restrictions (such as height or weight). Any such restricted areas are determined by the Commercial Vehicle Administration. A route would be electronically sent to the Commercial Vehicle with any appropriate dispatch instructions. The location of the Commercial Vehicle can be monitored by the Fleet and Freight Management subsystem and routing changes can be made depending on current road network conditions. Once a route has been assigned, changes must be coordinated between the Fleet and Freight Management subsystem and the Commercial Vehicle. Commercial Vehicle Drivers would be alerted to any changes in route from the planned route and given an opportunity to justify a rerouting. Any unauthorized or unexpected route changes by the Commercial Vehicle will register a route deviation alert with the Fleet and Freight Management subsystem. The Fleet and Freight Management subsystem can also notify local public safety agencies of the route deviation when appropriate (e.g., if there is safety sensitive HAZMAT being carried), by sending an alarm to the Emergency Management subsystem.
CV Administrative Processes	CVO04	This service package supports program administration and enrollment and provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in a variety of programs including electronic clearance and wireless inspection programs which allow commercial vehicles to be screened at mainline speeds. Through this enrollment process, current profile databases are maintained in the Commercial Vehicle Administration subsystem and snapshots of this data are made available to the roadside check facilities. Current program status is maintained and made available to carriers, drivers, and other authorized users of the data. Enrolled carriers are provided the option to review and challenge the collected data. Commercial Vehicle Administration subsystems can share current program status and credential information with other Commercial Vehicle Administration subsystems, so that it is possible for any Commercial Vehicle Administration subsystem to have access to all credentials, credential fees, credentials status and safety status information. In addition, it is possible for one Commercial Vehicle Administration subsystem to collect HAZMAT route restrictions information from other Commercial Vehicle Administration subsystems and then act as a clearinghouse for this route restrictions information for Information Service Providers, Map Update Providers, and Fleet and Freight Management subsystems.
CV Driver Security Authentication	CVO12	This service package provides the ability for Fleet and Freight Management to detect when an unauthorized commercial vehicle driver attempts to drive their vehicle based on stored driver identity information. If an unauthorized driver has been detected, Fleet and Freight Management can activate commands to safely disable the commercial vehicle. Alarms can also be sent to emergency management to inform them of a potential commercial vehicle hijacking or theft and potential hazardous situation. In addition, Emergency Management can request Fleet and Freight Management to disable a specific vehicle in their fleet.
CVO Fleet Maintenance	CVO09	This service package supports maintenance of CVO fleet vehicles with on-board monitoring equipment and Automated Vehicle Location (AVL) capabilities within the Fleet and Freight Management Subsystem. Records of vehicle mileage, repairs, and safety violations are maintained to assure safe vehicles on the highway.
Electronic Clearance	CVO03	This service package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This allows a good driver/vehicle/carrier to pass roadside facilities at

Service Package Name	Service Package	Service Package Description
		highway speeds using transponders and Field-Vehicle Communications to the roadside. Results of roadside clearance activities will be passed on to the Commercial Vehicle Administration. The roadside check facility may be equipped with Automated Vehicle Identification (AVI), weighing sensors, transponder read/write devices and computer workstations.
Freight Administration	CVO02	This service package tracks the movement of cargo and monitors the cargo condition. Interconnections are provided to intermodal freight shippers and intermodal freight depots for tracking of cargo from source to destination. In addition to the usual cargo monitoring required to insure that cargo gets from origin to destination, the Fleet and Freight Management subsystem monitors shipments to make sure that no tampering or breach of security occurs to the cargo on commercial vehicles. Any such tampering will be reported to the Fleet and Freight Management subsystem. In addition to exceptions (e.g., alerts) that are reported, on-going indications of the state of the various freight equipment are reported to the Fleet and Freight Management subsystem. The commercial vehicle driver is also alerted of any tampering or breach of cargo security. Freight managers may decide to take further action on the alerts and/or provide responses that explain that the alerts are false alarms. If no explanation is received, the Fleet and Freight Management subsystem may notify the Emergency Management subsystem. Commercial vehicle and freight security breaches may also be sent to the Commercial Vehicle Check subsystem.
Freight Assignment Tracking	CVO13	This service package provides for the planning and tracking of three aspects of commercial vehicle shipments. For each shipment, the commercial vehicle, the freight equipment, and the commercial vehicle driver are monitored for consistency with the planned assignment. Any unauthorized changes are determined by the Fleet and Freight Management subsystem and then the appropriate people and subsystems are notified. Data collected by the On-board CV and Freight Safety & Security and the On-board Driver Authentication equipment packages used in other service packages are also used to monitor the three aspects of assignment for this service package. In addition to this service package, Fleet and Freight Managers may also monitor routes and itineraries and this capability is included in Fleet Administration.
On-board CVO Safety	CVO08	This service package provides for on-board commercial vehicle safety monitoring and reporting. It is an enhancement of the Roadside CVO Safety Service Package and includes support for collecting on-board safety data via transceivers or other means. The on-board safety data are assessed by an off-board system. In some cases the monitoring and safety assessment may occur remotely (i.e., not at a roadside site). Following the assessment, safety warnings are provided to the driver, the Commercial Vehicle Check roadside elements, and carrier. This service package allows for the Fleet and Freight Management subsystem to have access to the on-board safety data.
Roadside CVO Safety	CVO07	This service package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the roadside check locations. The capabilities for performing the safety inspection are shared between this service package and the On-board CVO and Freight Safety & Security (CVO08) service package which enables a variety of implementation options. The basic option, directly supported by this service package, facilitates safety inspection of vehicles that have been pulled off the highway, perhaps as a result of the automated screening process provided by the Electronic Clearance (CVO03) service package. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-board CVO and Freight Safety & Security (CVO08) service package, utilize additional on-board vehicle

Service Package Name	Service Package	Service Package Description
		safety monitoring and reporting capabilities in the commercial vehicle to augment the roadside safety check.
Roadside HAZMAT Security Detection and Mitigation	CVO11	This service package provides the capability to detect and classify security sensitive HAZMAT on commercial vehicles using roadside sensing and imaging technology. Credentials information can be accessed to verify if the commercial driver, vehicle and carrier are permitted to transport the identified HAZMAT. If the credentials analysis and sensed HAZMAT information do not agree, the vehicle can be signaled to pull off the highway, and if required, an alarm can be sent to Emergency Management to request they monitor, traffic stop or disable the vehicle.
Vehicle Safety Monitoring	AVSS01	This service package will diagnose critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition, performance, on-board safety data, and display information.
Weigh-In-Motion	CVO06	This service package provides for high speed weigh-in-motion with or without Automated Vehicle Identification (AVI) capabilities. This service package provides the roadside equipment that could be used as a stand-alone system or to augment the Electronic Clearance (CVO03) service package.

4.11 EMERGENCY MANAGEMENT

Emergency management involves disaster planning, prevention, preparedness, response, and recovery from any situation that can cause deaths, injuries, or extensive environmental damage. In the context of Louisiana, emergencies may be natural (e.g., hurricanes, earthquakes, fires, flooding) or artificially induced by terrorist attacks, or accidental in an industrial disaster. Emergencies are a threat to public safety and therefore require coordinated effort of many public agencies to mitigate the impacts. The functions under emergency management include the following: emergency call taking, public safety dispatch, disaster response and evacuation, monitoring, etc. While some emergencies can be foreseen in advance, others are sudden and without warning. In both instances, the surface transportation system is critical to the success of the emergency management process. The roadway system is the primary means of evacuating the affected areas. The roadway network also serves as the means to send resources into affected areas for disaster mitigation and recovery.

A resilient surface transportation system will have a major impact on the success of the emergency management operations and deploying ITS devices strategically will significantly improve system performance. Robust, reliable communication between management support groups and transportation agencies enables swift coordinated movement of citizens to safety before, during, and after the emergency event. Traffic monitoring will yield real-time traffic information during emergencies to assess the performance of planned strategies, and respond appropriately. Continuous monitoring of the surface transportation system will lead to rapid detection of incidents for immediate action. Re-routing can be initiated if necessary to ensure

successful evacuation. The ITS architecture system for emergency response will facilitate this process and yield performance evaluation data for future planning. **Table 11** provides brief descriptions of the service packages included in the national ITS architecture for emergency management.

Table 11: Service Packages for Emergency Management

Service Package	Service Package Name	Service Package Description
EM05	Transportation Infrastructure Protection	This service package includes the monitoring of transportation infrastructure (e.g., bridges, tunnels and management centers) for potential threats using sensors and surveillance equipment and barrier and safeguard systems to control access, preclude an incident, and mitigate the impact of an incident if it occurs. Threats can result from acts of nature (e.g., hurricanes, earthquakes), terrorist attacks or other incidents causing damage to the infrastructure (e.g., stray barge hitting a bridge support). Infrastructure may be monitored with acoustic, environmental threat (such as nuclear, biological, chemical, and explosives), infrastructure condition and integrity, motion and object sensors and video and audio surveillance equipment. Data from such sensors and surveillance equipment may be processed in the field or sent to a center for processing. The data enables operators at the center to detect and verify threats. When a threat is detected, agencies are notified. Detected threats or advisories received from other agencies result in an increased level of system preparedness. In response to threats, barrier and safeguard systems may be activated by Traffic Management Subsystems to deter an incident, control access to an area or mitigate the impact of an incident. Barrier systems include gates, barriers and other automated and remotely controlled systems that manage entry to transportation infrastructure. Safeguard systems include blast shields, exhaust systems and other automated and remotely controlled systems that mitigate impact of an incident.
EM06	Wide-Area Alert	This service package uses ITS driver and traveler information systems to alert the public in emergency situations such as child abductions, severe weather events, civil emergencies, and other situations that pose a threat to life and property. The alert includes information and instructions for transportation system operators and the traveling public, improving public safety and enlisting the public's help in some scenarios. The ITS technologies will supplement and support other emergency and homeland security alert systems such as the Emergency Alert System (EAS). When an emergency situation is reported and verified and the terms and conditions for system activation are satisfied, a designated agency broadcasts emergency information to traffic agencies, transit agencies, information service providers, toll operators, and others that operate ITSs. The ITSs, in turn, provide the alert information to transportation system operators and the traveling public using ITS technologies such as dynamic message signs, highway advisory radios, in-vehicle displays, transit displays, 511 traveler information systems, and traveler information web sites.
EM07	Early Warning System	This service package monitors and detects potential, looming, and actual disasters including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and acts of terrorism including nuclear, chemical, biological, and radiological weapons attacks). The service package monitors alerting and advisory systems, ITS sensors and surveillance systems, field reports, and emergency call-taking systems to identify emergencies and notifies all responding agencies of detected emergencies.
EM08	Disaster Response and Recovery	This service package enhances the ability of the surface transportation system to respond to and recover from disasters. It addresses the most severe incidents that require an extraordinary response from outside the local community. All types of disasters are addressed including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and

Service Package	Service Package Name	Service Package Description
		man-made disasters (hazardous materials incidents, nuclear power plant accidents, and national security emergencies such as nuclear, chemical, biological, and radiological weapons attacks). The service package supports coordination of emergency response plans, including general plans developed before a disaster as well as specific tactical plans with short time horizon that are developed as part of a disaster response. The service package provides enhanced access to the scene for response personnel and resources, provides better information about the transportation system in the vicinity of the disaster, and maintains situation awareness regarding the disaster itself. In addition, this service package tracks and coordinates the transportation resources - the transportation professionals, equipment, and materials - that constitute a portion of the disaster response. The service package identifies the key points of integration between transportation systems and the public safety, emergency management, public health, and other allied organizations that form the overall disaster response. In this service package, the Emergency Management subsystem represents the federal, regional, state, and local Emergency Operations Centers and the Incident Commands that are established to respond to the disaster. The interface between the Emergency Management Subsystem and the other center subsystems provides situation awareness and resource coordination among transportation and other allied response agencies. In its role, traffic management implements special traffic control strategies and detours and restrictions to effectively manage traffic in and around the disaster. Maintenance and construction provides damage assessment of road network facilities and manages service restoration. Transit management provides a similar assessment of status for transit facilities and modifies transit operations to meet the special demands of the disaster. As immediate public safety concerns are addressed and disaster response transitions into recovery, this service package supports transition back to normal transportation system operation, recovering resources, managing on-going transportation facility repair, supporting data collection and revised plan coordination, and other recovery activities. This service package builds on the basic traffic incident response service that is provided by ATMS08, the Traffic Incident Management service package. This service package addresses the additional complexities and coordination requirements that are associated with the most severe incidents that warrant an extraordinary response from outside the local jurisdictions and require special measures such as the activation of one or more emergency operations centers. Many users of the National ITS Architecture will want to consider both ATMS08 and this service package since every region is concerned with both day-to-day management of traffic-related incidents and occasional management of disasters that require extraordinary response. Disaster Response and Recovery is also supported by EM10, the "Disaster Traveler Information" service package that keeps the public informed during a disaster response. See that service package for more information.
EM09	Evacuation and Reentry Management	This service package supports evacuation of the general public from a disaster area and manages subsequent reentry to the disaster area. The service package addresses evacuations for all types of disasters, including disasters like hurricanes that are anticipated and occur slowly, allowing a well-planned orderly evacuation, as well as disasters like terrorist acts that occur rapidly, without warning, and allow little or no time for preparation or public warning. This service package supports coordination of evacuation plans among the federal, state, and local transportation, emergency, and law enforcement agencies that may be involved in a large-scale evacuation. All affected jurisdictions (e.g., states and counties) at the evacuation origin, evacuation destination, and along the evacuation route are informed of the plan. Information is shared with traffic management agencies to implement special traffic control strategies and to control evacuation traffic, including traffic on local streets and arterials as well as the major

Service Package	Service Package Name	Service Package Description
		evacuation routes. Reversible lanes, shoulder use, closures, special signal control strategies, and other special strategies may be implemented to maximize capacity along the evacuation routes. Transit resources play an important role in an evacuation, removing many people from an evacuated area while making efficient use of limited capacity. Additional shared transit resources may be added and managed in evacuation scenarios. Resource requirements are forecast based on the evacuation plans, and the necessary resources are located, shared between agencies if necessary, and deployed at the right locations at the appropriate times. Evacuations are also supported by EM10, the "Disaster Traveler Information" service package, which keeps the public informed during evacuations. See that service package for more information.
EM10	Disaster Traveler Information	This service package uses ITS to provide disaster-related traveler information to the general public, including evacuation and reentry information and other information concerning the operation of the transportation system during a disaster. This service package collects information from multiple sources including traffic, transit, public safety, emergency management, shelter provider, and travel service provider organizations. The collected information is processed and the public is provided with real-time disaster and evacuation information using ITS traveler information systems. A disaster will stress the surface transportation system since it may damage transportation facilities at the same time that it places unique demands on these facilities to support public evacuation and provide access for emergency responders. Similarly, a disaster may interrupt or degrade the operation of many traveler information systems at the same time that safety-critical information must be provided to the traveling public. This service package keeps the public informed in these scenarios, using all available means to provide information about the disaster area including damage to the transportation system, detours and closures in effect, special traffic restrictions and allowances, special transit schedules, and real-time information on traffic conditions and transit system performance in and around the disaster. This service package also provides emergency information to assist the public with evacuations when necessary. Information on mandatory and voluntary evacuation zones, evacuation times, and instructions are provided. Available evacuation routes and destinations and current and anticipated travel conditions along those routes are provided so evacuees are prepared and know their destination and preferred evacuation route. Information on available transit services and traveler services (shelters, medical services, hotels, restaurants, gas stations, etc.) is also provided. In addition to general evacuation information, this service package provides specific evacuation trip planning information that is tailored for the evacuee based on origin, selected destination, and evacuee-specified evacuation requirements and route parameters. This service package augments the ATIS service packages that provide traveler information on a day-to-day basis for the surface transportation system. This service package provides focus on the special requirements for traveler information dissemination in disaster situations.
MC04	Weather Information Processing and Distribution	This service package processes and distributes the environmental information collected from the Road Weather Data Collection service package. This service package uses the environmental data to detect environmental hazards such as icy road conditions, high winds, dense fog, etc. so system operators and decision support systems can make decision on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination service package, and aid operators in scheduling work activity.

Service Package	Service Package Name	Service Package Description
MC12	Infrastructure Monitoring	This service package monitors the condition of pavement, bridges, tunnels, associated hardware, and other transportation-related infrastructure (e.g., culverts) using both fixed and vehicle-based infrastructure monitoring sensors. Fixed sensors monitor vibration, stress, temperature, continuity, and other parameters and mobile sensors and data logging devices collect information on current infrastructure condition. This service package also monitors vehicle probes for vertical acceleration data and other probe data that may be used to determine current pavement condition.

4.12 INFORMATION MANAGEMENT

Information management systems facilitate collaboration between stakeholders to ensure transportation system data required for planning and operations can be shared. The federal government has instituted the Real-Time System Management Information Program[10] with the goal to monitor traffic and travel conditions and provide a means of sharing the data with state and local governments and the traveling public. The intent is to make traffic data available in formats that can be used by all stakeholders who in turn deliver value-added information. This calls for data exchange protocols that will make this information ubiquitous. Archive data is critical for planning and knowledge development and should be made accessible through data storage system. **Table 12** summarizes the national ITS architecture service packages for data management.

Institutional barriers become impediments to sharing information critical to the advanced transportation management system. The success of ITS depends on obtaining and sharing useful information between all stakeholders especially real-time information for traffic operations. For instance, communication between emergency response teams for incidents or emergencies is critical not just to save lives but also to mitigate the impact of an incident on the transportation system. When stakeholders do not have effective communications this can severely affect management. The subsequent sections will discuss various communication options for ITS.

4.12.1 Center-to-Center Communications

One of the critical components of the ITS infrastructure is a secure and reliable communications system. All deployed field devices on the state managed road network must have communication to the Statewide TMC to enable primary and/or secondary operations. For instance, DMS device data and fault data must be communicated between the device site and the TMC to post current road conditions or to address maintenance needs. Sufficient bandwidth should be provided for CCTV camera feeds for image surveillance, analysis and incident

[10] http://www.ops.fhwa.dot.gov/1201/

verification. DOTD uses a mix of communication assets to meet its needs and further details are provided. Cloud computing is also becoming popular as a communications option for ITS.

4.12.2 Cloud Computing

Cloud computing allows users to access software applications and data from any computer connected to the internet. This may eliminate direct point-to-point communication. Cloud computing is becoming more pervasive and can save agencies money and resources. Cloud computing is versatile to meet peak load requirements which typically occur over a short period of time for instance during disasters and emergencies. Agencies do not have to invest scarce resources to meet the peak demands since cloud computing can afford such scalability at minimal cost. The challenge with cloud computing is security of data when using cloud-based infrastructure. The need for a secure system to protect against unauthorized intrusion or hacking is important.

4.12.3 Preferred Communication Development

The DOTD ITS fiber optic network has significantly improved communication capability by providing abundant capacity with immunity to data surge and electromagnetic interference. However, not all device locations are in close proximity to existing DOTD fiber and the distances involved may pose a challenge with regard to the feasibility of using fiber optics for communication. DOTD therefore has used a mix of communication assets (in addition to fiber optics there are cellular and licensed microwave links for communication) to address ITS needs especially the last mile so to speak. While secure wireless links may still be required to provide communication to distant locations in order to permit rapid deployment of devices, DOTD's preferred ITS communication is fiber optic because of its reliability and bandwidth. A reliable system will ensure high performance with fewer disruptions in communication especially during emergencies.

4.12.4 Archived Data Management

The archived data management system represents the functions to collect, process, store and utilize transportation data including traffic, safety, maintenance and construction, transit and operations, environmental data and others. Traffic data collected includes vehicle count, vehicle classification, occupancy, density, axle load data, travel time, transit vehicle passenger boardings, passenger origins and destinations, traffic incident, traffic control systems etc. Advanced Transportation Management Systems (ATMS) require data management components to provide data fusion and analysis, summarization, visualization, and data mining to facilitate discovery of information, patterns, and correlations with other data sets. The results can be displayed on a geographic information system (GIS) to facilitate further spatial analysis that support efficient transportation infrastructure management.

Table 12: Service Packages for Data Management

Service Package Name	Service Package	Service Package Description
ITS Data Mart	AD1	This service package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use. It provides the basic data quality, data privacy, and meta data management common to all ITS archives and provides general query and report access to archive data users.
ITS Data Warehouse	AD2	This service package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this service package in addition to the basic query and reporting user access features offered by the ITS Data Mart.
ITS Virtual Data Warehouse	AD3	This service package provides the same broad access to multimodal, multidimensional data from varied data sources as in the ITS Data Warehouse service package, but provides this access using enhanced interoperability between physically distributed ITS archives that are each locally managed. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse service package are parsed by the local archive and dynamically translated to requests to remote archives which relay the data necessary to satisfy the request.

4.13 WORK ZONE ITS

Work zones disrupt the normal operation of traffic and pose a safety hazard to travelers and construction crew. Adequate traffic management plans need to be implemented to enhance safety and mobility in and around work zones. ITS devices can play a role in managing traffic at work zones. Current work zone ITS include portable devices to monitor and control traffic such as CCTV cameras, portable changeable message signs (PCMS), variable speed limit signs, vehicle detection devices and communications typically wireless. Other applications of work zone ITS include dynamic lane merge, queue warning, variable speed limits, automated enforcement (speed management), and performance measurements. These devices can monitor speed, congestion and back of queue in real-time and any hazards can be identified and mitigated. Advance warning information can be posted on DMS or other traveler information systems (HAR, 511, smartphone apps) including expected delays, speed advisories and detour routes in the event of incidents or excessive delays. Work zone intrusion alert systems enhance the safety of construction crews by warning them of danger from vehicles that have breached protection systems or alert construction crews if they stray into danger zones.

Another application of work zone ITS is for performance based contracting where a contractor has to meet certain performance measures during site work and can be penalized for not

meeting a pre-defined minimum performance. Agencies with oversight can measure compliance and exact penalties when for example a contractor creates excessive delays. Work zone ITS can be used to provide continuous monitoring for compliance and preempt issues with staff availability.

Though work zone ITS is an emerging area, the protections it affords both travelers and construction crews are invaluable. Work zone ITS can be deployed on various scales commensurate with the magnitude of the construction project and the goals for the deployment. To facilitate work zone ITS deployment it can be included in the planning stages of projects and all stakeholders must be engaged early in the process. Planning for work zone ITS should include but not limited to the following[11]:

- Assessment of needs and concept of operations
- Concept development and feasibility
- Detailed system planning and design
- Procurement
- System deployment
- System operations, maintenance and evaluation

Detailed information on the above items is provided in the reference. Another important consideration is whether a proposed work zone ITS will be integrated into an existing regional ITS architecture and operated remotely from a TMC, or deployed to function independently. The latter may be encountered where a contractor sees value in deploying work zone ITS to protect workers, enhance quality and durability of work. Integration of work zone ITS into existing TMC operations may require a system engineering analysis showing details of the concept of operations and integration. The limitations on existing ITS architectures in the state (for instance prohibition on recording videos, zooming in on crash victims or private property) will apply to work zone ITS architectures. **Table 13** summarizes the service packages available in the national ITS architecture for work zone management.

[11] Work Zone Intelligent Transportation Systems Implementation Guide. Use of Technology and Data for Effective Work Zone Management. FHWA January 2014.

Table 13: Service Packages for Work Zone Management

Service Package Name	Service Package	Service Package Description
Work Zone Management	MC08	This service package manages work zones, controlling traffic in areas of the roadway where maintenance, construction, and utility work activities are underway. Traffic conditions are monitored using CCTV cameras and controlled using dynamic message signs (DMS), Highway Advisory Radio (HAR), gates and barriers. Work zone information is coordinated with other groups (e.g., ISP, traffic management, other maintenance and construction centers). Work zone speeds and delays are provided to the motorist prior to the work zones. This service package provides control of field equipment in all maintenance and construction areas, including fixed, portable, and truck-mounted devices supporting both stationary and mobile work zones.
Work Zone Safety Monitoring	MC09	This service package includes systems that improve work crew safety and reduce collisions between the motoring public and maintenance and construction vehicles. This service package detects vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment or other potential safety hazards. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone. The service package supports both stationary and mobile work zones. The intrusion detection and alarm systems may be collocated or distributed, allowing systems that detect safety issues far upstream from a work zone (e.g., detection of over dimension vehicles before they enter the work zone).

4.14 INFRASTRUCTURE MONITORING AND SECURITY

There are diverse hazards that transportation infrastructure are exposed to. Fire in tunnels for instance can threaten the lives of travelers from smoke inhalation. The Department of Homeland security defines hazard[12] as “a threat of an incident, natural or manmade, that warrants action to protect life, property, the environment, and public health or safety, and to minimize disruptions of government, social, or economic activities.” In Louisiana there is the hazard of hurricanes every year. Hazards may be predictable such as a hurricane or non-predictable in the case of terrorism or sabotage or an accident. A resilient system is one that is capable of recovering rapidly after disruptions whether natural or manmade. The critical role the transportation infrastructure plays in socio-economic activities requires a secure and resilient system that will minimize the impacts of any hazards. ITS devices can be deployed to serve dual purpose for traffic and infrastructure surveillance. The extensive nature of the transportation infrastructure and the cost involved precludes deployment of surveillance or deterrent systems to cover the entire network. However, the security of critical infrastructure such as bridges, tunnels, airports, transit stations can be enhanced by deploying for instance CCTV cameras or detection systems

[12] http://www.whitehouse.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil (Accessed 9/17/2013)

to help monitor infrastructure and detect hazards or intrusions by unauthorized personnel. **Table 14** summarizes the national ITS service packages for infrastructure monitoring and security.

Table 14: Service Packages for Infrastructure Monitoring and Security

Service Package Name	Service Package	Service Package Description
Infrastructure Monitoring	MC12	This service package monitors the condition of pavement, bridges, tunnels, associated hardware, and other transportation-related infrastructure (e.g., culverts) using both fixed and vehicle-based infrastructure monitoring sensors. Fixed sensors monitor vibration, stress, temperature, continuity, and other parameters and mobile sensors and data logging devices collect information on current infrastructure condition. This service package also monitors vehicle probes for vertical acceleration data and other probe data that may be used to determine current pavement condition.
Transportation Infrastructure Protection	EM05	This service package includes the monitoring of transportation infrastructure (e.g., bridges, tunnels and management centers) for potential threats using sensors and surveillance equipment and barrier and safeguard systems to control access, preclude an incident, and mitigate the impact of an incident if it occurs. Threats can result from acts of nature (e.g., hurricanes, earthquakes), terrorist attacks or other incidents causing damage to the infrastructure (e.g., stray barge hitting a bridge support). Infrastructure may be monitored with acoustic, environmental threat (such as nuclear, biological, chemical, and explosives), infrastructure condition and integrity, motion and object sensors and video and audio surveillance equipment. Data from such sensors and surveillance equipment may be processed in the field or sent to a center for processing. The data enables operators at the center to detect and verify threats. When a threat is detected, agencies are notified. Detected threats or advisories received from other agencies result in an increased level of system preparedness. In response to threats, barrier and safeguard systems may be activated by Traffic Management Subsystems to deter an incident, control access to an area or mitigate the impact of an incident. Barrier systems include gates, barriers and other automated and remotely controlled systems that manage entry to transportation infrastructure. Safeguard systems include blast shields, exhaust systems and other automated and remotely controlled systems that mitigate impact of an incident.

4.15 TMC DEVELOPMENT

Traffic Management Centers (TMCs) are important for active management of transportation. The common TMC functional areas identified include but are not limited to the following[13]: management of traffic control systems and assets; incident detection, response and clearance functions; emergency response functions; monitoring and surveillance of transportation network conditions; and acquisition and communication of traffic information. TMC staff coordinates with local public safety agencies and emergency services to respond to incidents on the roadway. During emergencies TMC staff is required to continuously monitor evacuation and reentry and

[13] Information-Sharing Guidebook for Transportation Management Centers, Emergency Operations Centers, and Fusion Centers. Published by FHWA (June 2010)

localized TMCs may be in a better position to actively manage traffic and also coordinate with Statewide TMC. There are nine (9) regional areas discussed in **Section 3.1** that have ITS devices deployed or proposed. Those without regional TMCs will be operated from the Statewide TMC.

As technology improves and navigation systems proliferate and become ubiquitous many drivers will have access to real-time traffic information similar to what a TMC can provide either built into their cars or available on portable personal devices. The connected vehicle concept is still in its infantile stages but promises to radically change driving and navigation and help drivers avoid congestion and incidents.

TMC operations though will still be critical during emergencies where it can serve as a centralized location to coordinate emergency response. In day-to-day operations where active traffic management is required for instance using barriers to close ramps to prevent more vehicles from getting onto an already congested freeway TMCs can provide such oversight and control. Another scenario will be using congestion pricing to actively manage freeways by varying tolls to discourage use. Use of reversible lanes will also require TMC oversight to ensure efficient and safe operation. TMC operations can be performed from a remote location by leveraging cloud based resources to monitor and manage transportation assets. This is also known as Virtual TMC. While the merits of a local TMC could diminish and give rise to more Virtual TMCs, local TMCs afford a common place for coordination during emergencies or major incidents.

4.15.1 Virtual TMC

A virtual TMC leverages cloud based systems to provide monitoring, control and management of transportation systems without a physical location to perform these like the traditional TMC. Virtual TMCs rely more on web-based software solutions that allow operators to be at different geographic locations and can still deliver all service – traffic monitoring, data collection and processing, information dissemination, incident management, and other control strategies- without a physical localized TMC. One advantage of virtual TMCs is eliminating the constraint of geographic location and the cost in providing a physical infrastructure and communications for the TMC. One disadvantage is the loss of synergy from collocating with other emergency management services or other agencies for transportation management. **Section 4.15.2** will describe factors that could be taken into consideration to determine the need for a TMC in a region. In addition to these requirements a virtual TMC will have to consider security for data and cloud based computing.

A hybrid TMC system will include the use of a centralized physical TMC nerve center and virtual TMCs. This hybridized approach will allow active management of traffic in areas without a TMC from remote locations and on as needed basis. It will also eliminate the need for an operator to be at the TMC to be able to perform functions for advanced transportation management.

4.15.2 TMC Planning Design and Implementation Criteria

In view of the importance of TMCs for operations and management of transportation systems, the criteria for establishing a TMC in a region is described. “Region” used in this context can be a corridor or a broader geographic area. A multifaceted decision process is required to determine if a local TMC is warranted for any region. The inputs into this decision making will include at a minimum the following:

1. Concept of operations
2. Frequency of incidents
3. Traffic volume and congestion
4. Prevalence of ITS devices in the region
5. Potential for growth of ITS device inventory
6. Motorist assistance patrol in the region
7. Transportation management area
8. Collocation with DTOE or municipal traffic engineering office
9. Documented pros and cons of TMC for region

The subsequent sections will discuss each of these identified criteria and provide some insights to guide the planning and implementation of a regional TMC.

4.15.2.1 Concept of Operations

A concept of operations must first be established when assessing the need to establish a new TMC in Louisiana. The concept of operations will define what needs to be achieved and how it will be achieved. The stakeholders must be identified and agree on the envisioned operations.

4.15.2.2 Frequency of Incidents

The underlining reason for a TMC is the management of incidents. If the geographic region where a TMC is desired has critical infrastructure that are severely impacted by incidents even minor stalls or crashes then active monitoring of such infrastructure may be required. Such critical infrastructure may include elevated roadways or bridges where traffic cannot be diverted around incidents. If incidents are frequent and a coordinated response such as performed by a TMC is required to avert adverse extensive impacts, then a TMC may be considered for the region.

4.15.2.3 Traffic Volume and Congestion

Regions with corridors that carry very high volumes of traffic and also experience congestion frequently should be considered for the implementation of a local TMC to manage traffic. Such high volume corridors could be prone to incidents and delays. A TMC can provide active management of traffic, real-time monitoring and traffic control, which can mitigate the negative impacts of incidents and congestion.

4.15.2.4 Prevalence of ITS Devices in the Region

As the ITS architecture expands and more devices are deployed, it may become necessary for a Local TMC to be established to actively manage traffic locally or regionally. The increase in devices could overtask existing staff and diminish benefits. However the proliferation of devices per se should not be the criteria but rather the functionalities embedded in devices and the task it places on a TMC operator. For instance CCTV camera technology could be embedded with video analytics software that only stream images when there is an active. The TMC operators task of monitoring all the CCTV cameras could be reduced to monitoring those streaming active incidents and therefore minimize the workload on operators and number of operators required.

4.15.2.5 Potential for growth of ITS Device Inventory

Generally, as more ITS devices are deployed in the state, the demand for operators to monitor devices in real-time from the existing Statewide TMC will grow. It may become necessary to develop a local TMC that will be staffed with operators to monitor and control devices for this local area to reduce the need to expand the Statewide TMC.

4.15.2.6 Motorist Assistance Patrol in the Region

The criteria for deploying MAP is discussed in **Section 4.16**. The presence or need for MAP in an area may also indicate a need for a TMC and a dispatcher.

4.15.2.7 Transportation Management Area

Growth in a given geographic area impacts the existing surface transportation system (increase in drivers and vehicular trips) and appropriate measures must be taken to address any congestion and safety related issues as a result of this growth. Local TMC operations can facilitate management of the surface transportation network by monitoring operations and addressing any incidents or initiating operational strategies to mitigate congestion. Urbanized area population could be used as criteria to establish a local TMC. Currently, the federal government designates any location where the population exceeds 200,000 as a transportation management area (TMA). A TMA is required to have a comprehensive transportation planning process and include congestion mitigation. Baton Rouge, New Orleans, and Shreveport are

currently TMAs and each has a TMC. Lafayette is becoming a TMA, however the city has established its own TMC. The Lafayette TMC does not perform active traffic management[14] yet.

4.15.2.8 Collocation with DTOE or Municipal Traffic Engineering

Where possible a local TMC should be collocated with the lead traffic management entity within the region such as the DOTD district traffic or municipal traffic engineer's office to leverage existing resources and manpower.

4.15.2.9 Documented Pros and Cons of TMC for Region

The broader impacts of establishing or not establishing a TMC must be rigorously assessed and the factors discussed above should be factored into the decision making process. For instance, as more ITS devices are deployed in a region, ITS operations may be more efficient with the establishment of a local TMC to monitor and manage devices and provide timely traveler information and incident management. The presence of a TMC can be leveraged for integrated corridor management which will have broader multimodal impacts on the transportation system and vice versa. On the other hand Virtual TMCs may become viable options as technology improves and this could reduce cost associated with constructing/retrofitting a building, maintenance and communications infrastructure required to set up the TMC.

4.16 MAP PATROL DEPLOYMENT

Motorist assistance patrol (MAP) is a useful component for the management of critical roadways where an incident can lead to extensive congestion and secondary incidents. MAP is usually the first to respond to an incident in corridors where it is deployed. MAP personnel can begin to secure a crash scene and warn drivers about the hazard and provide temporary traffic control. Map personnel also relay more accurate information about location and severity of incident for the appropriate response than the traveling public. This accelerates incident response and reduces clearance times.

Traffic incidents such as crashes are random and the time and location cannot be predicted in advance with any certainty. The inability to predict incidents therefore poses a challenge in addressing when and where to deploy MAP. Some transportation operations centers or traffic management centers use advanced analytics on prevailing roadway conditions (traffic volume and environmental conditions) to determine the potential for crashes and the impact on roadway system to determine when to deploy MAP. Advance deployment of MAP at strategic locations will reduce response times, reduce the potential for secondary incidents and reduce recovery time of the roadway system. Critical corridors such as elevated freeways and bridge crossings

[14] Lafayette Consolidated Government has a TMC that primarily provides management of the traffic signal system. It does not have operators monitoring cameras or congestion data and facilitating response. It currently operates in a reactive capacity.

exist in the state and crashes can be especially problematic since it may not be possible to move traffic until incident is cleared. Such locations may be targeted for MAP patrols. Generally, the following criteria may be considered in determining where to deploy MAP:

- Crash history of corridor where MAP is desired
- Ease of accessibility of response teams to incident site
- Impacts of incident response time on traffic operations within corridor
- Ability to reroute traffic

4.17 MAINTENANCE OF ITS DEVICES

From a Statewide perspective, DOTD is the responsible agency for operation and maintenance of the overall state/federal road network system. DOTD's performance based management initiative guides the operations and maintenance of the advanced transportation management system and components. As DOTD continues to build out the ITS infrastructure, there is a need for an asset management system to ensure effective maintenance of the infrastructure. Components and systems will fail with time or may have to be replaced because they have become obsolete. A functional asset management plan will help maintain the ITS architecture at minimum cost with fewer disruption of service. **Figure 4** shows the process for an asset management plan to ensure ITS deployments in the state are maintained and replaced in an efficient and effective manner[15].

[15] The figure is modified from the one provided in the Asset Management Primer published by the US Department of Transportation

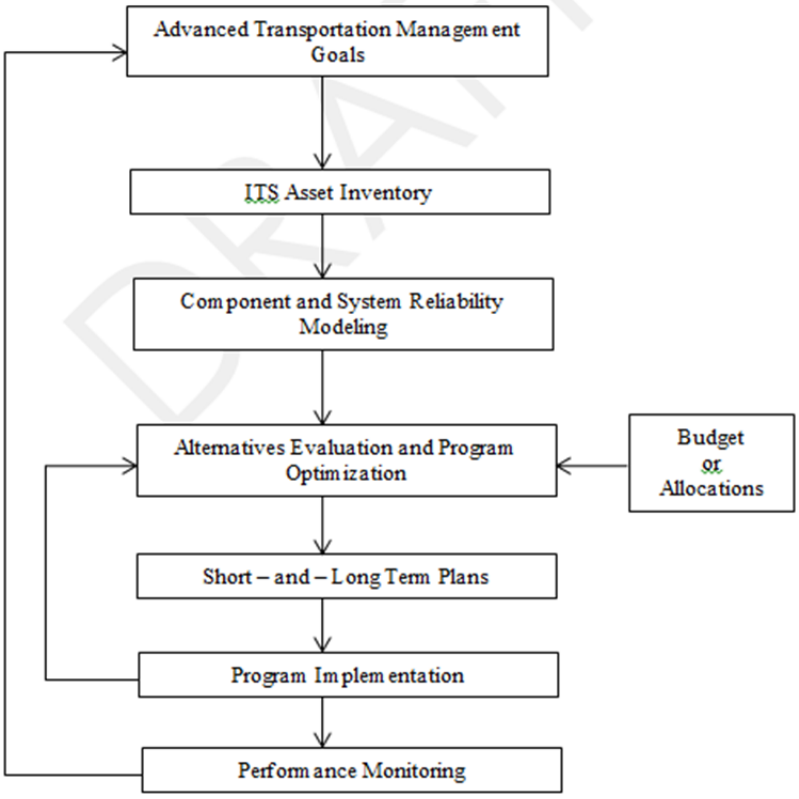


Figure 4: ITS Asset Management Plan

4.18 ADVANCED VEHICLE SYSTEMS

Advanced vehicle systems are currently being pursued under two broad concepts: connected vehicle (CV) and autonomous (or driverless) vehicle (AV). Soon vehicles will have the ability to communicate with each other, road side equipment (RSE) and portable devices to share information about location, trajectory and environment, and collaboratively use such information to enhance safety and mobility. Vehicles that can communicate in this manner are referred to as connected vehicles. The autonomous vehicle technology is aimed at developing vehicles that are capable of performing all tasks associated with driving without any input from a human (except perhaps to provide destination). The “driver” in the autonomous vehicle is the software. Autonomous or driverless vehicles are no longer something to be imagined but this potentially disruptive technology is progressing rapidly and testing has been undertaken (and is still on-going) in several cities around the United States and abroad.

The connected vehicle and autonomous vehicle advancements are game changers in transportation safety, mobility and the environment. FHWA, NHTSA and companies in the private sector have therefore shown keen interest in the development of these technologies. The primary reason for developing the connected vehicle and autonomous vehicle initiatives is

safety. Crashes are expected to be dramatically reduced with these technologies, and the autonomous vehicle paradigm hopes to eliminate the unpredictability of human drivers – the key contributory factor in most crashes – and thereby reduce the majority of crashes on roadways which would then lead to reductions in secondary crashes, congestion, fuel consumption, and greenhouse emissions.

The advancements in research and technology for autonomous and connected vehicles holds great promise that will go beyond impacting mobility, safety and the environment, but also spur new opportunities and businesses in mobility services. Certain subsystems of the autonomous vehicle concept have matured to the extent that NHTSA has adopted these proven advancements in automotive technologies and require automotive manufacturers to include them in vehicles as standard equipment. Furthermore, some automotive manufacturers are also deploying systems in their vehicles that will facilitate vehicle-to-vehicle communication. It is expected that these technologies and deployments will grow and impact transportation operations and land use planning. The subsequent sections will discuss in further detail the connected and autonomous vehicle initiatives including emerging issues and operational parameters.

4.18.1 Autonomous Vehicles

4.18.1.1 Autonomous Vehicle Concept

Automation systems can range from driver assistance for single functions e.g. brake assist, to full automation with no driver required[16]. The National Highway Traffic Safety Administration (NHTSA) and the Society of Automotive Engineers (SAE) each defines various levels of automation and functionality with slight variations in the definitions. The NHTSA scale of automation ranges from Level 0 (No-Automation) to Level 4 (Full Self-Driving Automation); the SAE scale ranges from Level 0 (No-Automation) to Level 5 (Full Automation). The following describe the functions under the NHTSA scale:

a) At Level 0 (No-Automation) there is no automation and the driver maintains full control of vehicle at all times. There may be enhancements to the driving task with the aid of warning or intervention systems but the driver is in sole control of the vehicle.

b) At Level 1 (Function-Specific Automation) there is function specific automation where one or more specific control functions are automated e.g. electronic stability control, or pre-charged brakes. Level 1 systems may also be classified as driver assistance.

c) At Level 2 (Combined Function Automation) involves at least two primary control functions working in unison to relieve a driver of control of these functions e.g. adaptive

[16] Benefits Estimation Framework for Automated Vehicle Operations. USDOT August 2015

cruise control and lane centering. Level 2 combines two or more primary functions working together. Level 2 can be classified as partial automation.

d) A Level 3 (Limited Self-Driving Automation) the driver can be relieved of all safety-critical functions under limited traffic and environmental conditions however the driver must be available to take control as needed. There is limited self-driving automation at Level 3 and it is also classified as conditional automation.

e) At Level 4 (Full Self-Driving Automation) the NHTSA definition describes a vehicle that performs all safety-critical driving functions and monitors conditions throughout the trip. There is full self-driving automation at Level 4 and the driver is only required to provide destination for each trip. The driver is not required to be in the vehicle.

The SAE defines six classes of automation distinguished by four other factors. The six classes of automation are listed below:

a) Level 0 (No Automation)

b) Level 1 (Driver Assistance)

c) Level 2 (Partial Automation)

d) Level 3 (Conditional Automation)

e) Level 4 (High Automation)

f) Level 5 (Full Automation)

The factors used to differentiate the levels of automation are based on whether a human or a system (artificial intelligence) performs the dynamic driving tasks listed below:

a) Execution of steering and acceleration or deceleration

b) Monitoring of driving environment

c) Fallback performance of dynamic driving task

d) System capability (driving modes)

Figure 5 shows where human input is required on the SAE scale. The NHTSA and SAE functions for Level 0, Level 1, Level 2 and Level 3 are similar. Level 3 (Limited Self-Driving Automation) on the NHTSA scale requires a driver to be available to take back control when requested to do so. The driver may not be available to respond to this request for any number of reasons and the SAE classification recognizes this scenario in its classification. The SAE Level 4 (High Automation) classification recognizes that the human driver may not be available to take

back control. In this scenario the system returns the vehicle to a failsafe condition if the driver does not respond to a request to take over control. In other words the fall back performance of the dynamic driving task (whether human or system) is used to distinguish between classes of automation: human in Level 3 and system in Level 4. In the event that a driver does not respond to a request to intervene, the vehicle can be brought to a minimal risk condition (say a stop).

The NHTSA definition for Level 4 (Full Self-Driving Automation) corresponds to the Level 5 for SAE (Full Automation) where all aspects of the dynamic driving task are performed by automation and under all roadway and environmental conditions that can be managed by a human driver.

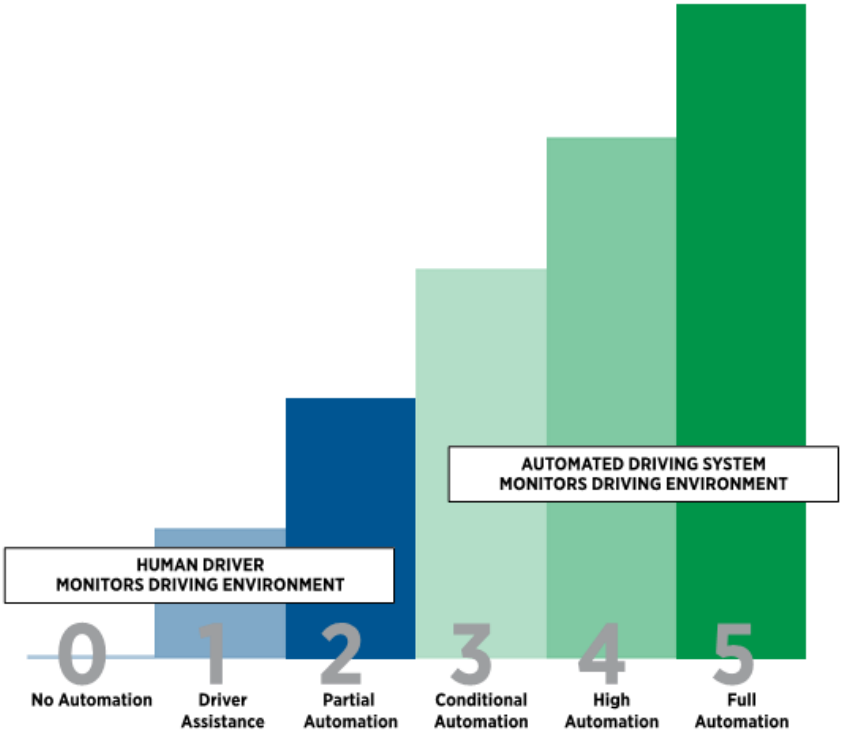


Figure 5: Levels of Automation for On-road Vehicles (Source: SAE)

4.18.1.2 Impacts of Autonomous Vehicles

While it is uncertain when fully autonomous vehicles will become available and a significant part of the fleet of vehicles on the roadway, there is some consensus on the anticipated impacts of autonomous vehicle use. The impacts anticipated include:

- Safety: crashes are a complex combination of several factors (generally human, vehicle and roadway/environment with human factor contributing to 93% of all crashes[17]). By removing the human element (distraction, fatigue, inattention, poor judgment, age, deficient driving habits) with autonomous vehicles there will be significant safety benefits.

- Mobility as a service: There could be significant changes in vehicle ownership with many people opting for mobility as a service than car ownership. This could impact transportation infrastructure planning and development and reduce public funds required to build parking garages, transit operations and roadways.

- The roll out of autonomous vehicles is expected to start with mostly fleet vehicles (for instance autonomous taxis) at the onset where there will be better control of issues related to security and safety features. These fleet vehicles could be owned by manufacturers or other businesses that provide mobility service, such as Uber and Lyft.

There are several benefits or applications that could potentially be derived from autonomous vehicles:

1. Depending on the level of automation, crashes that are the result of driver error can be reduced or eliminated resulting in more reliable and predictable travel times.

2. Automated vehicles can lead to shorter headways and narrower lanes as a result of precise braking and maneuvering and thereby improve functional capacity and reduce capital investments.

3. Autonomous vehicle concept also hopes to empower demographic groups that cannot drive such as children, the elderly, the blind or those with disabilities that prevents them from driving. Autonomous vehicles can meet the mobility needs of and bring new opportunities to these groups of people.

4. Autonomous vehicles can enable truck platooning for heavy duty trucks, which will reduce drag on vehicles, reduce energy consumption and thereby reduce emissions. For instance a lead vehicle operated by human can share dynamic information about braking and acceleration with trailing trucks that in turn use the broadcast information to maintain requisite headways for efficiencies in operation.

5. Autonomous vehicles can be used as driverless delivery vehicles for goods.

[17] Highway Safety Manual 1st Edition Volume 1

4.18.1.3 Challenges with Autonomous Vehicles

Autonomous vehicles are expected to function acceptably under a plethora of conditions involving sharing the roadway with other users (motorists, pedestrians, and bicyclists), varying conditions of roadway pavement (presence or absence of pavement marking, potholes, work zones, etc.), traffic control and route guidance, and different environmental conditions including snow, ice, fog and floods. In the NHTSA Level 4 (SAE Level 5) where the vehicle is completely autonomous and no driver inputs are required, the artificial intelligence embedded in the control systems is expected to handle these varying and unpredictable scenarios in a safe manner. Any gaps in the capabilities could pose significant safety risk for both occupants of the vehicle and other road users and could potentially manifest itself as a systemic flaw that repeats in many other instances. At the NHTSA Level 3 (SAE Level 4) where the vehicle is expected to cede control to driver when met with a perplexing situation it cannot navigate, the vehicle must be capable of anticipating this issue and giving sufficient time for a driver to assume control. The availability of the driver with situational awareness after an extended period with minimal load conditions is unknown and could pose safety issues.

The success of advanced vehicle systems depends on many key stakeholders (automotive industry, highway agencies, public, insurance agencies, etc.) collaborating to achieve the transportation benefits envisioned. There are questions yet to be answered and these include:

- How will autonomous vehicles interact with other vehicles on the roadway?
- Under what conditions are Level 3 or Level 4 automated vehicles permitted to operate and what minimum roadway conditions (for instance pavement marking, signage, control) must a roadway agency provide?
- How will humans interact with Level 3 or Level 4 automation and what impact will it have on drivers? A NHTSA-sponsored research[18] describes the situation called driver underload where “removing some level of task demand from the driver…can lead to fatigue, boredom, reduced levels of operator alertness, and sensation seeking behaviors.”
- Who is responsible when a vehicle crashes while changing modes from autonomous to human driver?[19]

[18] National Highway Traffic Safety Administration, “Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts,” August 2015

[19] Volvo, Mercedes Benz and Google have declared they will assume full liability for any crashes when their vehicles are operating in autonomous mode. (Traffic Technology International April/May 2016 page 021)

- How will the ethical issues associated with autonomous vehicles be dealt with? For instance will an autonomous vehicle run off the road to avoid collision with another vehicle or run onto a sidewalk with pedestrians present in order to protect vehicular occupants?
- Will insurance agencies cover autonomous vehicles at reasonable costs?
- How will local, municipal or State regulations affect usage of autonomous vehicles?
- How will public perception affect regulations for autonomous vehicles?
- Can safety-critical systems be protected from external intrusion by hackers?

While there are some legal and liability issues to be overcome before autonomous vehicles become mainstream, there is undoubtedly a paradigm shift unfolding and public policy is playing catch up.

In the meantime, automotive manufacturers will continue to evolve and develop highly intelligent vehicles with the primary goal of enhancing safety and addressing mobility needs. Mature automated functions will continue to be rolled out in a piecewise manner that will help garner public acceptance of the technology. For instance parking assist is available in some vehicles today. Highly automated vehicles connected to the infrastructure can enhance operation and navigation in the physical environment with awareness of traffic control devices, other vehicles, pedestrians, and other road users or obstacles. Commercial fleet vehicles are anticipated to be a good starting point for deployment. While there is some uncertainty when driverless or autonomous vehicles will be part of the mix of vehicles on the roadway, advancements thus far show it is only a matter of time.

4.18.2 LADOTD Role in Autonomous Vehicle Applications

There are many challenges that need to be resolved before autonomous vehicles become available on the market and at the forefront of this is the lack of federal regulation to guide development and operation of autonomous vehicles. There exists a patchwork of rules and regulations developed by a few states and some definitions therein are bothersome to auto manufacturers and could significantly impact full scale deployment of autonomous vehicles. California for instance requires a “licensed operator” to be present in an autonomous vehicle to be able to take control if needed. While this rule was passed to guide testing of autonomous vehicles, it could lead to autonomous vehicles being required to have a driver, a steering wheel and pedals and could require the driver to be engaged at all times. Furthermore it restricts auto manufacturers such as Google who want human control completely eliminated. While these issues are being sorted out, there is no doubt that auto manufacturers will continue to market vehicles with limited self-driving capability and the number of these vehicles on the roadways will continue to increase.

Research on automated road-vehicle systems is on-going. One of the key questions raised is: “Are there minimum condition ratings for say pavement markings, signs and work zone devices required for autonomous vehicles to operate safely?” If so, a State DOT may be required to invest in such upgrades to bring the infrastructure up to standard for autonomous vehicle operation if state or federal laws stipulated this requirement. Furthermore even though the MUTCD and the AASHTO Green Book are used as standards in highway infrastructure design, these provide guidance and allow flexibility in the designs or non-standard applications when design waivers are obtained. However if autonomous vehicles are designed to use digital mapping, some infrastructure elements such as signs, DMS, street lighting etc. may not be required. Lane assignments can be changed dynamically in response to downstream activities such as work zone, or incident blocking a lane.

At this point it is not clear if the rules that will guide autonomous vehicle operations when promulgated will require changes to existing infrastructure. The lack of rule-making at the federal level has led to an ad hoc approach at the state level with some states adopting a wait and see approach. The lack of regulation is attributable in part to the technology being in an infantile state and still evolving and also to a fear that regulation could stifle progress.

4.18.3 Connected Vehicles

4.18.3.1 Connected Vehicle Concept

Connected vehicles - vehicles that can communicate with each other and the roadway infrastructure - are in advanced research, development and testing stages. The primary objectives of connected vehicles are to improve safety, maximize mobility options and minimize environmental impacts. Connected vehicles are envisioned to become mainstream soon as advancements are made in wireless communications and smart infrastructure. The connected vehicle initiative will enable communications between vehicle and infrastructure also known as V2I (or vehicle infrastructure integration VII) or between vehicles to share information on roadway also known as vehicle-to-vehicle (V2V), or send information from roadside infrastructure to hand held devices (V2D). In V2V communication vehicles can share for instance information about position and speed so that vehicles within a certain radius are aware of each other and can optimize mobility and safety. Some aspects of the VII technology are mature and in use today in the area of electronic payment systems and others related to commercial vehicle operations via use of on board equipment or transponders.

Connected vehicle technology has the potential to significantly impact operations and also yield a plethora of probe data that can give the exact status of the transportation system and foster more reliable real-time traffic management. Some of the benefits anticipated and reported by

AASHTO deployment analysis report[20] and the field infrastructure foot print analysis report [21]include the following:

1. Reduce the likelihood of collisions at intersections (intersection collision avoidance systems)
2. Reduce the likelihood of forward and lateral (lane change and merge) collisions
3. Reduce the likelihood of secondary crashes
4. Reduce the likelihood of road departure crashes
5. Provide more accurate and timely road condition alerts (motorist advisories and warnings with emergencies, inclement weather, curve speed, oversize vehicle, etc.)
6. Reduced energy consumption and vehicle emissions (dynamic eco-routing)
7. Seamless multimodal travel

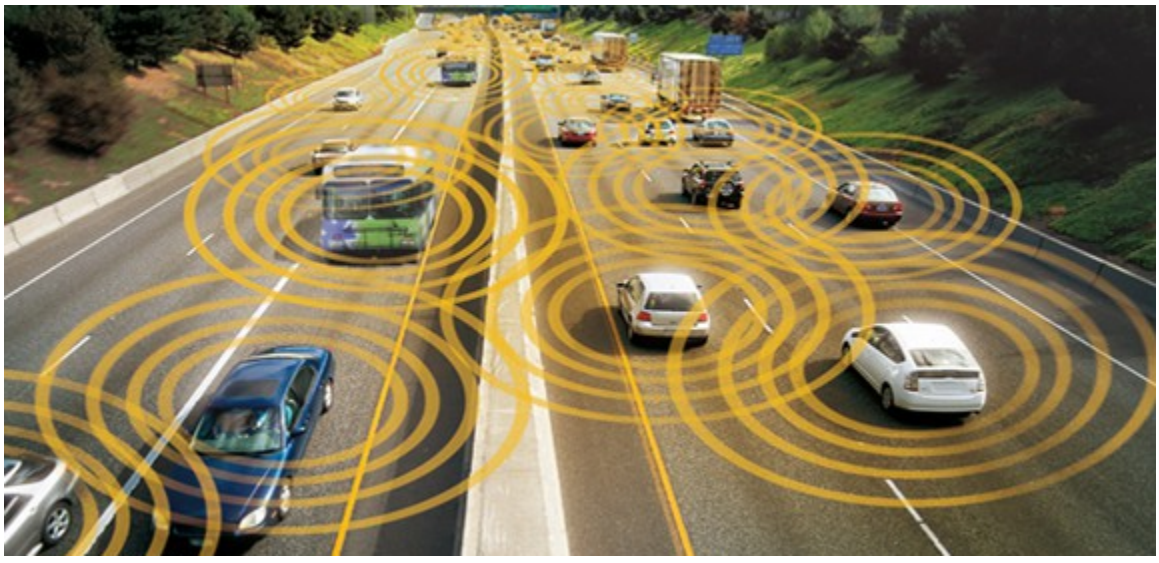


Figure 6: Information sharing among Connected Vehicles (Source: USDOT)

[20] AASHTO Connected Vehicle Infrastructure Deployment Analysis. Final Report June 17, 2011

[21] National Connected Vehicle Infrastructure Footprint analysis Deployment Concepts. Final Version 2 September 20, 2013

Before the anticipated benefits listed above can be realized, there are several challenges that have to be overcome first. The United States Government Accountability report[22] summarized the challenges:

1. Ensuring that possible sharing with other wireless users of the radio-frequency spectrum used by V2I communications will not adversely affect V2I technologies' performance

2. Addressing states and local agencies' lack of resources to deploy and maintain V2I technologies

3. Developing technical standards to ensure interoperability

4. Developing and managing data security and addressing public perceptions related to privacy

5. Ensuring that drivers respond appropriately to V2I warnings

6. Addressing the uncertainties related to potential liability issues posed by V2I

The industry stakeholders are working to address these issues and others related to emerging capabilities. The extent to which connected vehicle infrastructure is deployed will be at the discretion of state and local agencies. It is expected that aftermarket safety devices (ASD) will be available to motorists to purchase and install in cars without this technology. The ASD will monitor communications with other connected vehicles and the road side equipment (RSE) and provide alerts to drivers. General Motors is planning to deploy vehicles with Dedicated Short-Range Communications (DSRC) technology in 2017 and it is likely other original equipment manufactures (OEM) will follow suit. The cost of deployment will depend on the infrastructure existing and the additional component systems required. The range of benefits anticipated from connected vehicle technology makes it eligible for funding from these established sources[23]:

1. ITS funds from both federal and state sources

2. Safety funds

3. Congestion mitigation and air quality funds

[22] Intelligent Transportation Systems Vehicle-to-Infrastructure Technologies Expected to Offer Benefits, but Deployment Challenges Exist. September 2015

[23] Intelligent Transportation Systems Vehicle-to-Infrastructure Technologies Expected to Offer Benefits, but Deployment Challenges Exist. September 2015

4.18.3.2 Communications Technologies

4.18.3.2.1 DSRC Communications for Connected Vehicles

According to the *AASHTO Field Infrastructure Foot Print Analysis* report, the "fundamental premise of the connected vehicle environment lies in the power of wireless connectivity among Vehicles, the Infrastructure, and mobile devices to bring about transformative changes in highway safety, mobility, and in the environmental impacts of the transportation system." There are several communications technologies that have been discussed under the connected vehicle umbrella and these include Dedicated Short-Range Communications (DSRC), 4G cellular networks, Wi-Fi, Satellite etc. These communications technologies have their pros and cons and a variety could be applied depending on performance requirements. For safety critical functions where low latency, accuracy and reliability in communications are desired, DSRC technology will be applicable[24]. This is because DSRC can be used to collect "continuous high-speed, trusted and authenticable wireless data communications among moving vehicles and between vehicles and roadway infrastructure or mobile devices and the data can be used to provide real-time information on transportation system status to be broadcast to users. Information that can be shared includes but is not limited to vehicle size, vehicle position, speed, heading, steering angle, and brake status—generally referred to as basic safety messages (BSM). The DSRC technology will be used to broadcast BSM every 100 milliseconds. Currently only DSRC technology is capable of meeting the requirements for delivering the BSM especially because it enables broadcasting (one to many communications).

DSRC licensing will be critical for DOTs. Currently the way DRSC licensing is granted could pose a challenge if the new licensee faces any frequency interference. It is the responsibility of the new licensee to resolve with existing licensees in the DSRC spectrum. Certain fixed DSRC frequencies are currently used by Department of Defense for their radars and earth stations for links to satellites. Any interference issue that must be resolved is the responsibility of the entity installing new stations. The AASHTO analysis of connected vehicles shows this will pose a big challenge in urbanized areas where governmental, nongovernmental and commercial entities share spectrum and physical space. The Federal Communications Commission (FCC) has allocated 75MHz of spectrum in the 5.9GHz band for ITS applications.

The other communications technologies such as cellular can be used in other applications where latency is not a problem. For instance cellular can be used to inform commuters about transit options for travel or allow commuters can make requests for transit.

[24] Status of the Dedicated Short-Range Communications Technology and Applications Report to Congress (July 2015)

4.18.3.2.2 DSRC Applications

California, Michigan, New York, Florida, Arizona and Virginia are some of the States that have used DSRC in transportation applications. California Department of Transportation along with other partners developed a test bed for 5.96 GHz DSRC communications and connected vehicle applications starting in 2005. In 2008 this test bed became part of Safe Trip-21 program which used DSRC roadside infrastructure to connect 27 intersections to improve safety and mobility in a 6-mile corridor of El Camino Real. Additional technologies leveraging DSRC were used in the following applications:

1. At-grade light rail crossings
2. Station traveler information
3. Cooperative intersection collision avoidance systems
4. Signalized left turn assistance
5. Lane-level positioning capability

This test site communications were upgraded in 2012 and the 5.96 GHz DSRC radios were replaced. The lesson learned[25] is that "if roadside equipment exists, most connected software and infrastructure can be re-purposed and re-used to comply with needs of updated DSRC equipment."

4.18.3.2.3 Potential Applications

In a final report[26] of the World ITS Congress dated November 2014, the applications of DSRC technology were developed. **Table 15** provides a summary of the information. **Figure 7** through **Figure 10** provide concepts for safety application of connected vehicles. See **APPENDIX A** for more concept applications.

[25] USDOT. Status of the Dedicated Short-Range Communications Technology and Applications. Report to Congress.

[26] State DOT CEO Leadership Forum. A Focus on Transportation Futures. Final Report ITS World Congress.

Table 15: Applications for DSRC

Safety Applications	Mobility Applications	Agency Operations and Maintenance
Red light violation warning	Motorist advisories and warnings (emergencies, weather, variable speeds, curve speed, oversize vehicles)	Enhanced maintenance decision support
Curve speed warning	Real-time route specific weather information	Information for maintenance and fleet management systems
Stop sign gap assist	Advanced traveler information system	
Spot weather impact warning	Freight operator real-time information with performance monitoring	
Reduced speed/work zone warning	Transit signal priority	
	Emergency vehicle pre-emption	

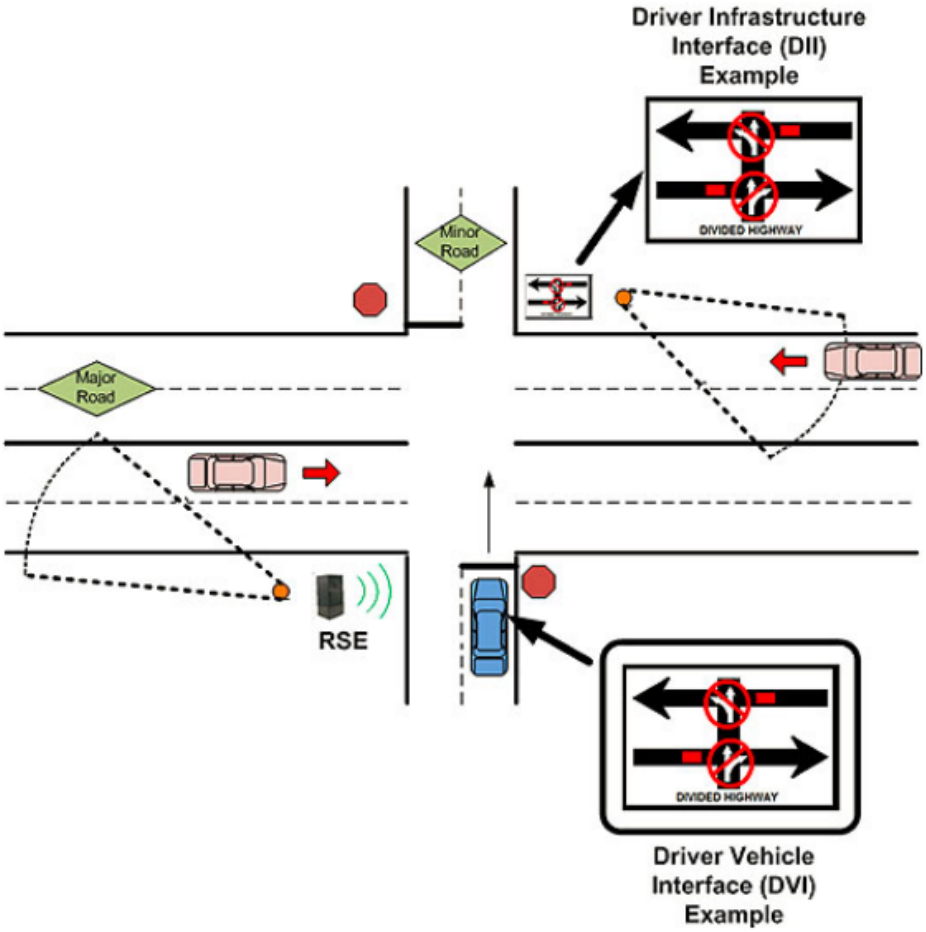


Figure 7: Stop Sign Gap Assist (Source: USDOT)

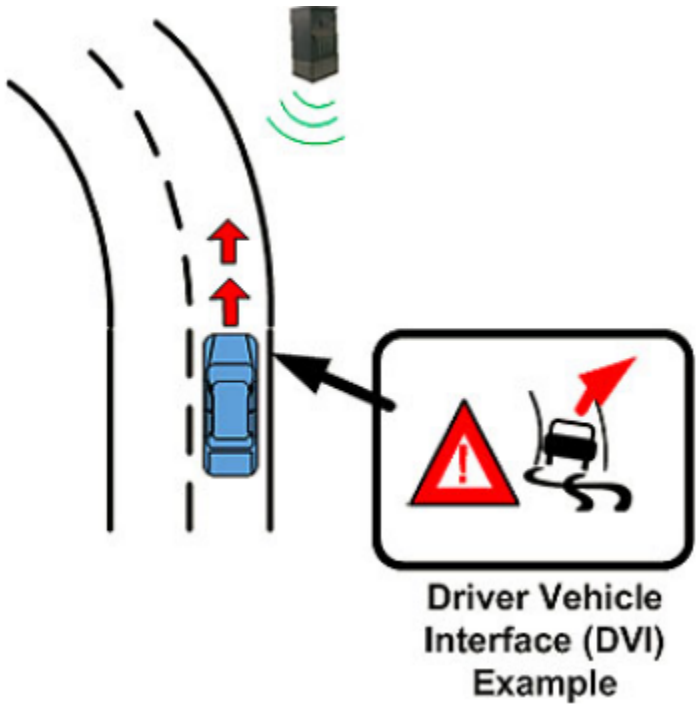


Figure 8: Curve Speed Warning (Source: USDOT)

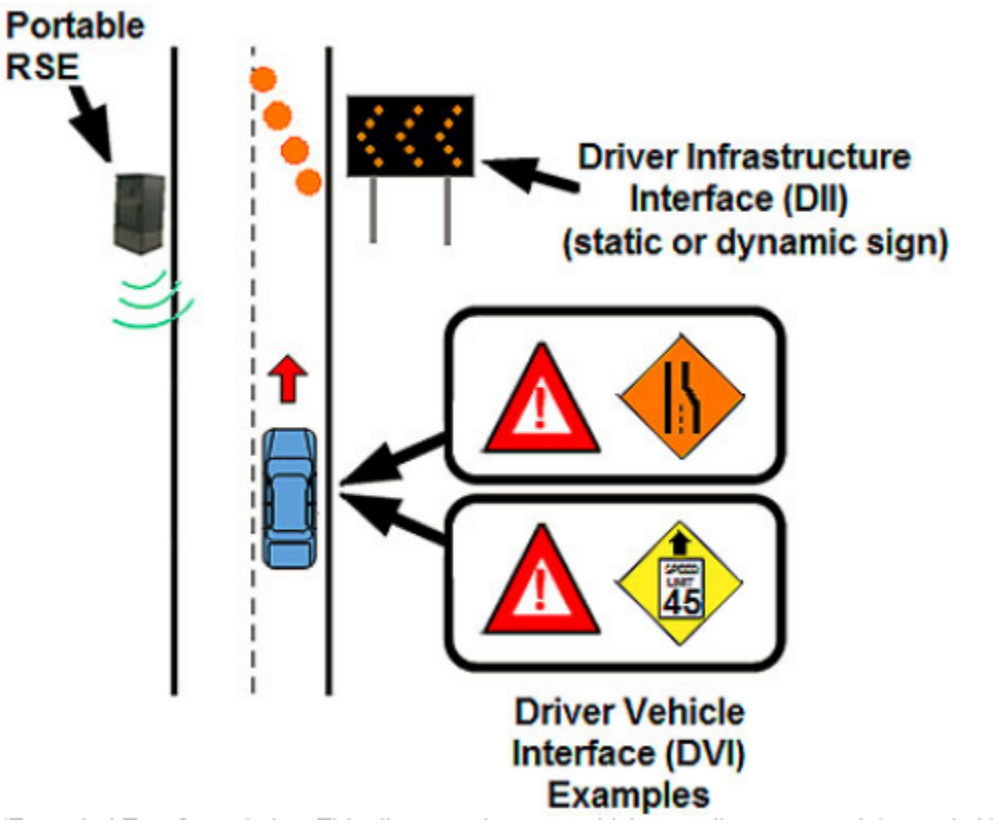


Figure 9: Work Zone Warning (Source: USDOT)

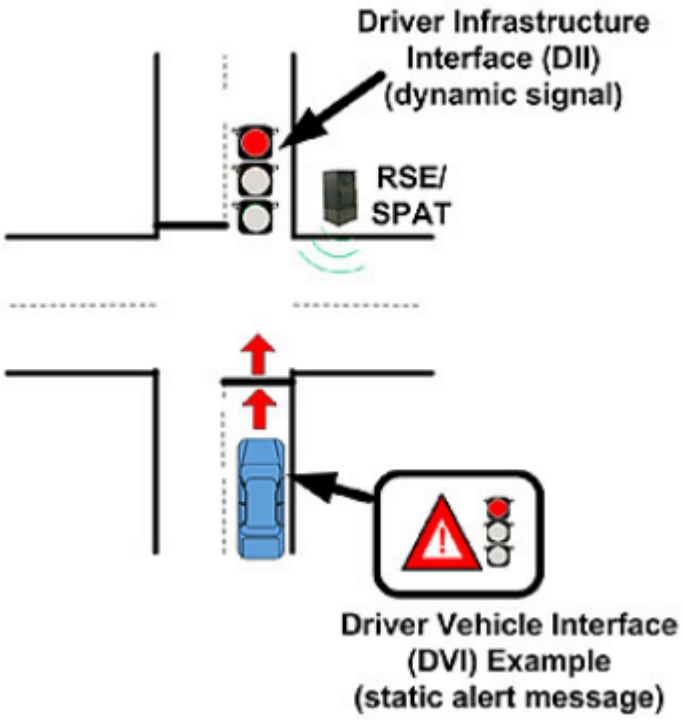


Figure 10: Red Light Warning Concept (Source: USDOT)

4.18.3.3 Challenges with Connected Vehicles

Connecting vehicles to infrastructure will require state DOTs to work out standards with the automotive industry and incorporate the required devices and communications into roadway infrastructure. There are many questions that need to be resolved by all stakeholders in order for such collaboration to succeed and yield results. For instance:

- What critical mass of vehicles with embedded technology is required in order for a transportation agency to make the required capital investment?
- How will data security be addressed and would travelers have the choice to opt in or out and share some personal information to receive benefits? .

4.18.4 LADOTD Role in Connected Vehicle Applications

The development and implementation of vehicle to vehicle communications fall under the purview of auto manufacturers and NHTSA will coordinate this V2V effort. The primary responsibility of LADOTD, and other State DOTS, is to determine the infrastructure it needs to deploy in order to leverage this technology for operations. The connected vehicle technology will provide a plethora of information to assess real-time roadway conditions, performance and also disseminate traveler information with a wider reach depending on the penetration of

connected vehicles in the vehicle population. With the right infrastructure investments, connected vehicles will share road condition and environmental data which LADOTD could collect for monitoring and operational purposes. For example warning messages about an incident and queue formation can be broadcast to connected vehicles upstream of the incident to alert travelers. The connected vehicle technology could have a wider reach beyond that which TMCs are currently capable of if messages can be transferred from vehicle to vehicle.

The infrastructure LADOTD has to deploy in order to benefit from the connected vehicle technology includes roadside equipment (DSRC radios), power supply, backhaul communication to the TMC (fiber or wireless) and data storage to support analysis. The availability of power supply and communications will vary considerably from site to site especially in rural versus urbanized settings. The concept of operations will determine the scale of deployment. For instance at a sharp curve in a rural setting the need may be DSRC system to warn approaching drivers of the hazard ahead from each side of the curve and may be designed as a stand-alone system. In the case of intersection collision avoidance, several more units may have to be deployed to monitor all approaches and warn drivers of red light runners. If data collection is required a low volume roadway will have less vehicle data information and therefore the communication bandwidth and data storage system requirements may be smaller. In an urban setting with higher volumes of traffic a higher bandwidth and data storage system may be required.

While the technology is still being tested and there will be no immediate return on any investment in connected vehicle technology, it will be prudent to provide some guidance to help with preparedness. For instance during intersection signal upgrades or installation of ITS field equipment, provisions can be made for connected vehicle technology by ensuring cabinets have space and communication for connected vehicle systems. Furthermore, integration of signal systems with broadband communications across jurisdictional boundaries will pave the way for seamless operation along arterials[27].

The systems deployed and LADOTD capabilities should at least cover these critical needs:

1. Data capture and sharing (broadcast, multicast and unicast)
2. Security and credentialing management system
3. Compatibility and interoperability with on-board equipment
4. Performance measures

[27] Traffic Technology International April/May 2016, page 073

Furthermore, in a connected vehicle environment there may be several transportation applications that can be developed from data that is collected. Several agencies can install devices to collect data and process them to meet user needs. These agencies can create clearinghouses and make such data available through registration and subscription. LADOTD may need to develop new relationships to share data collected to support new transportation applications or obtain data to support business functions.

4.18.5 Impacts of Advanced Vehicles

These initiatives in due course will become ubiquitous and transportation agencies will have to adapt to accommodate these novel means for transportation and leverage it to improve transportation operations and safety. For instance, the functional capacity of roadways is expected to improve with connected vehicles. Headways for instance can be reduced and several vehicles can drive collaboratively along a road as a "train". This will result in reduced fuel consumption, reduced emissions, improved safety and reduced congestion. Autonomous vehicles will have significant safety benefits by eliminating human error that sometimes leads to crashes and affects capacity of the roadway.

Autonomous vehicles will also make vehicles more accessible, enhance mobility and car sharing and deemphasize vehicle ownership. This trend of reduced car ownership has already been noted in millennials. Reduced vehicle ownership can have significant impacts on land use planning and transportation infrastructure development. For instance fewer parking places will be required and many parking lots or garages can be reassigned for other use. Another area where autonomous vehicle can affect mobility is in public transit. Connected autonomous vehicles can be used to address the "first mile" and "last mile" mobility needs for transit riders. Passengers can request a pick-up either from origin at a set time, or while on bus before arriving at their destinations. Users without smartphones can use transit consoles or kiosks to make such requests. This service could enhance transit ridership.

Public policy and the regulatory framework required for autonomous vehicle operations has yet to be developed. A few States however are proceeding with policy and legislation on autonomous vehicles. These States include California, Florida, Nevada, Michigan and Washington D.C. which have enacted bills to regulate licensing and operation of autonomous vehicles on public roads[28]. NHTSA and FHWA are conducting research that will lead to regulatory and policy developments which can serve as templates that individual states could adopt. LADOTD has formed the Autonomous Vehicle Technology Team (AVTT) comprised of 30 individuals from various disciplines within LADOTD to help define the department's role and advise on implementing technology, formulating policy, and identifying promising applications for use by LADOTD.

[28] Daniel J. Fagnant, Kara Kockelman. 2015: "Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations." Transportation Research Part A: Policy and Practice

The long-term impacts of autonomous vehicles on the driver and the general public are unknown and can only be determined in the future. There may be unintended consequences that may need to be addressed as and when they arise. **Table 16** summarizes the service packages in the national ITS architecture related to advanced vehicle safety systems.

Table 16: Service Packages for Advanced Vehicle Safety Systems

Service Package Name	Service Package	Service Package Description
Advanced Vehicle Lateral Control	AVSS09	This service package automates the steering control on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the steering. It requires on-board sensors to measure lane position and lateral deviations and a processor for controlling the vehicle steering.
Advanced Vehicle Longitudinal Control	AVSS08	This service package automates the speed and headway control functions on board the vehicle. It utilizes safety sensors and collision sensors combined with vehicle dynamics processing to control the throttle and brakes. It requires on-board sensors to measure longitudinal gaps and a processor for controlling the vehicle speed.
Automated Vehicle Operations	AVSS11	This service package enables “hands-off” operation of the vehicle on automated portions of the highway system. Implementation requires lateral lane holding, vehicle speed and steering control. Communications between vehicles and between the vehicles and supporting infrastructure equipment supports cooperative check-in to the automated portion of the system and transition to automated mode, coordination of maneuvers between vehicles in automated mode, and checkout from the automated system as the driver resumes control of the vehicle.
Cooperative Vehicle Safety Systems	AVSS12	This service package enhances the on-board longitudinal and lateral warning stand-alone systems by exchanging messages with other surrounding vehicles and roadside equipment. Vehicles send out information concerning their location, speed, and direction to surrounding vehicles. The roadside equipment provides information about potential safety hazards in the vehicle path such as stalled (unequipped) vehicles, wrong-way drivers, debris, or water hazards. The on-board systems can then process this information and present warnings to the driver including headway warnings, merge warnings, unsafe passing warnings, and warnings about hazards detected in the vehicle path. Special messages from approaching emergency vehicles may also be received and processed.
Driver Safety Monitoring	AVSS02	This service package will determine the driver’s condition, and warn the driver of potential dangers. On-board sensors will determine the driver’s condition, performance, on-board safety data, and display information.
Driver Visibility Improvement	AVSS07	This service package will enhance driver visibility using an enhanced vision system. On-board display hardware is needed

Service Package Name	Service Package	Service Package Description
Intersection Collision Avoidance	AVSS10	This service package will determine the probability of an intersection collision and provide timely warnings to approaching vehicles so that avoidance actions can be taken. This service package builds on the Intersection Safety Warning field and in-vehicle equipment and adds equipment in the vehicle that can take control of the vehicle to avoid intersection violations and potential collisions. The same sensors and communications equipment in the roadway infrastructure are used to assess vehicle locations and speeds near an intersection. This information is determined and communicated to the approaching vehicle using a short range communications system. The vehicle uses this information to develop control actions which alter the vehicle's speed and steering control and potentially activate its pre-crash safety system.
Intersection Safety Warning	AVSS05	This service package monitors vehicles approaching an intersection and warns drivers when hazardous conditions are detected. The service package detects impending violations (e.g., red-light violations) and potential conflicts between vehicles occupying or approaching the intersection (e.g., situations where a left turn would be unsafe because of approaching traffic). When a potentially hazardous condition is detected, a warning is communicated to the involved vehicles using short range communications and/or signs/signals in the intersection.
Lateral Safety Warning	AVSS04	This service package allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.
Longitudinal Safety Warning	AVSS03	This service package allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.
Pre-Crash Restraint Deployment	AVSS06	This service package provides in-vehicle sensors and on-board communications to monitor the vehicle's local environment, determine collision probability and deploy a pre-crash safety system. It will include on-board sensors to measure lateral and longitudinal gaps and together with weather and roadway conditions will determine lateral and longitudinal collision probability. It will exchange messages with other equipped vehicles to determine the precise location of surrounding vehicles. It will deploy a pre-crash safety system when a crash is imminent.
Vehicle Safety Monitoring	AVSS01	This service package will diagnose critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition, performance, on-board safety data, and display information.

4.19 OTHER EMERGING TECHNOLOGIES

4.19.1 Unmanned Aerial Vehicles

Unmanned aerial vehicles (UAV) or unmanned aircraft systems (UAS), also popularly known as drones, can be used to support ITS operations and infrastructure monitoring. Drones come in two types: fixed wing or rotary-wing. Rotary-wing drones are more versatile because they can hover over a location and provide stable camera coverage and also requires smaller space to land or take off. In the event of a crash or an incident, a CCTV camera near the site can be very useful in assessing severity of crash, lane blockage, traffic conditions and the level of response required. In the absence of such CCTV camera coverage the first responder on site can use a

drone to provide low cost real time imagery which is needed for response. In fact some law enforcement agencies use drones for crash scene photography or incident surveys to reduce the amount of time required before the roadway is returned to normal operations. Furthermore, during disasters or extreme weather, a drone can be used to assess the condition of critical roadways to see if they are passable. Drones can be programmed to fly a planned route, or can be geo-fenced to fly within a certain territory. As the technology improves, there is potential to use drones to monitor the back of queues in congested corridors and provide warning to vehicles upstream. A synthesis report[29] prepared by FHWA showed that unmanned aerial vehicles have applications in highway management. Some of the applications or future applications include the following:

- Washington State Department of Transportation used drones for winter storm management to reduce winter road closure. Drones can carry explosive charges that can be dropped to trigger controlled avalanches.
- Drones can be used to monitor traffic, evaluate and assess traffic patterns, and provide accurate traffic counts (for instance at an intersection). Use of drones to monitor congestion can provide some safety benefits.
- Drones can be used for inspection of bridges, and also collect condition and inventory data for roadside infrastructure
- Drones can be used to track a target and can provide real-time visual surveillance of moving targets.
- Drones can be used for weather observation for road weather information systems
- Drones can be leveraged in connected vehicle applications

There have been challenges with the use of drones especially on the issue of privacy. Furthermore, there are some risks associated with collisions between drones and infrastructure or vehicles which could be the result of mechanical failure, poor operator skills, weather, terrain or lack of fuel. These risks need to be mitigated for the safe operation of drones. Drones are subject to regulation by the Federal Aviation Administration (FAA) to ensure safety of flight, people and property on the ground. FAA's proposed rulemaking[30] defines "permissible hours of flight, the line-of- sight observation, altitude, operator certification, optional use of visual observers, aircraft registration and marking, and operational limits." This may inhibit the use of drones for ITS operations however there are still opportunities to use drones to leverage some benefits and extend the coverage area or functions for ITS operations.

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[29] http://www.fhwa.dot.gov/advancedresearch/pubs/14037/14037.pdf (accessed 4/6/2016)

[30] https://www.faa.gov/uas/regulations_policies/media/UAS_Fact_Sheet_Final.pdf (accessed 5/3/2016)

4.20 STAKEHOLDERS

Further details are defined in the Turbo Architecture tool and **Table 17** gives a summary of each agency's description.

Table 17: Statewide ITS Stakeholders

Stakeholder Name	Stakeholder Description
Airports	This represents the various airports in the state which are multimodal facilities. There are several airports that serve domestic as well as international flights. New Orleans airport is the only international airport in the state.
Archived Data Users	Represents users of archived data.
Communications Providers	This stakeholder group refers to all telecommunications providers including both fiber and wireless networks.
CVO	Commercial vehicle operators represents trucking companies in the state that move freight throughout the state.
Department of Public Safety	The Department of Public Safety (DPS) provides safety services to both the citizens of the state and visitors to the state of Louisiana by upholding and enforcing the laws, administering regulatory programs, managing records, educating the public and managing emergencies, both directly and through interaction with other agencies.
DEQ	The Department's mission is to provide service to the people of Louisiana through comprehensive environmental protection in order to promote and protect health, safety and welfare while considering sound policies regarding employment and economic development.
DOTD Contractor	
Emergency Medical Services	This includes local hospitals and emergency medical service providers (i.e., ambulance, air-evacuation, etc) that are components of emergency management.
Financial Institutions	These are financial institutions that support electronic payment.
GNOEC	The Greater New Orleans Expressway Commission, also known as the Causeway Commission, operates a 26-mile bridge across lake Pontchartrain. The Causeway commission functions independently of other regional traffic agency operations. The bridge has some ITS devices deployed.
GOHSEP	Governors Office for Homeland Security and Emergency Preparedness (GOHSEP) is responsible for public safety and security from emergencies and disasters. GOHSEP coordinates State Disaster Declarations authorized by the Governor. The disasters include but are not limited to terrorism, hazardous materials, flooding and hurricanes.

Stakeholder Name	Stakeholder Description
LADOTD	Louisiana Department of Transportation and Development (LADOTD) is an arm of the Louisiana government responsible for state-wide transportation. The LADOTD responsibilities include statewide transportation system operations. This stakeholder group includes all Department of Transportation and Development (DOTD) units (ITS, Office of Planning Programming, Highway Safety, Weights and Standards, Traffic Services, and Traffic Engineering) involved in transportation planning, operations, and maintenance. Some of the typical responsibilities include incident detection and response, evacuation planning and management, transportation data collection, management, and distribution for the local region as well as for the entire state.
LADOTD/GNOEC	This stakeholder group manage tolling facilities (LA 1 and Causeway)
Local DPW	Represents the local public works departments responsible for the maintenance of roadways and ITS field equipment.
Louisiana Department of Motor Vehicle	Department of Motor Vehicles is the agency responsible for motor vehicle licensing and registration.
Louisiana Motor Transport Association	LMTA represents the motor carrier operations industry in Louisiana. It includes both regulated and exempt, intrastate and interstate motor carrier operations
Louisiana State Police	Louisiana State Police (LSP) agency is responsible for operating Louisiana State Police Centers. This includes Computer Aided Dispatch database, which collects incident/emergency detection, dispatch, response, and status information related to the Louisiana State Police officers/equipment. They are also responsible for Louisiana State Police vehicles. LSP has nine (9) Troop Districts and has specialized training in emergency operations.
LTRC	The Louisiana Transportation Research Center (LTRC) conducts short-term and long-term research and provides technology assistance, engineering training and continuing education, technology transfer, and problem-solving services to DOTD and others in the transportation community.
Media	This stakeholder group includes local TV/Radio Channels and print media that are responsible for receiving and distributing transportation information like traffic conditions, incidents and road weather conditions.
MPO Group	This refers to all the metropolitan planning organizations (MPO) existing in the State of Louisiana. An MPO is federally mandated and federally funded transportation policy making organizations that are made up of representatives from local government and government transportation authorities. MPOs coordinate with LADOTD for regional ITS deployments.
NOAA - National Oceanic and Atmospheric Administration	National Oceanic and Atmospheric Administration. Includes the National Weather Service and the National Hurricane Center.
Planning Organizations	This refers to planning organizations that fall outside of the established MPOs in the State of Louisiana. This stakeholder group represents all planning organizations within parishes and towns that fall outside the MPOs.
Ports	This Stakeholder represents the Ports which are transfer points or multimodal facilities

Stakeholder Name	Stakeholder Description
Public	Members of the general public own and operate various devices/systems to access ITS information, including PDAs, cell phones, and personal computers.
Public Transit Providers	The Public Transit Providers includes all modes of transit (bus, rail, ferry, etc) responsible for establishing, financing, and sustaining effective public transit service in both urban and rural areas.
Regional Event Promoters	This refers to private entities that promote concerts, sporting events and other activities that significantly impact highway travel in the state.
Tourism and Traveler Information Service Providers	This includes various tourism agencies, chambers of commerce, hotel associations, motorist services, and map search.

4.20.1 Stakeholder Roles and Responsibilities

The roles and responsibilities of each stakeholder to meet the intended goals of the Statewide ITS Architecture are included in **Table 18**.

Table 18: Stakeholder Roles and Responsibilities

RR Area Name	RR Area Description	Stakeholder	RR Description
Archived Data Systems	The archived data system will be a repository of transportation data that will support LADOTD business operations: design, maintenance, operations, planning, safety, finance, environmental analysis, etc. The archive data system shall enable collection, distribution, analysis, reporting and maintenance of data. The system shall be capable of reporting data in the format that supports various business operations. The archive data management system shall also support data sharing and requests from other stakeholders such as MPOs, research organizations, and other authorized agencies.	CVO	provide freight and commercial vehicle operations data
		Department of Public Safety	provide highway safety data
		DEQ	emissions data
			environmental data
		LADOTD	provide data for HPMS requirements
			traffic monitoring data
			ITS operations data
			data storage and management
		Louisiana	emissions data

RR Area Name	RR Area Description	Stakeholder	RR Description
		Department of Motor Vehicle	vehicle registration data
		LTRC	data management
			data analysis
		MPO Group	data analysis
			provide transportation trend data
		Planning Organizations	transportation trend data
			data analysis
Arterial Management	Arterial management refers to the development and implementation of operational strategies for signal systems in a corridor to be responsive to traffic demand so delays are reduced and safety is enhanced. Where corridor traverses different agency jurisdiction, those agencies need to collaborate to ensure signals are coordinated and operate efficiently	Department of Public Safety	incident management coordination
		Emergency Medical Services	incident response
		LADOTD	traffic control
			incident management
			traffic surveillance
		Louisiana State Police	incident management
			traffic control
		Media	arterial status information
Commercial Vehicle Operations	This refers to the development of ITS systems to enhance commercial vehicle operations in Louisiana. Examples are electronic credentialing and weigh-in-motion systems.	Airports	multimodal coordination
		CVO	commercial vehicle fleet management
			commercial vehicle credentialing
		LADOTD	Alternate routing for commercial vehicles

RR Area Name	RR Area Description	Stakeholder	RR Description
			Travel time reliability for CVO
		Louisiana Department of Motor Vehicle	compliance with federal requirements
		Louisiana Department of Motor Vehicle	compliance with state registration requirements
			Commercial vehicle operation statistics
			Driver credentialing
		Louisiana State Police	electronic screening
			safety information exchange
			electronic credentialing
		Ports	multimodal coordination
Emergency Management	This refers to the development and implementation of systems to provide emergency services such as emergency call taking, dispatching, and emergency operations center.	Department of Public Safety	incident response
			infrastructure security
			event monitoring
			implement ramp closure for contra-flow
			traffic management
		Emergency Medical Services	emergency services
		GOHSEP	event monitoring
		GOHSEP	incident response
		GOHSEP	emergency management
		LADOTD	incident management

RR Area Name	RR Area Description	Stakeholder	RR Description
		LADOTD	surface streets management
		LADOTD	freeway management
		Media	broadcast traveler information
		Media	broadcast public safety information
		Public	end user of emergency information
Freeway Management	Freeway management refers to the development and implementation of ITS for freeway surveillance, incident detection and response, driver advisory systems, lane control and other operational strategies to improve flow of traffic on freeway.	Department of Public Safety	speed enforcement
		Emergency Medical Services	incident management
		LADOTD	network surveillance
		LADOTD	incident management
		LADOTD	traveler information
		Media	broadcast traveler information
		Tourism and Traveler Information Service Providers	traveler information services
Incident Management	Incident management refers to development and implementation of systems for rapid incident detection, verification and clearance. This also involves agency coordination such as public safety and emergency services to ensure incidents are effectively handled in a short period of time.	Department of Public Safety	incident clearance and recovery
		Department of Public Safety	traffic control
		Department of Public Safety	incident command

RR Area Name	RR Area Description	Stakeholder	RR Description
		Emergency Medical Services	incident management
		LADOTD	freeway management
		LADOTD	traveler information
		LADOTD	incident management
		Media	broadcast traveler information
		Media	broadcast incident information
Maintenance and Construction	This refers to the implementation of systems to manage the roadway infrastructure and coordinate maintenance activities to ensure minimal disruption of normal traffic flow. It includes managing active work zones to ensure safety for both workers and motorists.	Department of Public Safety	speed enforcement
		Department of Public Safety	traffic control
		LADOTD	freeway management
		LADOTD	maintenance operation
		LADOTD	traveler information
		Media	traveler information
		Tourism and Traveler Information Service Providers	traveler information
Transit Services	Transit management is focused on enhancing transit user experience by deploying technologies that the transit rider can use to access transit rider information, request services, perform electronic transactions and reservations. For the transit provider these technologies include computer aided dispatch, real -time transit vehicle tracking for expected arrival times and schedule adherence, electronic fare collection etc. There are other ITS technologies that can be implemented to support transit such as transit signal preemption.	LADOTD	support transit and paratransit services and management
		Media	disseminate public transit information
		MPO Group	support transit and paratransit management

RR Area Name	RR Area Description	Stakeholder	RR Description
			plan and develop transit and paratransit services
		Planning Organizations	support transit and paratransit services
			plan and develop transit and paratransit services
		Public	end user of transit services
		Public Transit Providers	coordinate transit services with other regional transit providers
			coordinate with other stakeholders for evacuation and reentry planning
			provide and operate transit services (transit terminals, transit stops, AVL, and transit security)
			provide electronic fare payment systems
			provide paratransit services
			provide transit traveler information
		Regional Event Promoters	coordinate transit services for events
			transit information dissemination
		Tourism and Traveler Information Service Providers	disseminate transit information to public
Traveler Information	Development and operation of systems for rapid dissemination of traffic information to roadway users. The systems may include roadside advisories, message boards, smartphone apps	LADOTD	freeway status information
		LADOTD	arterial status information

RR Area Name	RR Area Description	Stakeholder	RR Description
	or webpages with real-time traffic information.	Media	freeway information dissemination
		Media	arterial information dissemination
		Public	arterial information end user
		Public	freeway information end user
		Tourism and Traveler Information Service Providers	freeway information
		Tourism and Traveler Information Service Providers	arterial information

5 FUNCTIONAL REQUIREMENTS

The functional requirements describe the task or activities that must be performed by each system in the Statewide ITS architecture to achieve the required services. The service packages in the national ITS architecture define several specific functional requirements or operational details to implement the ITS services under the Concept of Operations. These functional requirements do not specify technology. The functional requirements described here reflect those of the national ITS architecture but tailored to the needs of Louisiana Statewide ITS architecture. **Table 19** gives a summary of the functional requirements. (Only a few elements have been displayed. For complete table of functional requirements please see Turbo Architecture file).

Table 19: Functional Requirements

Element Name	Entity Name	Functional Area	Functional Area Description	Requirement
CCTV	Roadway	Roadway Basic Surveillance	Field elements that monitor traffic conditions using loop detectors and CCTV cameras.	The field element shall collect, process, and send traffic images to the center for further analysis and distribution.
				The field element shall return sensor and CCTV system operational status to the controlling center.
				The field element shall return sensor and CCTV system fault data to the controlling center for repair.
			Field elements that monitor traffic conditions to identify incidents. It includes traffic detectors that collect traffic flow information and identify unusual traffic conditions and advanced CCTV cameras with built-in incident detection algorithms.	The field element shall collect, process, and send traffic images to the center for further analysis and distribution.
				The field element shall remotely process video data and provide an indication of potential incidents to the traffic management center.
				The field element's video devices shall be remotely controlled by a traffic management center.

Element Name	Entity Name	Functional Area	Functional Area Description	Requirement
				The field element shall provide operational status and fault data for the incident detection devices to the traffic management center.
Commercial Vehicles	Vehicle	Vehicle Toll/Parking Interface	On-board systems to support paying toll without stopping and pay for parking without the use of cash through the use of an active tag interface and debit/credit card interface.	The vehicle shall respond to requests from toll collection equipment for credit identity, stored value card cash, etc.
				The vehicle shall provide an interface with the traveler card / payment instrument carried on-board the vehicle - to exchange identity information and payment transactions.

6 ITS INVENTORY

An inventory of existing and planned intelligent transportation systems is the basis for the Statewide ITS Architecture. The transportation system inventory was developed based on input from stakeholders throughout the region. The inventory includes a list of ITS elements and the associated stakeholder responsible for system operation.

Table 20 describes the inventory of elements for the Statewide ITS architecture. A transportation element can be a center, vehicle, traveler or field equipment. Each transportation element listed below has one or more stakeholders associated (see **Section 4.20** for list of stakeholders). In order to reduce the complexity of the architecture, some transportation elements with like functionality have been grouped together. Each transportation inventory element is mapped to at least one National ITS Architecture entity.

Table 20: ITS Inventory

Element Name	Element Description	Stakeholder	Element Status
Airports	Louisiana has several airports for public use with a major international airport in New Orleans.	Airports	Existing
Commercial Vehicles	This represents motor carriers equipped with on-board communications to communicate with infrastructure on or near the roadway. Such infrastructure may include CVISN and PRISM.	CVO	Existing
CVO Inspection Stations	This represents commercial vehicle inspection stations operated within the state to check credentials of commercial vehicle operations and axle weight enforcement.	LADOTD	Existing
DEQ	DEQ is responsible for environmental conservation and has the mandate to protect and enhance environment and natural resources	DEQ	Existing
Emergency 911 Centers	This element represents the emergency response operations including fire, police, 911, and any other emergency response operators. This element is responsible for the emergency response operations and management within its jurisdiction	Department of Public Safety	Existing
Emergency Services Functions	There are 16 ESF entities that can be activated during an emergency to use their resources for emergency operations.	GOHSEP	Existing
Event Promoter	Event promoters plan and manage various activities for cultural, entertainment and sports purposes.	Regional Event Promoters	Existing

Element Name	Element Description	Stakeholder	Element Status
GNOEC/LADOTD	Responsible for financial transactions for fare/toll payment	GNOEC/LADOTD	Existing
GOHSEP	GOHSEP represents the Governor's Office for Homeland Security and Emergency Preparedness and is responsible for emergency response to major disaster in Louisiana.	GOHSEP	Existing
HAZMAT Mobile Response	HAZMAT Mobile response includes dispatch and vehicles operated and maintained by regional public safety agencies or private entities to respond to HAZMAT occurrences.	Department of Public Safety	Existing
LADOTD Detectors	Detectors will provide speed monitoring, traffic counts, vehicle classification, presence detection, headway measurements and WIM data where applicable. Detector data can be used to give travel time information.	LADOTD	Existing
LADOTD District Traffic Operations	This element represents traffic operations or traffic engineering within the district office that is responsible for traffic management activities within its jurisdiction. The typical activities include traffic monitoring, traffic data collection, traffic signal operations, and other traffic management related activities. This also includes communicating with Traffic Management Center (TMCs) and other departments like maintenance for roadway maintenance activities.	LADOTD	Existing
LADOTD Flood Warning Systems	The flood warning system consists of water level monitoring equipment on roads at locations that are susceptible to flooding including underpasses, tunnels and low lying roadways.	LADOTD	Existing
LADOTD ITS Field Equipment	This element includes the equipment distributed on and along the roadway that monitors and controls traffic and monitors and manages the roadway itself. Equipment includes traffic signals, traffic detectors, environmental sensors, highway advisory radios, dynamic message signs, CCTV cameras and video image processing systems, and grade crossing warning systems.	LADOTD	Existing
LADOTD ITS Section	This element represents ITS Section (Section 56) under the LADOTD. The ITS section is responsible for Statewide operations center located in DOTD headquarters. Also, the ITS section is responsible for management information system for transportation, Statewide ITS elements operations, and maintenance. The ITS section is also responsible for maintenance of all ITS equipment in the state.	LADOTD	Existing
LADOTD Social Media	Facebook and Twitter	LADOTD	Existing
Local DPW	This refers to the local public works departments responsible for the maintenance of roadways and field equipment	Local DPW	Existing
Local Emergency Services	This represents emergency medical service (EMS) including dispatch, ambulances, communications and computer aided dispatch (CAD) system.	Emergency Medical Services	Existing

Element Name	Element Description	Stakeholder	Element Status
Local Planning Organizations	This refers to all the planning organizations existing outside of the established metropolitan planning organizations in the State of Louisiana.	Planning Organizations	Existing
Local Public Safety Agencies	Local Public Safety Agencies represents the local public safety providers. This includes local law enforcement providers, fire services and emergency responders and 911 call centers.	Department of Public Safety	Existing
Louisiana 511 Website	This element provides traveler information service provided by the LADOTD in conjunction with private partner.	LADOTD	Existing
LSP	Louisiana State Police (LSP) agency is responsible for operating Louisiana State Police Centers. This includes Computer Aided Dispatch database, which collects incident/emergency detection, dispatch, response, and status information related to the Louisiana State Police officers/equipment. They are also responsible for Louisiana State Police vehicles. LSP has nine (9) Troop Districts and has specialized training in emergency operations.	Louisiana State Police	Existing
Media	This stakeholder group includes local TV/Radio Channels and print media that are responsible for receiving and distributing transportation information like traffic conditions, incidents and road weather conditions.	Media	Existing
Personal Devices	Primarily PDA, pagers, etc.	Public	Existing
Ports	This element refers to various ports in the state including inland ports along the Mississippi River.	Ports	Existing
Public	Members of the general public own and operate various devices/systems to access ITS information, including PDAs, cell phones, and personal computers.	Public	Existing
Public Transit Services	This refers to all transit agencies including paratransit service in urbanized and rural areas.	Public Transit Providers	Existing
TMC	This element represents the traffic management center that is responsible for traffic management activities. The typical activities include traffic monitoring, traffic data collection, operation of ITS elements (CCTV, DMS, etc.), detection and verification of incidents, traffic signal monitoring, and other traffic management related activities. This also includes communicating with other agencies, districts, and DOTD departments such as maintenance for roadway incident management and maintenance activities.	LADOTD	Existing
Toll Plaza	Toll Plaza offices, which operate and monitor the toll plazas	GNOEC/LADOTD	Existing
Tourism and Travel Service Information Sources	Private Tourism and Traveler Information Websites, local hotel associations, visitor centers, etc.	Tourism and Traveler Information Service Providers	Existing

Element Name	Element Description	Stakeholder	Element Status
Traffic Signal Systems	Field communications, field controllers, field masters, and vehicle detection on state highways (non-freeway) that are operated and maintained by the LADOTD.	LADOTD	Existing
Transportation Database	This is a data repository that collects highway operational data.	LADOTD	Planned
Work Zone ITS	This refers to ITS equipment deployed to manage work zones such as work zone intrusion alarm, portable CCTV and DMS.	LADOTD DPWs Contractor	Planned

6.1 EXISTING ITS SYSTEMS

The areas with existing regional ITS architectures and devices deployed are summarized in **Table 21**. The regional ITS architectures typically fall within the metropolitan planning organization (MPO) boundary. The Statewide ITS architecture targets the major routes that serve as bridges between regional architecture in order to provide seamless advance transportation management along critical corridors in the State.

Table 21: Regional ITS Devices Deployed

Region	CCTV	DMS	VD	Ramp Meters
Baton Rouge	137	20	>33	I-12
Shreveport	42	20	>64	None
Lake Charles	4	3	5	None
Lafayette	>50	7	15	None
Houma	15	2		None
New Orleans/Hammond/North	103	23	>6	I-10

6.1.1 Traveler Information

Louisiana DOTD has a 511-traveler information system that provides drivers with information about the surface transportation network to empower users to make smart travel decisions. The 511-traveler information system is available via telephone or the internet (www.511LA.org). LADOTD has also launched a smartphone app called “Way to Geaux” which allows travelers to specify a region where traffic reports are desired. The app automatically sends drivers real-time traffic updates in “hands-free, eyes-free” mode with audible traffic messages. LADOTD also uses social media to update travelers of road conditions. There are Facebook and Twitter accounts that are used to disseminate information about incidents on the roadway.

Figure 11: Smartphone App

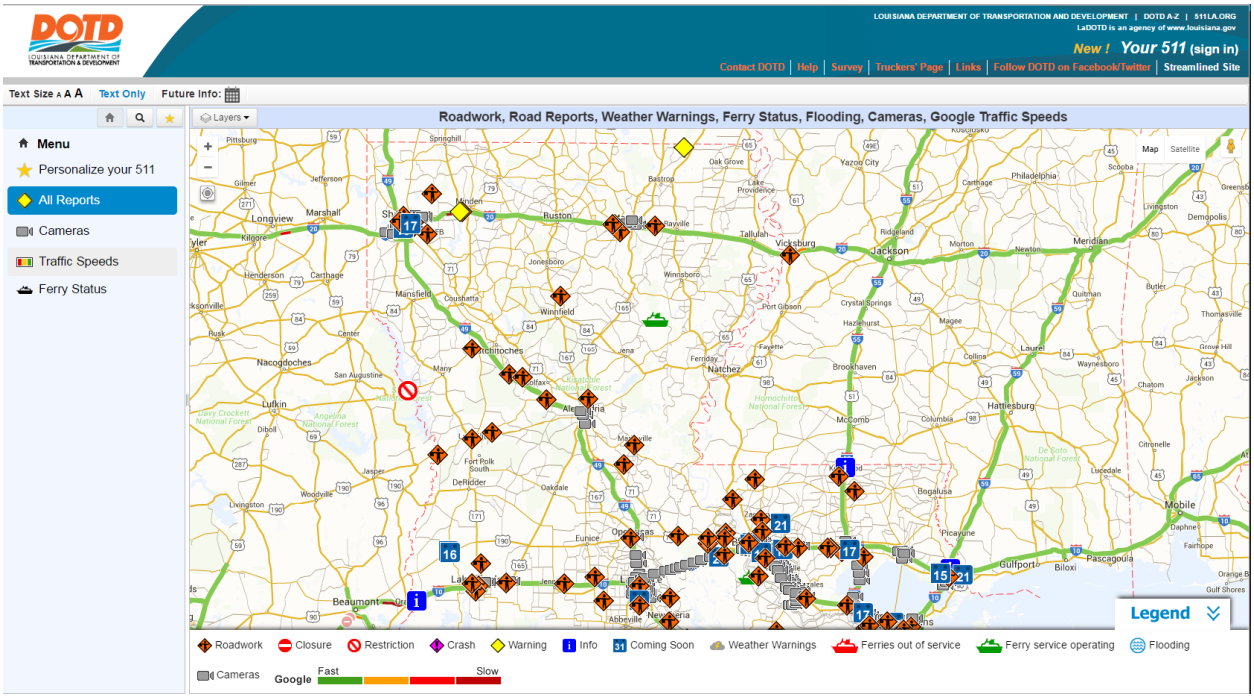

Figure 12: LADOTD 511 Webpage

6.1.2 Roadside Advisory

Dynamic message signs (DMS) are still an integral part of the driver information system used in Louisiana. There are permanent DMS locations and portable DMS which can be deployed as needed. These DMS are used to provide real-time traffic advisories and route guidance information to road users. In the event of emergencies they are used to provide critical information for evacuation or Amber Alerts.

Another roadside advisory system is the highway advisory radio (HAR). These are typically AM radio broadcast systems used to broadcast incidents or emergencies as needed. Traveler information that can be relayed using the HAR system include traffic congestion, traffic detours and road weather condition. Static signs with beacons are used to advise travelers to tune in to particular frequency for traffic information when beacons are activated.

Figure 13: DMS on Urban Arterial (US 61)

6.1.3 Electronic Fare Collection

There are currently a few toll roads in the State of Louisiana. The toll facilities include the Lake Pontchartrain Causeway and LA 1 in Leeville, Louisiana. These toll facilities support electronic and manual payment of tolls. Tolling is used to generate revenue to maintain or develop new transportation infrastructure. Toll plazas have traditionally been choke points because vehicles have to come to a stop to pay tolls and continue. Apart from the congestion that this created during peak demand period, the stopping and acceleration increased emissions into the environment.

Figure 14: Electronic and Manual Tolling on LA 1

6.1.4 Vehicle Detection

The vehicle detection systems consist of several different technologies of vehicle detectors on the roadways including microwave radars, Bluetooth, and video detection systems. There are also private sources of detection data for example INRIX and Traffic.com. DOTD has access to probe data to obtain travel-times through INRIX which provides speed maps to the TMCs without a fee. Traffic.com provides traffic count data as part of a public-private partnership by allowing DOTD to access their data server.

Although conscientious efforts were made by the DOTD and the regional stakeholders to strategically deploy the appropriate types of detectors for different applications based on technologies available and the planned ATMS, DOTD currently faces challenges to keep all the VDs operational due to growing quantity and the uncertainty in purpose of all the locations. **Section 6.3** provides a detailed analysis of detection needs under the Louisiana Statewide ITS Architecture Plan.

Figure 15: Vehicle Detection Systems Mounted on Lamp Post

6.1.5 Commercial Vehicle Operations

The state currently has weigh-in-motion (WIM) systems and the PrePass automated vehicle identification (AVI) system to improve and expedite operations of both private and commercial vehicles on highways in Louisiana. WIM systems prescreen axle loads at highway speed and flag trucks with axle loads beyond a threshold to enter the roadside weigh station for more precise axle load compliance checks with static scales. The WIM system helps to improve efficiency (time and cost) of commercial vehicle operations by targeting only those vehicles that may not be in compliance. Trucks within legal and permitted limits continue moving without stopping thereby improving time and cost of trucking. The WIM system also adds a layer of safety since overloaded vehicles that pose a hazard to all road users can be targeted for enforcement. There are currently 6 WIM stations at the following locations:

1. I-20 at Delta
2. Greenwood on I-20 at the Texas Stateline
3. I-10 at Toomey

4. I-10 at Breaux Bridge
5. I-10 at Laplace
6. I-12 at Baptist near Hammond

Figure 16: Weigh Station on I-12

6.1.6 Archived Data Management

Currently there is no unified transportation data archive system. Different stakeholders within the State collect data as needed for business functions. Therefore there exists a wide array of data that is distributed among different agencies and it is not readily known who has what and the accuracy of the data. This has led to repetition in data collection which wastes money and slows down project delivery. A centralized transportation data management system will facilitate data sharing and eliminate repetitive data collection. DOTD has made some effort to implement a data warehouse and management system for the ADT count program. A pilot program is currently under way to include data from other DOTD departments such as Traffic Engineering and ITS for archiving. The system as is has the capability to be expanded to include data from other agencies such as MPOs and DPWs. A system-to-system interface is the preferred way to share and archive data. In order for the data to be integrated and archived properly the stakeholders must develop protocols for data collection to ensure data consistency and accuracy of data. (See **APPENDIX E** for meeting minutes on Archive Data Management System)

6.1.7 Communications

DOTD has used different communications options which include fiber optics, microwave, and leased lines to support center-to-center communications. While the preferred option is fiber communication to all devices and centers, a complete build out is cost prohibitive. Microwave wireless and cell modem have enabled communication to locations without fiber optic links. While this approach meets short-term needs for rapid deployment of devices, some of the technologies lack the reliability to support advanced operational strategies. A more robust communication system based on fiber optic networks is a more sustainable and reliable option.

6.1.7.1 Fiber Optic Communication

DOTD fiber optic resources can be categorized into two main components: permitted fiber and ITS build-out fiber. The permitted fiber assets are obtained from resource-sharing agreements with various private entities in exchange for Louisiana's highway right-of-way for the purpose of installing telecommunication trunk line. Other communication assets that could also be obtained from this type of agreements include conduits, bandwidth, maintenance services, and equipment. The permitted fiber optic system consists of a northern and a southern component. The northern fiber system consists of 8 strands of single-mode fiber along I-20 between Shreveport/Bossier City and Monroe. The southern fiber system consists of 8 strands of single-mode fiber from the visitor center 1 mile east of the Texas state line to downtown New Orleans. For detailed route descriptions and historical background information, refer to the Statewide Architecture[31] completed in 2003. Since the last update in 2003, however, 4 strands from each system have been utilized for the Louisiana Optical Network Initiative (LONI) leaving 4 remaining for continued operations of the DOTD ITS fiber optic backbone. Despite the reduction in fiber strands, LONI network is currently providing a 1 Gbps connection for the DOTD Monroe district office and as the LONI network further develops, it will also provide 1 Gbps connections for the Shreveport district office, Alexandria district office, and a 10 Gbps connection for the DOTD HQ in Baton Rouge in the near future. In short, LONI is a Louisiana state project which is run by the Board of Regents and contracted out to LSU. The purpose of the LONI network is to build Statewide fiber optic network to connect research universities in Louisiana as well as Mississippi. This partnership with LONI network have proven critical as it completes the missing link between the northern fiber optic system and the southern fiber optic system for the ITS Statewide backbone. Other developments in the permitted fiber also include the 48 strand single mode fiber installed through the Detel permit from the Texas state line all the way to Hammond following the Qwest route and 48 strand single mode fiber installed from Hammond to downtown New Orleans also following the Qwest route. A permit executed with NEXUS has 1 Gbps bandwidth from Monroe to Bossier utilizing all 4 strands of the existing dark fiber. IDS has fiber optics from New Orleans near the Superdome to Kenner. A conceptual illustration is provided in **Figure 17**.

[31] Louisiana Statewide ITS Implementation and Telecommunications Plan (2003)

Since the last update in 2003, numerous ITS projects have been completed to installed fiber optic resources for ITS field device communications. The major deployments include ITS Design Build Phase 1, Phase 2, and Phase 3. The fiber optic installation from these projects is significant because they provide redundant fiber paths for the backbone fiber in addition to connecting all the field devices included in these projects. For example, 96 strands of single mode fiber were installed in the DB2 project that span from Scott Tower in Lafayette to the Gross Tete Tower in west Baton Rouge. DB3 project also extended fiber optic communications from I-10 @ Siegen Lane in Baton Rouge to I-10 @ US 61 hub site near Sorrento.

Furthermore, LADOTD has signal systems with fiber optic for communications between signal controllers at intersections in the corridor. **APPENDIX B** shows for each District, the locations of intersections with fiber optic communications.

Other communication options include shared communication assets with partner agencies such as leased or permitted fiber lines. These shared assets have the potential to reduce cost, however this has to be balanced with the security afforded by dedicated agency assets and limitations on use by other agencies that LADOTD partners with on other business functions.

6.1.7.2 Microwave Wireless

Since the last update in 2003, there has been no major development in the Microwave wireless communication system for the purpose of long-haul infrastructure communications. Some of the analog microwave connections have been replaced by fiber optics or leased circuits. The rest of the microwave connections that are still in operation are either used for monitoring tower lights which consumes very low bandwidth or providing backup connections for the leased and fiber connections. In the device communication perspective, the microwave radio continues to serve as an alternative communication mechanism for ITS devices that are not in the area where fiber optic resources are available. Microwave wireless radios are used for DMS, CCTV, and majority of the radar vehicle detectors (RVD) currently deployed.

6.1.7.2.1 DOTD Point to Point Licensed Wireless System

DOTD may choose to build out the device communications network with wireless communication system using Point to Point Licensed Microwave Ethernet Radios. This option will require funding for the implementation of the wireless system. Despite added costs in the implementation and maintenance of the wireless microwave system, DOTD will gain from this option the independence in the design and operation of the communication system. Licensed Microwave is less vulnerable to frequency interference in comparison to its unlicensed wireless counterparts because of the restricted access of the frequency band. This option is feasible when existing poles have adequate height to establish line of sight. Licensed wireless provides greater, more reliable bandwidth then unlicensed, but it is potentially subject to fading during severe weather conditions.

6.1.7.2.2 Unlicensed Serial Wireless

DOTD has deployed unlicensed wireless radios and used for DMS, CCTV, and majority of the radar vehicle detectors (RVD) currently deployed. Some of the analog connections have been replaced by fiber optics or leased circuits. The rest of the microwave connections that are still in operation are either used for monitoring tower lights which consumes very low bandwidth or providing backup connections for the leased and fiber connections. Unlicensed wireless is subject to weather as well as interference from other competing radio links because of the lack of regulation (unlicensed).

6.1.7.3 Cellular Wireless

Cellular deployments have grown rapidly for the ITS communication system since the last update in 2003. Due to expansions in the coverage areas of all major cellular carriers as well as increases in bandwidth using technologies such as GSM (Global System for Mobile communication) or CDMA (Code Division Multiple Access), cellular modems have become a popular choice for ITS mobile applications such as portable message signs and portable cameras. Some permanent sites have also been outfitted with cellular modems due to the lack of fiber optic resources and various challenges to implement wireless radios. Currently, the entire fleet of ITS portable message signs utilize cellular modems for communications to the ITS network. Static IP addresses are assigned in each cellular modem for the purpose of identifying and programming the message boards. Cellular communications rely on a 3rd party provider, so the control of the network is reliant on them.

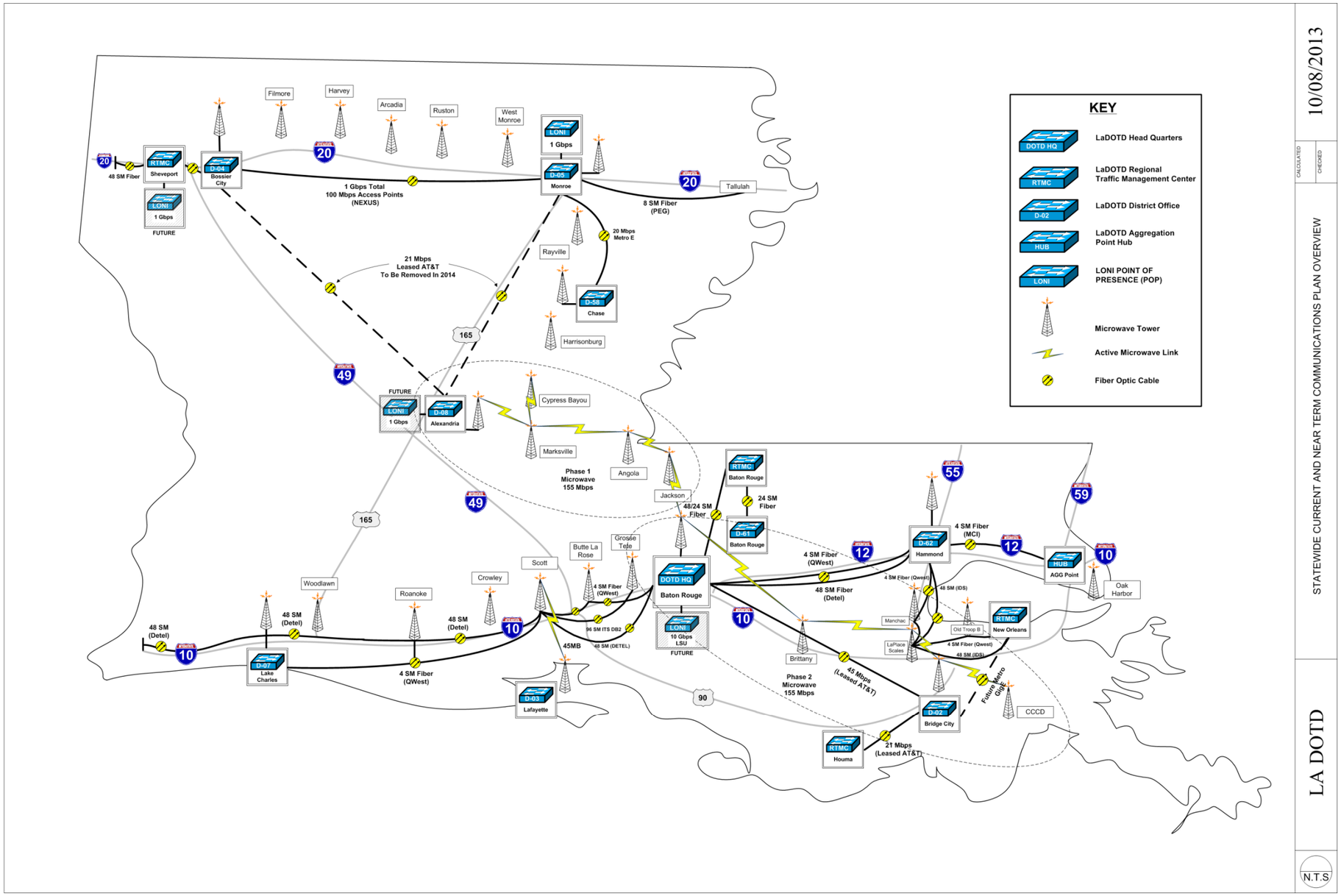

Figure 17: Statewide Communication Diagram

6.1.8 Surface Water Stations

USGS maintains several gauging stations for surface water monitoring in the State of Louisiana. **Figure 18** shows the locations of surface water gauges in the State. Flooding occurs extensively during and after hurricane events and this may block key evacuation routes or require some roads to be closed to traffic to safeguard the public. This situation can potentially trap residents who need to evacuate. The surface water stations provide key data needed to make critical decisions on road closure by LSP.

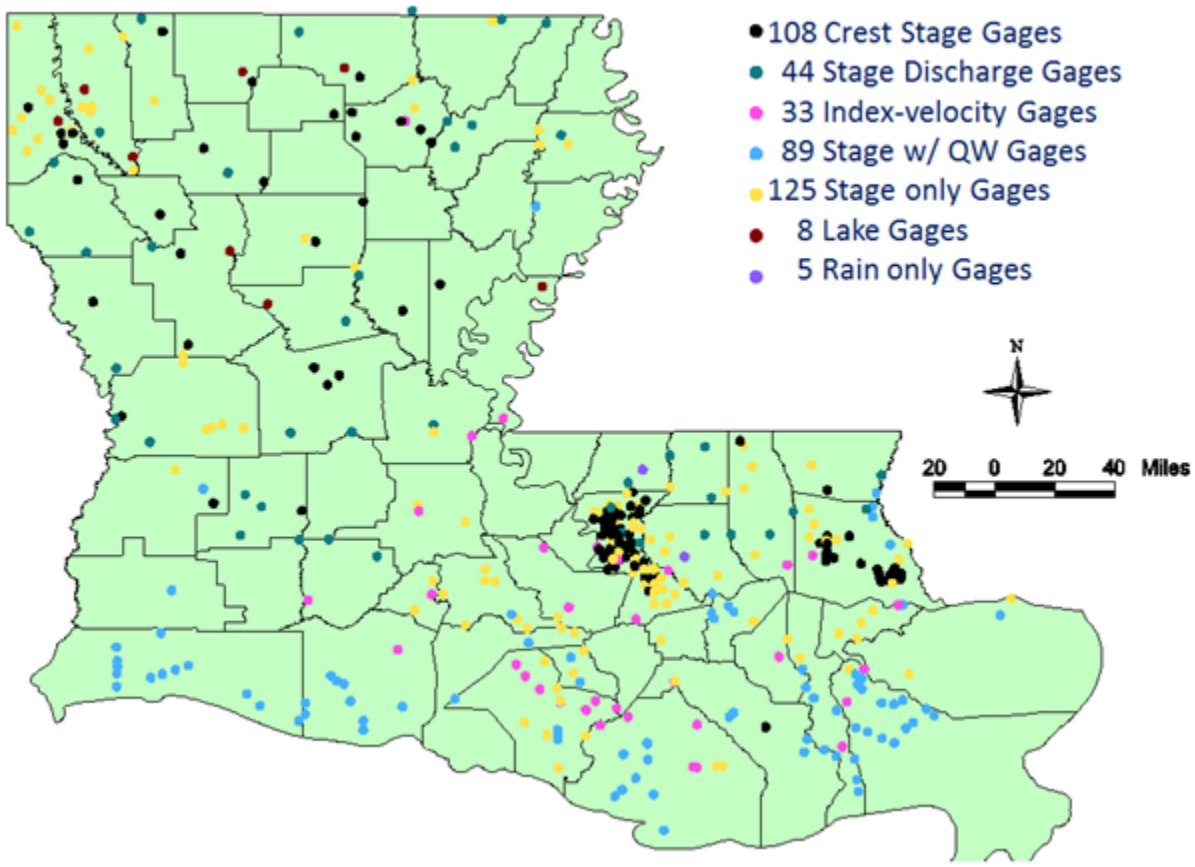

Figure 18: USGS Surface Stations in Louisiana

6.1.9 Traffic Signal System

The traffic signal systems that exist in the state of Louisiana generally lack communication except for a few corridors and therefore cannot support adaptive signal control for efficient movement of traffic in corridors. Strategic corridors which are critical for evacuation or serve as alternate routes when incidents occur on the interstate system can be targeted for upgrades with communication and controller systems that can be remotely controlled. Currently during

evacuation, DOTD sends personnel to manually change signal timing at each controller box. This approach is unsafe and not efficient to support coordinated evacuation.

6.2 ITS NEEDS

6.2.1 Freeway Management

There are segments of freeway corridors in the state that have no devices for direct monitoring of traffic or incident detection and therefore the TMCs have to depend of third party sources such as WAZE, INRIX or Google Maps for traffic information. Some of these corridors have been identified for basic surveillance and communications to enable the TMC detect incidents and manage traffic. During emergency evacuations surveillance is critical to monitor the progress and to identify bottlenecks in the process.

6.2.2 Work Zone ITS

The use of work zone ITS during freeway construction or rehabilitation work is also desired. See **Section 4.13** for a detailed discussion of work zone ITS.

6.2.3 Arterial Management

Many signals on the arterial system lack communication and operate in isolation. These legacy traffic signal systems need to be upgraded with detection and communication in order to support demand responsive operation. There are corridors on some principal arterials which parallel the interstate system and can be used to support demand management or to reroute traffic if an incident limits capacity on the interstate. The signal systems on these corridors need to be upgraded with communications to support real-time operational needs. Furthermore information about arterial condition status such as travel time, congestion, incidents, etc. can be shared with travelers to facilitate smart transportation choices. Arterials are important during emergency evacuation and critical corridors need to be upgraded with communications to the signal system and surveillance to monitor the progress during emergencies.

6.2.4 Incident Management

Incidents are random events and can occur on any part of the road network system. The Statewide incident management program cannot cover the entire network of roads and therefore incidents for most locations will be addressed by the local emergency service. However, there are critical corridors where targeted or augmented incident management will have extensive impact on the roadway system and rapid detection and incident clearance are vital. Locations such as bridges, elevated roadways, high traffic volume segments qualify for implementation of specialized incident management plans. Elevated roadways have limited locations to divert traffic and pose a significant challenge to rerouting traffic in the event of an incident. Travelers are trapped and remain on the elevated segment until the incident is cleared and roadway is passable. Such locations can be targeted for incident management to reduce response and clearance time and thereby enhance safety and throughput. Some bridges do not have shoulders and therefore any stalled vehicle effectively blocks the lane occupied and merging vehicles further reduce capacity of adjacent lanes and also increase crash hazard.

Some bridges over navigable waters are designed with high clearances over the water and such vertical curves may limit sight distance and pose a safety hazard for vehicles by increasing the potential for rear end collisions.

6.2.5 Detection for Emergency Management

In the event of emergencies that require mass evacuation of residents the interstates and major arterials serve as the primary evacuation routes. GOHSEP may activate any of its sixteen emergency support functions whose expertise is required for emergency management. One of the key challenges during this time is communication between various agencies who have to collaborate for evacuation. Furthermore, real-time traffic flow information is required to monitor the progress of evacuation and to detect promptly any incidents that reduce capacity and slow down evacuation. Ample detectors deployed along key evacuation routes will provide critical information for evacuation. One observation made by DOTD is that detectors existing in lanes used for contra-flow are not useful since they are not configured to measure flow in opposing direction. This needs to be addressed to ensure reliable information is obtained from all detectors.

6.2.6 Video Distribution

LADOTD currently has a video distribution management system (VDMS) designed to provide secure priority access to CCTV camera imagery to key partners such as police, fire, emergency management and homeland security. The VDMS is internet based and only requires a computer and internet for access to video data. The service provides a map interface to select cameras for view. The VDMS also provides streaming video to the LADOTD 511 system and media outlets.

A cooperative endeavor agreement between LADOTD and media outlets exists to provide access to the LADOTD CCTV camera network. This grants media outlets access to all multi-cast video at a point of presence (POP) which is typically located within LADOTD facility where there is access to LADOTD network such as a TMC location. The media outlet is responsible for all equipment, software and communication required to transport streaming video to their studios for broadcasting. LADOTD is responsible for configuration guidance, maintaining network connections between LADOTD owned network equipment and that provided by the media outlet, and a list of all IP addresses of the multi-cast traffic cameras accessible at the POP. The media outlet is responsible for maintaining and troubleshooting its equipment and the network services between the studio and POP and all other requirements downstream of the POP.

6.2.7 Public Transportation

Public transportation plays a crucial role by providing mobility and making jobs, critical services and other places accessible. The mission[32] of LADOTD with regard to public transportation is "improve public transit in all areas of the State so that Louisiana's citizens may enjoy an adequate level of personal mobility regardless of geographical location, physical limitation or economic status." The urbanized areas have public transit systems that operate fixed route and paratransit routes to serve the needs of the community. These transit operators receive funding from Federal Transit Administration (FTA).

LA Swift was set up as an emergency intercity transit bus after hurricane Katrina. It provided service from Baton Rouge to New Orleans with stops at Gonzales, Sorrento, LaPlace and Kenner. LA Swift service was suspended in July 2013 due to funding. When it was set up as an emergency transit system it received 100% funding from FTA however now that it cannot be classified as providing service during an "emergency" the funding level has been reduced to 50% and requires LADOTD to provide a match. The Lack of funds has resulted in the service being suspended.

There is currently no intercity transit service provided in the state. There are however paratransit services available for rural areas where the State provides funds to support transit projects.

6.2.8 Active Traffic Management

The goal of active traffic management is to anticipate future traffic conditions and to implement traffic control strategies to mitigate any foreseen undesirable conditions. This involves active management of capacity by using travel demand management strategies. Active traffic management requires the use of predictive algorithms to forecast traffic conditions or incident clearance times. The benefits of active traffic management include the following[33]:

1. Decrease primary incidents by alerting drivers to congested conditions and promoting more uniform speeds

2. Decrease secondary incidents by alerting drivers to the presence of queues or incidents downstream

3. Increase throughput by reducing the delay associated with incidents, reducing speed differentials in traffic flow, and reducing shockwave effects.

4. Improvement in speed uniformity during congested periods in order to reduce crashes

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[32] http://www.dotd.la.gov/Intermodal/transit/

[33] Active Transportation and Demand Management. U.S. Department of Transportation Federal Highway Administration

5. Increase trip reliability by increasing capacity, reducing delays associated with incidents.

LADOTD desires the implementation of dynamic lane use control signals on bridges to facilitate management of traffic over bridge crossings especially in the event of incidents or stalled vehicles.

6.2.9 ITS Maintenance

DOTDs existing ITS network includes an extensive fiber optic backbone and wireless communications network (See **Figure 17** for the Statewide communication diagram), CCTV cameras, DMS and vehicle detectors. The inventory keeps expanding as more ITS devices are deployed in new regions and existing coverage is broadened. DOTD ITS Section is responsible for oversight and maintenance of ITS infrastructure deployed throughout the state. The current maintenance plan uses a combination of preventive and responsive maintenance. Routine or preventive maintenance is carried out on regularly scheduled intervals. Responsive maintenance refers to scenarios where a failure is reported and equipment is either fixed or replaced. Responsive maintenance can be escalated to emergency maintenance when a critical component fails and must be repaired or replaced immediately. Critical locations requiring traveler information, highly congested corridors or declared emergencies are one of several criteria to warrant emergency repair. Both private contractors and DOTD staff are engaged to maintain ITS systems located in the various Districts.

6.2.10 Network and Infrastructure Security

LADOTD desires enhanced security for its communications network and certain critical infrastructure within the State. The extensive network of the LADOTD backbone fiber poses a challenge to secure the network from unauthorized intrusion. A reliable, resilient and secure communications infrastructure will ensure information flow and information integrity between systems and agencies especially during critical period of emergencies.

LADOTD also desires protection for some physical assets such as bridges over the Mississippi River. LADOTD desires CCTV cameras to be deployed on all bridges across the Mississippi River to enable remote surveillance of the bridges. CCTV camera coverage of critical infrastructure will enable streaming of video images in real-time to law enforcement agencies for rapid identification and response to any breach in security.

6.2.11 Bridge Monitoring

Fiber optic communication on bridges will facilitate deployment of bridge sensors such as strain gauges and accelerometers for infrastructure health monitoring. This may also facilitate deployment of other devices such as CCTV cameras for surveillance and detection of unauthorized activities.

6.2.12 Vehicle Detection

The MPO require detection data for speed, classification and volume collected in 15-minute intervals, 24 hours a day, 365 days in a year. While ideally this information will be required for

all major roadways, due to the constraint on funding desired roadways are interstates first and then major principal arterials. The MPOs for the major urbanized areas (New Orleans and Baton Rouge) were solicited for data needs that help guide vehicle detection deployments. Detection on the interstate system is desired before and after each interchange.

Table 22 shows some of the locations where the MPOs require detection.

Table 22: MPO Detection Needs (NORPC and CRPC)

MPO	Corridor	Segment	Description
NORPC	I-12	LA 43 to I-10 MS Stateline	Before and after every interchange
	I-59	I-10/I-12 and MS Stateline near Kentwood	Detection should be located between the US 51 exit off the bridge to Kentwood and complement existing detection Traffic.com has in place
	US 90/US 90 B	Between Westwood Drive in West Jefferson to Lafourche Parish	Location near key intersections in this corridor
	CMPP network of principal arterials and major arterials	Principal arterials in urbanized areas.	To be undertaken when funds are available
CRPC	All interstate roadways	Interchanges	Before and after each interchange to address data required for interchange justification requests when the need arises

MPO	Corridor	Segment	Description
	Other roadways		ITS coverage should address all modes of transportation where there is a need. Deployments should progressively cover other modes such as pedestrians and bicycles as the need arises

6.3 COMPREHENSIVE DETECTION ANALYSIS

Selecting the right vehicle detectors can be a challenging task. Since the vehicle detection industry is composed of a variety of makes and models that work in various ways, users often choose the product based on what has been implemented in the past rather than trying a new product that may be more suitable for the intended application. Furthermore, due to advances in technology such as computers and cell phones, there have been more new and promising technologies than before. This section aims to evaluate the most common types of vehicle detection technologies that are currently available so that it may assist in the decision making process of choosing the right vehicle detectors for the intended usage. Three categories of detection systems are identified and summarized to provide a better understanding of the similarities and differences between vehicle detectors. Detection data management and maintenance considerations are also discussed to provide additional insight into the vehicle detector selection process. Detailed analysis of individual detection sensors is provided in **Section 6.3.6**.

6.3.1 Intrusive Vehicle Detection

An Intrusive vehicle detector is usually installed in the roadway in such a way that it is either

- Embedded in the pavement of the roadway,
- Embedded in the subgrade of the roadway, or
- Taped or otherwise attached to the surface of the roadway.

Examples of intrusive vehicle detectors include inductive loop, which require saw-cuts in the pavement; weigh-in-motion sensors, and magnetometers, which may be embedded or placed underneath a paved roadway or bridge structure. Pneumatic road tubes and piezoelectric cables are also considered as intrusive sensors because they are mounted on the surface of the roadway and obtain the vehicle data through direct contact.

The operation of most of these sensors is well understood as they generally represent applications of mature technologies to traffic surveillance. The drawbacks to their use include disruption of traffic for installation and repair and failures associated with installations in poor road surfaces and use of substandard installation procedures. Resurfacing of roadways and utility repair can also create the need to reinstall these types of sensors.

6.3.2 Non-Intrusive Vehicle Detection

A Non-Intrusive vehicle detector is usually installed over the roadway in such a way that it is either

1. Above the roadway itself or

2. Alongside the roadway, offset from the nearest traffic lane by some distance.

Examples of non-intrusive detectors are video image processors that utilize cameras mounted on poles adjacent to the roadway, a structure that spans the roadway, or on traffic signal mast arms over the roadway; microwave radar sensors mounted adjacent to the roadway or over the lanes to be monitored; ultrasonic, passive infrared, and laser radar sensors normally mounted over the lanes to be monitored; and passive acoustic sensors mounted adjacent to the roadway. Bluetooth technology has also emerged in recent years as a viable alternative to other non-intrusive sensors. Bluetooth sensors are usually mounted at heights between 12-15 ft. and at distance within150 ft. of the roadway. Other emerging applications for wide area surveillance envision non-intrusive sensors such as RF radar mounted on tall buildings and radio towers near the roadway and on aerial platforms. This radar technology application is relatively new and experimental at the time of this assessment.

Similar to intrusive sensors, the non-intrusive sensors provide vehicle count, presence, and travel time data. However, many also readily provide vehicle speed, vehicle classification, and multiple-lane, multiple-detection zone coverage.

6.3.3 Vehicle Probe Technology

The vehicle probe industry is emerging as a viable means to monitor traffic flow, delivering both speed and travel-time information for the purposes of advanced traffic management systems and advanced traveler information services applications. Furthermore, the vehicle probe technology also supports a myriad of other transportation agency requirements, including monitoring the impacts of construction activities, planning, and engineering. Meanwhile, the high cost of installing and maintaining fixed-point loop detectors is driving transportation authorities to consider both outsourcing traffic monitoring and developing new methods of detection. Vehicle probe technology encompasses two primary methods: GPS data obtained from fleet management services and geo-location schemes that leverage cellular phone infrastructure. The proliferation of GPS and mobile data services is fueling these industries and strengthening the demand from travelers for accurate real-time traffic information. In addition, adoption of such technologies is driven by the high cost of deploying and maintaining fixed-sensor networks as

previously discussed while the proliferation of GPS and mobile data services and new businesses dedicated to traffic data collection and dissemination are driving the cost down in obtaining the data.

Examples of the probe vehicle technology include cell phone probes; automated vehicle location services, and toll-tags. Cell phone probes can be further divided into two sub-categories of signaling information and embedded GPS technology within the cell phones. Whichever method is used, any cell phone approach requires a partnership with a major cell phone carrier within the region. Automated vehicle location (AVL) service is gathered by established commercial businesses. Such system relies on GPS receivers to track individual vehicles in a fleet, and locations are periodically reported via satellites, radios, or cellular data services. Because the costs of GPS receivers have gotten much cheaper over the years, the AVL systems are being used in regional fleets, such as taxis, buses, and short-haul truck delivery. The growth rate of GPS data available from AVL services is estimated to grow from 60% to 100% per year. Lastly, the toll tag technology represents a class of vehicle probe technology based on automated toll-tag systems. This technology shares the same attributes as the cell phone and AVL probes, but requires additional toll-tag readers to be deployed in the right-of-way. Unlike the previous two, the toll-tag systems are owned and maintained by road authorities or agencies closely aligned with public transportation sector.

The Probe Vehicle Technology drastically differs from rest of the fixed road-way sensors in that the user and/or client is not required to own any detection hardware but instead procure the traffic information from a private business entity that employs contracts with data sources such as cellular carriers and the trucking industries to obtain the data. Upon obtaining the data, the private business entity then capitalizes on their mega data warehouse to store, filter, organize, and manage the billions of data points so as to provide useful information for their clients. Software analytics can also be purchased as part of the integrated service package to enhance the data mining and reporting purposes.

6.3.4 Detection Data and Management

One of the major components in a vehicle detection system is a data repository or data warehouse that encompasses the ability to archive various types of data and organize them so that the information can be retrieved easily to produce reports. A good data management system should also allow for the identification of trends in traffic parameters as well as analysis and comparison of historical data to produce models of future patterns. As the vehicle detection devices continue to grow in number, the need for a robust data warehouse becomes increasingly important. The purpose of this section is to identify the types of data that are needed by different stakeholders and provide the pre-requisites for a centralized data management system that would serve DOTD’s needs. The relationship between the stakeholders and the detection data that’s needed by each stakeholder are illustrated below.

Table 23: Stakeholder Detection Data Requirements

Stakeholder\Traffic Data	Volume/Count	Speed	Density	Travel Time	Occupancy	Classification	Axle Load
MPO	•	•	•	•	•	•	
DOTD Planning	•	•	•	•		•	
DOTD Pavement	•					•	•
DOTD ITS	•	•	•	•	•		•
Law Enforcement		•					•
Local Government Agencies	•	•			•		

As indicated in the table above, because various stakeholders have different data requirements, the responsibility of collecting and managing the data is left to the individual stakeholders. As a result, same information may be collected multiple times and the information does not always produce similar results because methodology of data collection varies from one stakeholder to another. Moreover, some stakeholders are often required to request data from other department or sections depending on what type of data is needed. It can be a difficult and time consuming process to locate the available data and reaching the individuals who have access to the data. Local data collection and storage methods as described offer certain advantages such as ease of access for whomever has ownership of the data, but it does not offer uniformity and ease of sharing with others. While this assessment recognizes the implausibility for a single entity to collect and/or procure the data needed by all stakeholders, it is important to develop a centralized and shared data warehouse where each stakeholder can store the data once it is obtained. DOTD is currently in the process of acquiring an ATMS solution that will include a data archiving and reporting module. Although this module is designed for monitoring the entire ITS including DMS and incident activities, the functionalities such as traffic data reporting of various time periods and VDS traffic data reporting looks to be promising.

6.3.5 Maintenance Considerations

A well maintained system is crucial for the success of any system implementation. It is especially true for vehicle detection systems because it usually requires many sensor deployments to achieve higher data quality. As expected, larger systems will require more time and resources to maintain the same level of readiness compared to smaller systems. Unfortunately, maintenance budget and staff are often times limited and many users including LADOTD find themselves abandoning locations of lesser priority due to these constraints. From the planning standpoint, this would naturally lead to conclusions of reducing the number of sensors deployed in the future or halting the deployment at once. However, the importance of vehicle detection data is becoming more significant as more congestion and incidents are occurring on the roadways. Achieving high return of investment on the vehicle detection system may be challenging but it is not an impossible task. For example, below are several ways to minimize maintenance resources for future deployments:

1. Select only detection technologies that require little or no maintenance – as discussed earlier, intrusive vehicle detectors require roadway closures for installation as well as maintenance procedures. Therefore, non-intrusive sensors are obviously a better choice

when maintenance resources are limited because this type of sensor is easier to gain access to for repair or replacement. Procuring vehicle probe data may also be an option depending on the type of traffic data needed because no equipment is required to obtain the data.

2. Select detection technologies that provide greater distance between sensors and maintain same level of accuracy - Greater distance between sensors require less deployment locations to provide needed data to calculate traffic data such as travel time. By reducing the number of sensors deployed, the owner of the system is allowed to obtain data from wider ranges of the highway while keeping the maintenance budget relatively low.

3. Install sensors at key locations rather than providing full coverage for the entire interstate network – Although installing vehicle detectors at every exit would provide very accurate data, it is definitely not a very effective way when maintenance considerations are taken into the account. As history has shown, deployments that exceeded the maintenance resources available in any region always resulted in degraded performance if it didn't become useless altogether. This is simply because the maintenance staff simply cannot keep up with the rate of failure of all the ITS devices requiring maintenance and hence a perpetual backlog is created as a result.

4. Install sensors to co-locate with other ITS devices such as CCTV cameras and DMS – co-location is an efficient strategy to minimize the footprint of the ITS deployment whether it is used for an existing or future deployment. Smaller footprint means reduced amount of resources needed for future maintenance. Although it will not always provide ideal locations for vehicle detection, a significant amount of the ITS device locations are potential candidates for consolidation by implementing sound planning strategy. Advantages of co-location at an existing site include direct access to existing electrical power and communication resources.

A Statewide vehicle detection implementation plan has been outlined in **Section 6.3.7** and will provide further insight into the strategy to improve the efficiency and return of investment for the DOTD's vehicle detection system.

6.3.6 Vehicle Detection System Detailed Analysis

A detail analysis of the potential vehicle detection technologies for Intelligent Transportation Systems is provided in **Table 24**.

Table 24: detail analysis of the potential vehicle detection technologies

Category	Detector Type	Technology	Pros	Cons	Analysis	ITS Feasibility	Cost[1] (Per Unit)
Intrusive	Inductive Loop Detector	This is the most common detector used in traffic management applications. The dimension and shape varies from 5 to 6 ft. in square, rectangular, and round configurations. The main components consist of insulated wire loop buried in shallow saw-cut in the roadway connected to an electronic controller. The controller is mounted in a cabinet nearby usually along with other traffic signal equipment. The loop functions as an inductive element and when vehicle stops on or passes over the top of the loop, the inductance of the loop is decreased and triggers a pulse to the electronic controller indicating the movement of the vehicle.	• The technology is mature and well understood in providing basic traffic parameters such as volume, occupancy, speed, and gap. • Not sensitive to weather. • The design is relatively flexible and simple which makes it suitable for many applications.	• The installation is intrusive thereby requiring disruption of traffic for initial deployment and repair. • Roadway resurfacing requires reinstallation of detectors • Performance is vulnerable to deteriorating road surfaces and substandard installation procedures. • Performance is subject to stresses of traffic and road temperature • Multiple detectors are likely to be required for a location depending on lane configuration.	Appropriate for collecting vehicle movement, presence, count, and occupancy data. Multiple detectors can also be combined to measure speed and vehicle length. Newer technology utilizing sophisticated electronic components can also be used to determine vehicle classification by measuring specific levels of metal content under the vehicle. Installation can be a concern in areas of high traffic and roadway open to traffic. Although frequency of maintenance is relatively low, it is difficult to schedule repair due to required lane closures. This technology is mostly used for intersection applications.	• Suitable for ITS application such as Electronic Payment and Pricing to provide vehicle classification and vehicle occupancy data • Not recommended for collecting corridor traffic data such as volume and travel time due to higher maintenance resources required	$2K to $6K
	Magnetometer	Magnetometer detects the presence of a metallic object such as vehicles by measuring the disturbances in the Earth's magnetic field (also known as magnetic anomaly) caused by the object. This type of detector is passive and contains windings around a magnetic material core. The dimensions are usually small and can be installed in a cylindrical hole core drilled in the roadway. The detector unit usually operates on batteries and transmits a wireless signal to the controller sometimes through an access point for extended range. Depending on make and model, some detectors can be mounted on the surface while others require approximately 6" core drill for flush mount.	• Less susceptible to stresses of traffic compare to loops. • Smaller installation foot print has smaller impact on pavement life. • Does not need saw-cut to install communication cable to controller • Some detectors depending on make and model can be installed on surface of roadway eliminating any pavement cuts	• Most detectors require pavement cut, coring, and boring under the roadway requiring lane closure. • Roadway resurfacing requires reinstallation of detectors • Some models do not detect stopped or slow moving vehicles. • Smaller detection zones • Poor performance in identifying the perimeter of the vehicle and hence classifying vehicle type • Requires two closely spaced magnetometers to increase accuracy in occupancy and speed.	Appropriate for collecting vehicle movement and traffic count data. Multiple detectors can also be combined to measure speed, and occupancy data. Installation is less intrusive than loop detectors because it requires smaller installation footprint. Installation time is also significantly shorter than loop installations especially for surface mount magnetometers.	• Not recommended for collecting corridor traffic data such as volume and travel time due to higher maintenance resources required	$1.5K - $2K
	Pneumatic Road Tube	By using the air pressure that is generated by a vehicle passing over a rubber tube, pneumatic road tubes send a burst of the air pressure to an air switch to generate an electrical signal. This electrical signal is consequently interpreted by analysis software to provide axle count and vehicle classifications.	• Simple and quick implementation • Provides both portable and permanent mounting options. • Low cost and easy to maintain	• Inaccurate when truck and bus volume is high • The air switch is sensitive to temperature • Air tube easily damaged due to direct contact with moving traffic • Multiple detectors are likely to be required for a location depending on lane configuration and type of data needed. • High frequency in maintenance due to wear and tear.	Appropriate for short-term temporary traffic counting applications such as research and planning studies that require spot counts. Multiple devices can be deployed to determine vehicle class and spacing.	• Not recommended for collecting corridor traffic data such as volume and travel time due to higher maintenance resources required	$5K - $6.5K

	Piezoelectric Cable	Piezoelectric material produces a voltage by converting kinetic energy to electrical energy. For example, when the tire of a vehicle comes in contact with the piezoelectric cable and creates a variation in force upon the cable material, it coverts that force into an electrical voltage. In addition, the magnitude of voltage generated by the piezoelectric material is proportional to the force and weight of the vehicle during the contact. If the force ceases to change, however, the charge will eventually decay to zero until a new differential in force is detected.	• High accuracy in collected data such as speed, axle count, and classification. • Provides both portable and permanent mounting options. • Minimal equipment is needed • Can be used to determine weight of vehicle hence commonly used for weigh-in-motion (WIM) applications • Proven technology	• Require disruption of traffic for installation and maintenance. • Roadway resurfacing requires reinstallation of detectors • Performance is vulnerable to deteriorating road surfaces and substandard installation procedures. • Multiple detectors are likely to be required for a location depending on lane configuration and type of data needed. • Sensitive to pavement temperature, speed of the vehicle, and quality of the installation.	Appropriate for classifying vehicles by axle account, axle spacing, as well as measuring vehicle's weight and speed. Commonly used for Average Daily Traffic (ADT) Counts and Peak Hour traffic counts, piezoelectric cable can be used in portable applications where data is only needed during short time frames and location of the count needed varies. WIM is also an ideal application to use Piezoelectric cable technology because it is capable of measuring vehicle weight information.	• Suitable for WIM applications • Not recommended for collecting corridor traffic data such as volume and travel time due to higher maintenance resources required	$1.5K - $2K
Non-Intrusive	Video Image Processor	Video Image Processor system utilizes single or multiple CCTV cameras to obtain imagery from the roadway and sends them to a controller to process and analyze the data. The controller can be software based or hardware based systems. It provides traffic data such as volume and speed by processing the digitized information received from the cameras. Stopped vehicles or wrong way traffic can also be detected in the camera field of view using sophisticated software analytics. Some products support auto generated electronic alerts for the traffic management personnel to instantly verify the incidence using the real time video stream.	• Installation is non-intrusive to the roadway and lane closure, if necessary, is usually minimal. • Live and recorded video are available for manual analysis of traffic conditions as well as data validation. • Accuracy of data is not reliant on the amount of congestion. • Single camera may be used to monitor multiple lanes simultaneously. • Multiple cameras and zones can be combined for various applications	• High winds may cause significant camera motion that result in unstable video and inaccurate data. • Artifacts caused by obstructions, shadows, variable lighting levels, reflections, and inclement weather may also produce inaccurate data. • Require periodic cleaning of camera lenses. • Cameras must be mounted at certain heights and angles relative to the roadway.	Appropriate for detection of traffic across several lanes because multiple detection zones can be setup within a camera's field of view. In addition, a single video image processor can handle video streams from multiple cameras as technology is continuing to improve in in the processing power of the CPU. Data that may be provided by the video image processor includes traffic count, speed, occupancy, lane to lane vehicle movement, traffic direction, and vehicle classification.	• Suitable for providing incident detection information for ITS	$8K - $16K
	Microwave Radar	Microwave radar transmits energy from an antenna mounted over the roadway to collect traffic information in a defined area. The area is controlled by the level of energy transmitted by the antenna and the data is collected when the transmitted energy is reflected back toward the antenna when a vehicle passes through the transmitted beam. The traffic information such as volume, speed, and occupancy are calculated based on the profile of the reflected signal.	• Installation is non-intrusive to the roadway and lane closure if necessary, is usually minimal. • Multiple configuration options available to monitor single or many lanes. Side mounted radars can be setup to have multiple detection zones. • Insensitive to inclement weather. • Provide direct measurement of vehicle speed • Easy to install and operate • Excellent range of detection	• A wide range of products from different vendors and models are available and the appropriate type of radar must be selected for a particular application in order to collect accurate data. • Requires periodic calibration and maintenance. • Doppler sensors do not detect stopped vehicles. • Does not provide direct measurement of travel time • Sensor spacing is typically between 0.5 to 2 mi for accurate measurement of travel time data	Appropriate for collecting data at traffic signal intersections and detection of traffic across several lanes. The sensors can also be mounted sideways to collect highway vehicle speed data and calculate travel time using multiple sensors. Also referred to as RVD (Radar Vehicle Detector) or RVSD (Radar Vehicle Sending Device), this technology provides highly accurate spot counts such as speed, occupancy, classification, and volume.	• Suitable for providing traffic volume and speed data for ITS • Evacuation scenarios such as natural disasters often require accurate real time traffic count data to assist the decision makers in activating the contra-flow on the evacuation routes	$8K - $11K
	Ultrasonic	Ultrasonic sensors transmit sound waves at frequencies between 25 and 50Khz, which is outside the audible range of humans. When the sound wave is reflected by a vehicle upon contact, the sensor receives the returned signal and determines the presence of the vehicle by comparing the signal received to the signal transmitted. The signal processing electronics is a standalone component that may be installed with the transducer or in a separate unit mounted in a cabinet on the roadside.	• Installation is non-intrusive to the roadway and lane closure, if necessary, is usually minimal. • Some models provide monitoring capabilities of multiple lanes	• Temperature and air turbulence could affect the performance of the sensors. • Requires high pulse repetition frequencies to measure vehicles traveling at high speeds • Does not provide vehicle classification information • Does not provide direct measurement of travel time	Appropriate for detection of vehicle occupancy, vehicle presence, and vehicle count information. Speed information can also be determined by using pulses transmitted at different incident angles. Multiple sensors can be setup to monitor several lanes and it may also be used in conjunction with other types of sensors to improve accuracy.	• Not recommended for ITS deployment to collect travel time data because multiple sensors are required to monitor multiple lanes	$3K - $6.5K
	Passive Infrared	Passive infrared sensors detect the natural transmitted energy from vehicles, road surfaces, and other objects in the field of view but they transmit no energy of their own. By detecting the changes in emitted energy received, the sensor interprets the signal and determines vehicle speed, vehicle occupancy, vehicle presence, and vehicle classification information.	• Installation is non-intrusive to the roadway and lane closure, if necessary, is usually minimal. • Inexpensive sensors	• Reduced sensitivity to vehicles in heavy rain, snow, haze and dense fog • Signal produced by vehicle decreases on overcast, high humidity, and rainy days • Sunlight glare may cause unwanted and confusing signals	Appropriate for traffic signal applications to measure vehicle volume, speed, queue, and classification data. It is also a low cost option where budget constraint becomes a major factor.	• Not recommended for ITS deployment to collect travel time data because multiple sensors are required to monitor multiple lanes	$0.6K - $1K

	Bluetooth	The Bluetooth sensors detect Bluetooth signal transmitted from the vehicles passing through the detection zone and records and timestamps the MAC address of the Bluetooth device. When the MAC address is recorded again as the vehicle passes through the subsequent detection zone, the travel time between the two detection zones is determined. In addition, by determining the distance between the sensors which is equivalent to the distance traveled, the sensor can also compute the vehicle speed data based on the travel time recorded.	• Installation is non-intrusive to the roadway and lane closure, if necessary, is usually minimal. • Provide direct measurement of travel time • Easy to install and operate • Compatible with both the Ethernet and Cellular communication options. • Sensor spacing requirement on interstate can be as far as 4 to 5 miles for travel time measurement	• Not every vehicle has Bluetooth device activated while passing through detection zones. • Critical mass of users is necessary for success. • Data lag time is associated with the spacing of each sensor deployed. • Interference with Wi-Max • Provides invalid data when vehicle makes detours or stops before reaching next detection zone • Not designed for traffic signal applications	Appropriate for providing accurate travel time information on the interstate or highways with minimal on-ramp and off-ramps such as bridges. Vehicle speed information can be calculated using travel time but it is not capable of proving volume and classification data.	• Suitable for providing travel time data for ITS in urban and urbanized areas.	$4K - $5K[2]
	Active Infrared (Laser Radar)	Active infrared sensors illuminate the detection zone with low power infrared energy produced by laser diodes. By recording the emitted infrared energy reflected back from a vehicle entering the illuminated zone of detection, the electronic sensor interprets the signal and determines vehicle speed, vehicle occupancy, vehicle presence, and vehicle classification information.	• Installation is non-intrusive to the roadway and lane closure, if necessary, is usually minimal. • Multiple lane presence detection is available in side-mounted models. • Multiple beams transmitted by the sensor provide more accurate data.	• Glare from sunlight causes unwanted signal and may reduce accuracy of the data. • Airborne particles and inclement weather can scatter or absorb energy that is needed for accurate detection such as fog, haze, rain, snow, smoke, and dust.	Appropriate for traffic signal applications to measure vehicle volume, speed, queue, and classification data. It is also capable of classifying up to 11 types of vehicles which is ideal for use at toll road facilities.	• Not recommended for ITS deployment to collect travel time data because multiple sensors are required to monitor multiple lanes	$4.7k - $6k
Vehicle Probe	GPS/Cellular	Vehicle probe technology encompasses two primary methods: GPS data obtained from fleet management services and geo-location schemes that leverage cellular phone infrastructure to provide traffic data. The Probe Vehicle Technology is unique compared to other technologies because the user and/or client procure the traffic information from a private business entity that employs contracts with data sources such as cellular carriers and the trucking industries to obtain the data. Examples of data providers utilizing GPS data, cellular data, or a combination of both data sources include INRIX, TrafficSense by Cellint, and LandSonar.	• No installation and maintenance of sensor equipment is required • The data provider offers suites of web applications and software analytics to manage and query data • Provides data in rural areas where sensors are difficult to manage and expensive to install • Data is becoming more accurate as GPS and Cellular devices becomes more prevalent and widely used • Cellular network coverage along arterial roads is very high, especially in urban areas.	• Provides no control over the quality of purchased data • Critical mass of users is necessary for success. • Provides no mechanism to validate accuracy of the data without field sensors • Not designed for traffic signal applications • Not cost competitive; Pricing structure is dependent on the amount and type of data needed	Appropriate for obtaining estimated traffic data such as speed, volume, and travel times in large sample areas such as rural areas, metropolitan areas, or even Statewide. Historical traffic patterns or information can also be obtained through the provider's database or data warehouse.	• This technology should be utilized to provide travel time data for ITS in rural areas • No equipment deployment is required	N/A
Crowd-Sourcing	GPS/Cellular	Driver's vehicles or mobile devices provide information on their location, speed, and possibly additional information directly to a public or private entity, and that information is used to generate traffic/travel time information. The typical model for crowd-sourced data involves location aware devices running an application that automatically sends information to a central server using cellular transmission. Similar to vehicle probe technology, one particular advantage of location-based crowdsourcing is that vehicles can be individually tracked in near real-time, allowing more precise and timely speed and travel time estimates than can be achieved by other data collection technologies. The major difference to the vehicle probe technology is that the data is obtained directed from mobile or GPS device users who are running the software/application or some sort of subscription. Examples of the service provider include Beatthetraffic, INRIX, and Google.	• No installation and maintenance of sensor equipment is required • The data provider offers suites of web applications and software analytics to manage and query data • Provides data in rural areas where sensors are difficult to manage and expensive to install • Data is becoming more accurate as GPS and Cellular devices becomes more prevalent and widely used • Cellular network coverage along arterial roads is very high, especially in urban areas. • Motorist can obtain traffic information directly from service providers through internet, GPS, or cellular network. Basic traffic information such as congestion maps and travel time are provided for free.	• Vehicle/motorist must have device capable of transmitting information; no roadway infrastructure needed. • Private sector currently dominate this market • Privacy issues largely within purview of private sector entities • Provides no mechanism to validate accuracy of the data without field sensors • Not designed for traffic signal applications • Require users to install a specific application on their devices and not currently implemented by public sector	Using this technology, the traveling public may obtain traffic information such as travel time and roadway congestion directly from a service provider through internet, GPS, and mobile devices. Although lack of validation in its data may affect the level of accuracy, the data is nonetheless sufficient for estimation purposes.	• Crow-Sourcing is currently a technology dominated by the private industry. There is no example of a public entity that is implementing this technology as of this study.	N/A

1. Capital cost/pricing information is obtained from 2009 U.S. Department of Transportation Research and Innovative Technology Administration's Adjusted Equipment Cost Database except noted otherwise.
2. Capital cost/pricing information is obtained from manufacturer or distributer.

6.3.7 Statewide Deployment Plan

The comprehensive approach to establish the statewide deployment plan for ITS vehicle detection (VD) system is to first identify the type of traffic data that is needed and secondly, determine the purpose of the traffic data so that it can help prioritize the list of needs. Once the traffic data needs have been identified and finalized, the next step is to analyze and select the detection technologies that are suitable for collecting the data. The preceding steps are then constrained to make necessary compromises to the list of needs based on deployment strategies such as maintenance considerations as described in **Section 6.3.5**. The analysis utilizing the outlined approach and the deployment plan that resulted from the analysis is provided in the list below.

1. Travel Time – Sensor on major highways is crucial in providing the most up to date travel time information to the motorists. This is especially true in metropolitan areas and large population centers. As previously discussed, the most suitable VD technology for collecting the travel time data is the Bluetooth technology because it provides direct measurement of travel time and it requires minimal maintenance while providing maximum detector spacing. As such, the Bluetooth detectors should be installed at strategic locations along all interstate corridors including interchanges such as I-10 @ I-110, I-10 @ I-12, and I-20 @ I-49 because these locations provide the highest data volume and hence increases the accuracy of the data. In addition, these major interchanges are also vital locations for incident management and are typically installed or have plans to install ITS devices which serve as excellent candidates for equipment co-location.

   APPENDIX D is provided to show the recommended locations for the sensor deployment based on strategies previously discussed in **Section 6.3.5**. This is only illustrative and the number of detectors actually deployed in each DOTD district will depend on need, maintenance resources and staff availability. The locations shown represent major highway intersections that produce higher volume of data points and serve as ideal candidates for colocation as previously described.

   In rural areas, the procurement of vehicle probe data is recommended to obtain travel time data because these areas are usually scarce in communication resources and also require greater time and distance of travel for the maintenance personnel and exponentially increases the maintenance budget for day to day operations.

2. Traffic Volume/Count and speed data – Traffic count and speed data are important not only for the traveling public in terms of detecting traffic incidents quickly but this data can also be vital for transportation planners and agencies when analyses are needed to determine the impacts of roadway construction to the traffic as well as determining the level of usage of the roadway. In this analysis, the traffic volume and speed data is further categorized into 3 sub-categories based on the purpose of the data in order to determine the best strategy for deployment.

a. Planning – The traffic volume and speed information is most widely used by transportation planners for the purpose of determining highway needs. For example, data such as annual average daily traffic (AADT) is used to request federal funding for the maintenance and improvement of highways. Because the federal government requires that the AADT data to be included in the Highway Performance Monitoring System (HPMS), state agencies must obtain the required traffic data and incorporate them into the system. In this instance, the traffic volume data is required because amount of funding is appropriated based on the level of highway usage in addition to other factors. Also, as previously mentioned, the traffic volume information can also be used to determine the impacts of constructions on the highway due to lane closures as well as major community functions such as sport events or music concerts. These types of analysis using the traffic data provides important tools for transportation planners in preparing for traffic congestions due to these events.

b. Evacuation – The traffic count and speed data can be utilized to manage traffic congestion during emergency events such natural disasters. Because these types of events usually cause traffic congestions in larger scales and do not provide adequate time for advanced planning, responders of these types of situations need to quickly determine the best course of action based on information collected from the roadway in a real time basis. In this instance, the traffic count and speed data can be used to assist the emergency responders in identifying the congested routes and determine alternate paths for relieving the traffic. The traffic volume and speed data for evacuation purposes can be collected by deploying microwave radar technology at the outskirts of all metropolitan areas as evacuations often means migration of traffic from one city to another for safety. As such, major roadways leaving and entering these areas are excellent locations for proving the traffic volume and speed data. The microwave radar technology is the most suitable VD technology for collecting this data because it provides direct measurement of traffic volume and speed so that the data collected is highly accurate. In addition, this technology requires minimal maintenance in comparison to the other technologies.

c. Incident Detection – Traffic count and speed data can also be combined to detect traffic incidents on the roadway. Although other types of traffic data such as travel time may be used to detect traffic incidents, traffic volume and speed data is collected through direct measurement and therefore allows quicker identification of traffic incidents. New technology is also being developed to automatically detect incidents by using CCTV cameras and proprietary software which actively monitors traffic in the camera's field of view. As such, traffic volume and speed data will possibly play a lesser role in incident detection as new technology advances.

The Statewide detection deployment details can be found in **APPENDIX D**.

7 ITS Services

ITS services describe what can be done to improve the efficiency, safety, and convenience of travel on the Statewide transportation system through better information, advanced systems and new technologies. Some services are specific to one primary stakeholder while others require broad stakeholder participation. **Table 25** describes the ITS services that address the transportation needs in the region. Detailed description of each service package and associated information exchanges can be found in Turbo Architecture Software file.

Table 25: Statewide ITS Services

Service Package	Service Package Name	Service Package Status	Included Elements
AD1	ITS Data Mart	Existing	CVO Inspection Stations
			Emergency 911 Centers
			GOHSEP
			LADOTD District Traffic Operations
			LADOTD ITS Section
			Local Planning Organizations
			TMC
AD2	ITS Data Warehouse	Existing	TMC
APTS01	Transit Vehicle Tracking	Existing	Public Transit Services
APTS02	Transit Fixed-Route Operations	Existing	Public Transit Services
APTS03	Demand Response Transit Operations	Existing	Public Transit Services
APTS04	Transit Fare Collection Management	Existing	Public Transit Services
APTS05	Transit Security	Existing	Emergency 911 Centers
			Local Emergency Services
			Local Public Safety Agencies

Service Package	Service Package Name	Service Package Status	Included Elements
			LSP
			Public Transit Services
APTS06	Transit Fleet Management	Existing	Public Transit Services
APTS07	Multi-modal Coordination	Existing	Airports
			LADOTD District Traffic Operations
			TMC
APTS08	Transit Traveler Information	Existing	Event Promoter
			Media
			Public
APTS09	Transit Signal Priority	Planned	LADOTD District Traffic Operations
			ITS Field Equipment
			Local DPW
			Public Transit Services
			TMC
APTS11	Multimodal Connection Protection	Planned	Event Promoter
			Personal Devices
ATIS01	Broadcast Traveler Information	Existing	LADOTD Social Media
			Louisiana 511 Website
			Media
			Personal Devices
ATIS02	Interactive Traveler Information	Existing	LADOTD Social Media
			Louisiana 511 Website
			Personal Devices

Service Package	Service Package Name	Service Package Status	Included Elements
ATIS06	Transportation Operations Data Sharing	Existing	LADOTD District Traffic Operations
			TMC
ATMS01	Network Surveillance	Existing	LADOTD District Traffic Operations
			LADOTD ITS Field Equipment
			LADOTD ITS Section
			TMC
ATMS06	Traffic Information Dissemination	Existing	Event Promoter
			LADOTD Social Media
			Louisiana 511 Website
			Media
ATMS07	Regional Traffic Management	Existing	LADOTD District Traffic Operations
			LADOTD Flood Warning Systems
			LADOTD ITS Field Equipment
			LADOTD ITS Section
			LSP
			TMC
			Traffic Signal Systems
ATMS08	Traffic Incident Management System	Existing	Emergency 911 Centers
			HAZMAT Mobile Response
			LADOTD District Traffic Operations
			LADOTD Social Media

Service Package	Service Package Name	Service Package Status	Included Elements
			Local Emergency Services
			Local Public Safety Agencies
			Louisiana 511 Website
			LSP
			TMC
ATMS09	Transportation Decision Support and Demand Management	Existing	LADOTD District Traffic Operations
			TMC
ATMS10	Electronic Toll Collection	Existing	Toll Plaza
ATMS11	Emissions Monitoring and Management	Existing	DEQ
ATMS18	Reversible Lane Management	Planned	LADOTD District Traffic Operations
			LADOTD ITS Field Equipment
			TMC
CVO01	Carrier Operations and Fleet Management	Existing	Ports
CVO03	Electronic Clearance	Existing	CVO Inspection Stations
			Local Public Safety Agencies
			Ports
CVO04	CV Administrative Processes	Existing	CVO Inspection Stations
			Local Public Safety Agencies
CVO06	Weigh-In-Motion	Existing	CVO Inspection Stations
CVO10	HAZMAT Management	Existing	Commercial Vehicles
			GOHSEP
			HAZMAT Mobile Response

Service Package	Service Package Name	Service Package Status	Included Elements
			LADOTD District Traffic Operations
			Local Emergency Services
			Local Public Safety Agencies
			TMC
CVO13	Freight Assignment Tracking	Existing	CVO Inspection Stations
			Local Public Safety Agencies
			Ports
EM01	Emergency Call-Taking and Dispatch	Existing	Emergency 911 Centers
			Local Public Safety Agencies
EM02	Emergency Routing	Existing	Emergency 911 Centers
			TMC
EM06	Wide-Area Alert	Existing	Emergency 911 Centers
			Local Public Safety Agencies
			Louisiana 511 Website
			Personal Devices
			Public
			TMC
EM07	Early Warning System	Existing	Emergency 911 Centers
			Emergency Services Functions
			GOHSEP
			Local Public Safety Agencies
			LSP
EM08	Disaster Response and Recovery	Existing	Emergency 911 Centers

Service Package	Service Package Name	Service Package Status	Included Elements
			GOHSEP
			HAZMAT Mobile Response
			LADOTD District Traffic Operations
			Local Emergency Services
			TMC
EM09	Evacuation and Reentry Management	Existing	GOHSEP
			LADOTD District Traffic Operations
			LADOTD ITS Section
			LADOTD Social Media
			Local Emergency Services
			Local Public Safety Agencies
			Louisiana 511 Website
			TMC
EM10	Disaster Traveler Information	Existing	GOHSEP
			LADOTD District Traffic Operations
			LADOTD Social Media
			Louisiana 511 Website
			Media
			Personal Devices
			Public
			TMC
MC03	Road Weather Data Collection	Existing	LADOTD Flood Warning Systems

Service Package	Service Package Name	Service Package Status	Included Elements
			LADOTD ITS Field Equipment
			TMC
MC04	Weather Information Processing and Distribution	Existing	GOHSEP
			LADOTD District Traffic Operations
			LADOTD Social Media
			Louisiana 511 Website
			Media
			TMC
MC08	Work Zone Management	Existing	LADOTD District Traffic Operations
			Local DPW
			Louisiana 511 Website
			Media
			TMC
MC09	Work Zone Safety Monitoring	Planned	LADOTD District Traffic Operations
			LADOTD ITS Field Equipment
			Work zone ITS
MC10	Maintenance and Construction Activity Coordination	Existing	LADOTD District Traffic Operations
			Local DPW
			TMC
MC12	Infrastructure Monitoring	Existing	LADOTD District Traffic Operations
			LADOTD ITS Field Equipment

Service Package	Service Package Name	Service Package Status	Included Elements
			LADOTD ITS Section
			TMC

7.1 PROJECT SEQUENCING

Table 26 describes the proposed projects and or programs that may be implemented to enhance Statewide traffic management and help achieve the visions and goals for advanced traffic management in Louisiana. The opinion of probable cost for implementation of each proposed project or program is presented. **APPENDIX G** shows the project schematic diagrams.

Table 26: Project Sequence

Name	Description	Service Scope	Geographic Scope	Time frame	Market Packages	Design Cost			Capital Cost			O&M			Total Cost		
Statewide Motorist Assistance Patrol (MAP)	Project to deploy Motorist Assistance Patrol vehicles and services	Freeway Service Patrol including the following services: -TMC Support -Traffic Incident Management Services -Motorist Services (e.g., change tires, fuel, first aid, etc.) -Emergency vehicle fleet -Tow service on bridges -General contract management	High crash corridors	TBD	ATMS01 ATMS07 EM04	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD
Statewide Incident Management Program	This is a program to provide ITS applications to enhance incident management along targeted corridors.	This will include the deployment of portable incident response trailers.	-Atchafalaya Basin Bridge -Twin Span Bridge - Elevated roadways with limited access	TBD	ATMS01 ATMS06 ATMS07 EM04	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD
Travel Time for Emergency Evacuation	Portable travel time detection devices that can be deployed during emergencies to monitor travel time in critical corridors	The portable travel time devices will be deployed in corridors critical to hurricane evacuation to determine route performance and alternate routes to support maximum throughput	Travel time detection devices will be deployed in corridors critical to hurricane evacuation based on anticipated area of landfall.	TBD	ATMS01 ATMS07 ATMS08	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD
CCTV Surveillance on LA 3213 south of Airline Hwy to Veterans Bridge	This project will provide CCTV camera coverage with communication and integration into TMC.	This project will deploy CCTV cameras with PTZ capability and communications (fiber) and integration into Statewide TMC	-LA 3213 from US 61 to Veterans Bridge	TBD	ATIS06 ATMS07	$ 40,000.00	-	$ 120,000.00	$ 800,000.00	-	$ 1,500,000.00	$ 120,000.00	-	$ 375,000.00	$ 960,000.00	-	$ 1,995,000.00
Network Security	This project is envisaged to provide security from unauthorized intrusion into LADOTD ITS infrastructure system.	Upgrade existing field network switches for intrusion prevention and detection.	All locations with field access network switches	TBD	N/A	$ 50,000.00	-	$ 120,000.00	$ 1,000,000.00	-	$ 1,500,000.00	$ 150,000.00	-	$ 375,000.00	$ 1,200,000.00	-	$ 1,995,000.00

Name	Description	Service Scope	Geographic Scope	Time frame	Market Packages	Design Cost			Capital Cost			O&M			Total Cost		
CCTV Camera Surveillance and Communications (fiber) on I-10 between Lafayette and Lake Charles	This project will provide CCTV camera coverage and integration into TMC.	This project will deploy CCTV cameras with PTZ capability and integration into Statewide TMC	10 CCTV Cameras	TBD	ATIS06 ATMS07	$ 75,000.00	-	$ 200,000.00	$ 1,500,000.00	-	$ 2,500,000.00	$ 225,000.00	-	$ 625,000.00	$ 1,800,000.00	-	$ 3,325,000.00
Communication (Fiber Optics)	I-49 Corridor from Lafayette to Alexandria	Fiber optic installation and integration into TMC.	I-49 corridor from hub near I-10/I-49 interchange to Alexandria	TBD	ATIS06	$ 725,000.00	-	$ 1,280,000.00	$ 14,500,000.00	-	$ 16,000,000.00	$ 2,175,000.00	-	$ 4,000,000.00	$ 17,400,000.00	-	$ 21,280,000.00
Communication (Fiber Optics)	Provide fiber communication along US 61 from Sorrento - I-310	Fiber optic installation and integration into TMC.	US 61 from Sorrento to I-310 interchange	TBD	ATIS06	$ 275,000.00	-	$ 680,000.00	$ 5,500,000.00	-	$ 8,500,000.00	$ 825,000.00	-	$ 2,125,000.00	$ 6,600,000.00	-	$ 11,305,000.00
I-10 CCTV Camera Surveillance Upgrades and communication (Baton Rouge to New Orleans)	This project will provide CCTV camera coverage and communication to fill in gaps in surveillance and integration into TMC.	CCTV communications will be via solar cellular modems.	-I-10 @ LA 641 interchange (CCTV) -I-10 @ LA 22 interchange	TBD	ATIS06 ATMS07	$ 25,000.00	-	$ 80,000.00	$ 500,000.00	-	$ 1,000,000.00	$ 75,000.00	-	$ 250,000.00	$ 600,000.00	-	$ 1,330,000.00
Work Zone ITS	Deployment of ITS devices to help reduce congestion and enhance safety in and near work zones.	This project will deploy portable DMS, CCTV cameras, variable speed limits, queue detection, highway advisory radios, intrusion alarms, etc. for work zone surveillance and traveler information in critical corridors.	Interstate projects that require Level 4 TMP with extended construction period.	TBD	ATMS01 ATMS07 ATMS08 MC08 MC09	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD
Video Content Analytics	This project will facilitate roadway surveillance for safety and congestion management.	This project will provide hardware/software required for image processing for presence detection, automatic incident detection, abnormal flow or congestion detection, stalled vehicle detection, etc. Video analytics will provide traffic counts, classification and speed data.	Provide video analytics for corridors with CCTV installations. Analytics will be based on preferred streaming from strategic locations.	TBD	ATMS01 ATMS07 ATMS08	$ 34,000.00	-	$ 160,000.00	$ 680,000.00	-	$ 2,000,000.00	$ 102,000.00	-	$ 500,000.00	$ 816,000.00	-	$ 2,660,000.00

ITS Services

Name	Description	Service Scope	Geographic Scope	Time frame	Market Packages	Design Cost			Capital Cost			O&M			Total Cost		
Probe Data Outsourcing	Acquisition of probe data to support network performance monitoring and real-time congestion monitoring	Probe data to include volumes, real-time travel time, delays, congestion levels and summaries of historical performance on critical corridors.	Locations in rural areas especially where there is no ITS deployment to support basic network surveillance and incident detection and verification	TBD	ATMS01 ATMS07 ATMS08	N/A	-	N/A	N/A	-	N/A	N/A		N/A	$ 1,000,000.00		$ 1,500,000.00
I-49 CCTV Camera Surveillance and Communications Lafayette to Alexandria	This project will provide CCTV camera coverage and communication and integration into TMC.	This project will deploy CCTV cameras with PTZ capability and communications (fiber) and integration into Statewide TMC	14 CCTV Camera locations	TBD	ATIS06 ATMS07	$ 100,000.00	-	$ 240,000.00	$ 2,000,000.00	-	$ 3,000,000.00	$ 300,000.00	-	$ 750,000.00	$ 2,400,000.00	-	$ 3,990,000.00
CCTV Camera Surveillance and Communications future I-49 corridor (Lafayette to New Orleans)	This project will provide CCTV camera coverage and communication and integration into TMC.	This project will deploy CCTV cameras with PTZ capability and communications (fiber) and integration into Statewide TMC	I-49 Corridor from Lafayette to New Orleans - all interchanges 14 Cameras (to Morgan City)	TBD	ATIS06 ATMS07	$ 600,000.00	-	$ 1,120,000.00	$ 12,000,000.00	-	$ 14,000,000.00	$ 1,800,000.00	-	$ 3,500,000.00	$ 14,400,000.00	-	$ 18,620,000.00
Communication (Fiber Optics)	From Morgan City to Houma	Fiber optic installation and integration into TMC.	US 90 from Morgan City to Houma	TBD	ATIS06	$ 225,000.00	-	$ 480,000.00	$ 4,500,000.00	-	$ 6,000,000.00	$ 675,000.00	-	$ 1,500,000.00	$ 5,400,000.00	-	$ 7,980,000.00
Communication (Fiber Optics)	From Houma to New Orleans	Fiber optic installation and integration into TMC.	US 90 from Houma to New Orleans	TBD	ATIS06	$ 400,000.00	-	$ 880,000.00	$ 8,000,000.00	-	$ 11,000,000.00	$ 1,200,000.00	-	$ 2,750,000.00	$ 9,600,000.00	-	$ 14,630,000.00
Bridge Surveillance	Bridge surveillance project will provide CCTV camera and communications to monitor the bridges.	This project will deploy CCTV cameras and communication Veterans Memorial Bridge across the MS River (fiber to airline and on bridge)	Gramercy Bridge	TBD	ATMS01 ATMS07 EM05	$ 65,000.00	-	$ 160,000.00	$ 1,300,000.00	-	$ 2,000,000.00	$ 195,000.00	-	$ 500,000.00	$ 1,560,000.00	-	$ 2,660,000.00
Bridge Surveillance	Bridge surveillance project will provide CCTV camera and communications to monitor the bridges.	This project will deploy CCTV cameras and communication Luling Bridge across the MS River (include fiber to airline hwy and on bridge only)	Luling Bridge	TBD	ATMS01 ATMS07 EM05	$ 85,000.00	-	$ 160,000.00	$ 1,700,000.00	-	$ 2,000,000.00	$ 255,000.00	-	$ 500,000.00	$ 2,040,000.00	-	$ 2,660,000.00
Bridge Surveillance	Bridge surveillance project will provide CCTV camera and communications to monitor the bridges.	This project will deploy CCTV cameras and communication on St. Francisville Bridge across the MS River	St. Francisville Bridge	TBD	ATMS01 ATMS07 EM05	$ 22,500.00	-	$ 52,000.00	$ 450,000.00	-	$ 650,000.00	$ 67,500.00	-	$ 162,500.00	$ 540,000.00	-	$ 864,500.00

ITS Services

Name	Description	Service Scope	Geographic Scope	Time frame	Market Packages	Design Cost			Capital Cost			O&M			Total Cost		
Bridge Surveillance	Bridge surveillance project will provide CCTV camera and communications to monitor the bridges.	This project will deploy CCTV cameras and communication on Huey P. Long Bridge across the MS River (no communications included)	Huey P. Long Bridge	TBD	ATMS01 ATMS07 EM05	$ 15,000.00	-	$ 40,000.00	$ 300,000.00	-	$ 500,000.00	$ 45,000.00	-	$ 125,000.00	$ 360,000.00	-	$ 665,000.00
Asset Management	Implementation of an asset management system to help maintain the ITS infrastructure, the data and processes required for advanced transportation management systems.	All assets in Louisiana ITS deployment architecture.	Regional and Statewide ITS device deployments	TBD	N/A	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD	TBD	-	TBD

7.2 NATIONAL ITS STANDARDS

Standards ensure that systems and components are compatible in technology and functionality. The standards are required so that the different stakeholders with diverse business functions and needs can work collaboratively to enable data sharing and coordination for systems that are deployed and leveraged for ITS applications. Standards facilitate system interoperability and regional integration, makes testing easier and minimizes integration costs for future devices. **Table 27** shows the standards applicable to the Louisiana Statewide ITS Architecture.

Table 27: Standards Definition

SDO	Group Short Name	Group Name	Included Standard Doc ID	Included Standard Title
AASHTO/ITE/NEMA	NTCIP C2C	NTCIP Center-to-Center Standards Group	NTCIP 1102	Octet Encoding Rules (OER) Base Protocol
			NTCIP 1104	Center-to-Center Naming Convention Specification
			NTCIP 2104	Ethernet Subnetwork Profile
			NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile
			NTCIP 2303	File Transfer Protocol (FTP) Application Profile
			NTCIP 2304	Application Profile for DATEX-ASN (AP-DATEX)
			NTCIP 2306	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML)
AASHTO/ITE/NEMA	NTCIP C2F	NTCIP Center-to-Field Standards Group	NTCIP 1102	Octet Encoding Rules (OER) Base Protocol
			NTCIP 1103	Transportation Management Protocols (TMP)
			NTCIP 2101	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile
			NTCIP 2102	Point to Multi-Point Protocol Using FSK Modem Subnetwork Profile

SDO	Group Short Name	Group Name	Included Standard Doc ID	Included Standard Title
			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	Simple Transportation Management Framework (STMF) Application Profile
			NTCIP 2302	Trivial File Transfer Protocol (TFTP) Application Profile
			NTCIP 2303	File Transfer Protocol (FTP) Application Profile
ASTM	DSRC 915MHz	Dedicated Short Range Communication at 915 MHz Standards Group	ASTM E2158-01	Standard Specification for Dedicated Short Range Communication (DSRC) Physical Layer using Microwave in the 902-928 MHz Band
ASTM/IEEE/SAE	DSRC 5GHz	Dedicated Short Range Communication at 5.9 GHz Standards Group	ASTM E2213-03	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems - 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications
			IEEE 1609.1-2006	Standard for Wireless Access in Vehicular Environments (WAVE) - Resource Manager
			IEEE 1609.2-2006	Standard for Wireless Access in Vehicular Environments (WAVE) - Security Services for Applications and Management Messages
			IEEE 1609.3	Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services
			IEEE 1609.4-2006	Standard for Wireless Access in Vehicular Environments (WAVE) - Multi-Channel Operation

SDO	Group Short Name	Group Name	Included Standard Doc ID	Included Standard Title
			IEEE 802.11p	Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - Part II: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification
			IEEE P1609.0	Standard for Wireless Access in Vehicular Environments (WAVE) - Architecture
IEEE	IEEE IM	Incident Management Standards Group	IEEE 1512 -2006	Standard for Common Incident Management Message Sets for use by Emergency Management Centers
			IEEE 1512.1-2006	Standard for Traffic Incident Management Message Sets for Use by Emergency Management Centers
			IEEE 1512.2-2004	Standard for Public Safety Traffic Incident Management Message Sets for Use by Emergency Management Centers
			IEEE 1512.3-2006	Standard for Hazardous Material Incident Management Message Sets for Use by Emergency Management Centers
			IEEE P1512.4	Standard for Common Traffic Incident Management Message Sets for Use in Entities External to Centers
SAE	ATIS General Use	Advanced Traveler Information Systems (ATIS) General Use Standards Group	SAE J2266	Location Referencing Message Specification (LRMS)
			SAE J2354	Message Set for Advanced Traveler Information System (ATIS)
			SAE J2540	Messages for Handling Strings and Look-Up Tables in ATIS Standards
			SAE J2540/1	RDS (Radio Data System) Phrase Lists
			SAE J2540/2	ITIS (International Traveler Information Systems) Phrase Lists
			SAE J2540/3	National Names Phrase List

SDO	Group Short Name	Group Name	Included Standard Doc ID	Included Standard Title
SAE	ATIS Low Bandwidth	Advanced Traveler Information Systems (ATIS) Bandwidth Limited Standards Group	SAE J2266	Location Referencing Message Specification (LRMS)
			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	RDS (Radio Data System) Phrase Lists
			SAE J2540/2	ITIS (International Traveler Information Systems) Phrase Lists
			SAE J2540/3	National Names Phrase List

8 INTERFACES AND INTERCONNECTS

The interfaces of the transportation systems in the architecture are based on the National ITS Architecture and tailored to reflect the plan for the Louisiana Statewide ITS Architecture. The context diagrams display the transportation systems and how these systems are and will be connected with one another so that information can be exchanged and transportation services can be coordinated. Stakeholders may use these diagrams to identify integration opportunities. Each system under the Statewide ITS Architecture can be represented with two types of diagrams: an overall interconnect diagram and element specific architecture flow context diagrams, both described below.

The interconnect context diagram shows the connections between systems (i.e., Elements). Interconnects are represented as single lines and indicate information sharing without specifying the type of information being shared or the direction of the information movement, shown as planned or existing. An architecture flow context diagram shows a particular system and all other systems with which it is interconnected, the information being shared (i.e. architecture flows), and the direction of the flow. Descriptions of the architecture flows are include in **APPENDIX B**. The architecture flow and interconnect context diagrams have been included within this document as part of **APPENDIX F**. Information about the interfaces of the systems is contained in the Turbo Architecture™ database.

9 AGREEMENTS

All existing agreements under the regional ITS deployments also apply to the Statewide ITS architecture. (See LADOTD website for information on regional planning documents[34]). New agreements with local agencies will be developed as the Statewide ITS architecture is expanded into new jurisdictions. **APPENDIX H** shows applicable agreements between LADOTD and other entities for ITS operations including video distribution agreements with media and joint use agreement for the proposed Northshore Traffic Management Center.

[34] http://www.dotd.la.gov/operations/its/documents.aspx#deployment

10 ARCHITECTURE MAINTENANCE PLAN

10.1 INTRODUCTION

This section discusses the proposed Maintenance Plan for the Statewide ITS Architecture. FHWA's Final Rule on ITS Architecture and Standards (23 CFR Part 940) requires development of an architecture maintenance plan. Paragraph 940.9 (f) states that:

> "The agencies and other stakeholders participating in the development of the regional ITS architecture shall develop and implement procedures and responsibilities for maintaining it, as needs evolve within the region."

In January 2004, FHWA issued guidance on what should be contained in an architecture maintenance plan in order to be compliant with FHWA requirements. The Maintenance Plan for the Statewide ITS Architecture is based on the guidelines provided by FHWA's White Paper[35].

This report provides some background on the need for architecture maintenance and addresses key issues under the following headings:

1. Why maintain a Statewide ITS Architecture?
2. Who will maintain the Architecture?
3. When will the Architecture be updated?
4. What will be maintained?
5. How will the Architecture be maintained?

10.2 WHY MAINTAIN A STATEWIDE ITS ARCHITECTURE?

As ITS projects are implemented, the Statewide ITS architecture will need to be updated to reflect new ITS priorities and strategies that emerge through the transportation planning process. It will also need to be updated to account for expansion in ITS scope and to allow for the evolution and incorporation of new ideas. The goal of the maintenance plan is to guide controlled updates to the Statewide ITS architecture baseline so that it continues to accurately reflect the State's existing ITS capabilities and future plans.

[35] http://ops.fhwa.dot.gov/its_arch_imp/guidance.htm

10.3 WHO WILL MAINTAIN THE ARCHITECTURE?

To maintain a consensus ITS architecture, ideally all stakeholders should participate in the process. The primary requirements of the Statewide architecture maintainer are the mission/authority to perform such functions and the necessary skills to perform the same. The mission of the ITS architecture maintainer most closely resembles a Statewide planning body that, as consistent with its mission, has the authority to initiate, update, and document changes in Statewide planning documents. For the Statewide ITS Architecture, LADOTD ITS Section will assume the role of the ITS Architecture keeper and maintainer.

The Statewide ITS planning document covers a period of 10 years however yearly meetings of the stakeholder group will allow periodic evaluation of the existing system and updates to programs or projects.

A qualified consultant to assist with the ITS architecture maintenance activities is desirable. (LADOTD has on a retainer contract a professional engineer consulting firm to provide ITS TIM Program, TMC Operations Staffing and Systems Engineering Support).

Although LADOTD ITS Section will lead the architecture maintenance activities, like all other Statewide planning activities, ITS architecture maintenance will take close coordination between several stakeholder agencies. LADOTD ITS Section will need to coordinate with other major stakeholders* in the state, including:

1. LADOTD District Offices
2. Louisiana State Police
3. Emergency Medical Services
4. Department of Public Safety
5. Department of Public Works
6. DEQ
7. LTRC
8. Metropolitan Planning Organizations

*Note – Other stakeholders may be included as necessary based on ITS development and deployment activities.

As LADOTD ITS Section takes responsibility for architecture maintenance, they will use agreements to create a management/oversight function to oversee ITS architecture

maintenance work, which would have representation from the key stakeholders to the agreement as listed above. At a minimum, such a committee will include two LADOTD representatives, an MPO representative, and one FHWA representative.

It is proposed that the stakeholder group for the Statewide ITS Architecture meet at least once a year to report/discuss and recommend updates to the existing ITS Architecture. This stakeholder group will also be responsible for reporting all new ITS deployments that can be leveraged for Statewide application. LADOTD ITS Section will also be responsible for following up with all of stakeholders to ensure that any and all ITS deployments are reported and documented in the Statewide plan including updates to the Statewide ITS architectures. Other responsibilities include but are not limited to the following:

1. Verify that the Statewide ITS architecture Turbo Architecture™ source file is kept up to date with the Statewide ITS deployment projects

2. Update plans for future deployments by Statewide stakeholder

3. Review changes in State and National ITS Architectures, regulations, and requirements, if any

4. Determine any needs for an update to the Statewide ITS Architecture

10.4 WHEN WILL THE ARCHITECTURE BE UPDATED?

The Statewide ITS architecture is not static. It must change as plans change, as ITS projects are implemented, and as the ITS needs and services evolve in the State. At a minimum, the Statewide ITS architecture will be reviewed annually by the stakeholders. The stakeholders may meet and perform architecture updates more frequently to keep with the pace of the State's ITS implementation. Annual or more frequent updates will include integrating completed projects into the Statewide ITS architecture Turbo Architecture™ source file. A one page summary of the change will be added as an appendix to the Statewide ITS architecture document.

Regardless of the frequency selected for periodic updates, it is recommended that the stakeholders recognize the potential need for "Exception Maintenance" to occur in the event of major project implementations, major revisions to the National ITS Architecture, or to meet the requirements of future regulations. It is recommended that the Statewide ITS architecture is fully updated every ten years. The following list includes many of the events that may cause change to a Statewide ITS architecture:

10.4.1 Changes in Statewide Needs

Statewide ITS architectures are created to support transportation planning in addressing Statewide needs. Over time these needs can change and the corresponding aspects of the Statewide ITS architecture that addresses these needs may need to be updated. These

changes in needs should be expressed in updates to planning documents such as the Statewide Transportation Plan.

10.4.2 New Stakeholders

New stakeholders become active in ITS and the statewide ITS architecture should be updated to reflect their place in the statewide view of ITS elements, interfaces, and information flows. New stakeholders might represent new organizations that were not in place during the original development of the statewide ITS architecture.

10.4.3 Changes in Scope of Services Considered

The range of services considered by the Statewide ITS architecture could expand. This might happen because the National ITS Architecture has been expanded and updated to include new user services or to better define how existing elements satisfy the user services. The National ITS Architecture may have expanded to include a user service that is not in the Statewide ITS architecture, or was included in only a very cursory manner. Changes in the National ITS Architecture are not of themselves a reason to update a Statewide ITS architecture, but the stakeholders may want to consider any new services in the context of their statewide needs.

10.4.4 Changes in Stakeholder or Element Names

An agency's name or the name used to describe their element(s) undergoes change. Transportation agencies occasionally merge, split, or just rename themselves. In addition, element names may evolve as projects are defined. The statewide ITS architecture should be updated to use the current, correct names for both stakeholders and elements.

10.4.5 Changes in Other Architectures

A Statewide ITS architecture may interface with adjoining regional or statewide ITS architecture. Changes in the adjoining architecture may necessitate changes in the Statewide ITS Architecture to maintain consistency between the two. Architectures may also overlap (e.g. a Statewide ITS architecture and a regional ITS architecture for a region within the state) and a change in one might necessitate a change in the other.

10.4.6 Changes due to Project Definition or Implementation

There are several changes relating to project definition that will cause the need for updates to the Statewide ITS architecture. When actually defined or implemented, a project may add, subtract or modify elements, interfaces, or information flows from the Statewide ITS architecture. Because the Statewide ITS architecture is meant to describe the current, as well as future, statewide implementation of ITS, it must be updated to correctly reflect how the developed projects are integrated.

10.4.7 Changes due to Project Addition/Deletion

Occasionally a project will be added or deleted through the planning process, or through project delivery, and some aspects of the Statewide ITS architecture that are associated with the project may be expanded, changed, or removed.

10.4.8 Changes in Project Priority

Due to funding constraints, or other considerations, the planned project sequencing may change. Delaying a project may have a ripple effect on other projects that depend on it. Raising the priority for a project's implementation may impact other projects that are related to it.

10.5 WHAT WILL BE MAINTAINED?

Those constituent parts of the Statewide ITS architecture that will be maintained are referred to as the "baseline". This section considers the different "parts" of the Statewide ITS architecture and whether they should be a part of the baseline. Baseline parts are annually updated within the Statewide ITS architecture Turbo file and every ten years within the document. The parts discussed are:

- Description of Region
- List of Stakeholders
- Operational Concepts
- List of ITS Elements
- List of Agreements
- Interfaces between Elements
- System Functional Requirements
- Applicable ITS Standards
- Project Sequencing

One of the benefits of a Statewide ITS architecture is to enable the efficient exchange of information between ITS elements in one region with elements outside the region. Efficiency refers to the economical deployment of ITS elements and their interfaces. The result of these ITS deployments should be contributions to the safe and efficient operation of the surface transportation network. Each of the components in the Statewide ITS architecture below have a role in this economy and an appropriate effort should be levied to maintain them.

10.5.1 Description of Region

This description includes the geographic scope, functional scope, and architecture timeframe, and helps frame each of the following parts of a Statewide ITS architecture. Geographic scope defines the ITS elements that are “in” the State, although additional ITS elements outside the State may be needed to be described if they communicate ITS information to elements inside the State. Functional scope defines which services are included in the ITS architecture. Architecture timeframe is the distance (in years) into the future that the Statewide ITS architecture will consider. The description of the region is usually contained in an architecture document, but may reside in a database containing aspects of the Statewide ITS architecture, and should certainly be a part of the baseline.

10.5.2 List of Stakeholders

Stakeholders are of great importance to the definition of the architecture. Stakeholders may consolidate or separate and such changes should be reflected in the architecture. Furthermore, stakeholders that have not been engaged in the past may be approached through outreach to be sure that the Statewide ITS architecture represents their ITS requirements as well. The stakeholders should be described in architecture documentation (and may also reside in a database representing aspects of the Statewide ITS architecture). Their listing and description should be part of the baseline.

10.5.3 Operational Concepts

It is crucial that the operational concepts represented as roles and responsibilities or as customized service packages in a Statewide ITS architecture accurately represent the consensus vision of how the stakeholders want their ITS to operate for the benefit of surface transportation users. These should be reviewed and, if necessary, changed to represent both what has been deployed (which may have been shown as “planned” in the earlier version of the statewide ITS architecture) and the current consensus view of the stakeholders. Many of the remaining maintenance efforts will depend on the outcome of the changes made here. The operational concept will reside in the architecture documentation and possibly in a diagramming tool if a customized service package approach is used, and should be part of the baseline.

10.5.4 List of ITS Elements

The inventory of ITS elements is a key aspect of the statewide ITS architecture. Changes in stakeholders as well as operational concepts may impact the inventory of ITS elements. Furthermore, recent implementation of ITS elements may change their individual status (e.g. from planned to existing). The list of elements is often contained in architecture documentation and is key information in any architecture database. It is a key aspect of the baseline.

10.5.5 List of Agreements

One of the greatest values of a statewide ITS architecture is to identify where information will cross an agency boundary, which may indicate a need for an agency agreement. An update to the list of agreements can follow the update to the Operational Concept and/or interfaces between elements. The list of agreements will usually be found in the architecture documentation. This listing should be a part of the baseline.

10.5.6 Interfaces between Elements

Interfaces between elements define the “details” of the architecture. They are the detailed description of how the various ITS elements are or will be integrated throughout the timeframe of the architecture. These details are usually held in an architecture database. They are a key aspect of the architecture baseline and one that will likely see the greatest amount of change during the maintenance process.

10.5.7 System Functional Requirements

High-level functions are allocated to ITS elements as part of the Statewide ITS architecture. These can serve as a starting point for the functional definition of projects that map to portions of the Statewide ITS architecture. Usually this information is held in spreadsheets or databases, but may be included in the architecture document. They are a part of the baseline.

10.5.8 Applicable ITS Standards

The selection of standards depends on the information exchange requirements. But in addition, the maintenance process should consider how ITS standards may have evolved and matured since the last update and consider how any change in the “standards environment” may impact previous standards choices (especially where competing standards exist). For example, if Extensive Markup Language (XML) based Center-To-Center standards reach a high level of maturity, reliability, and cost-effectiveness, then a statewide standards technology decision may be made to transition from investments in other standards technologies (e.g. Common Object Request Broker Architecture (CORBA) to XML). The description of the standards environment for statewide, as well as the details of which standards apply to the architecture, should be part of the baseline.

10.5.9 Project Sequencing

While project sequencing is partly determined by functional dependencies (e.g. “surveillance” must be a precursor to “traffic management”), the reality is that most project sequences are local policy decisions. Project sequences should be reviewed to make sure that they are in line with current policy decisions. Furthermore, policy makers should be informed of the sequences and their input should be sought to make the project sequences coincide with their expectations. This is crucial to eliminate the possibility of the Statewide ITS architecture becoming irrelevant. The project sequencing should be included in the architecture

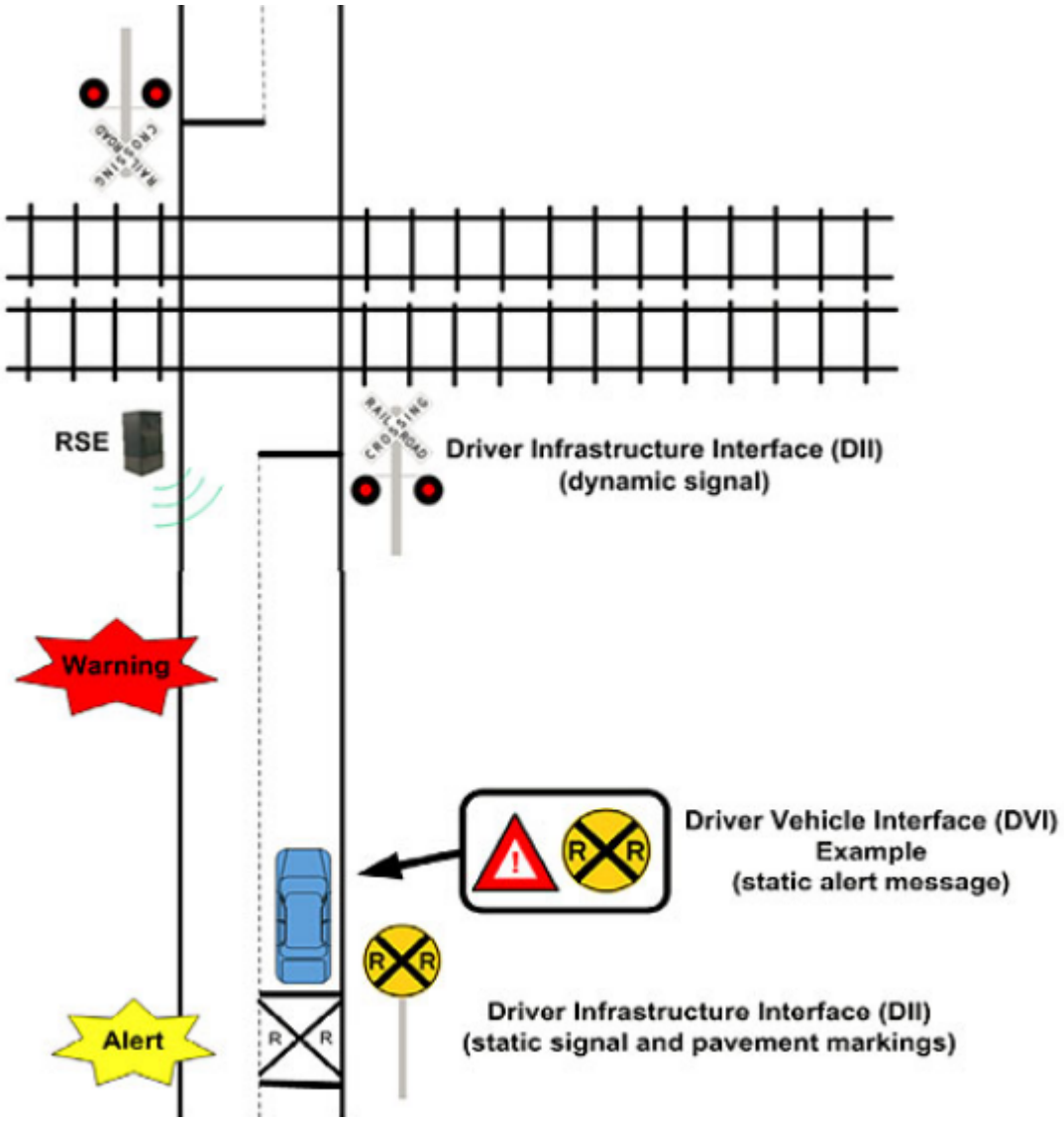
documentation and may also be held in a spreadsheet or database. These should be part of the architecture baseline.

10.6 HOW WILL THE ARCHITECTURE BE MAINTAINED?

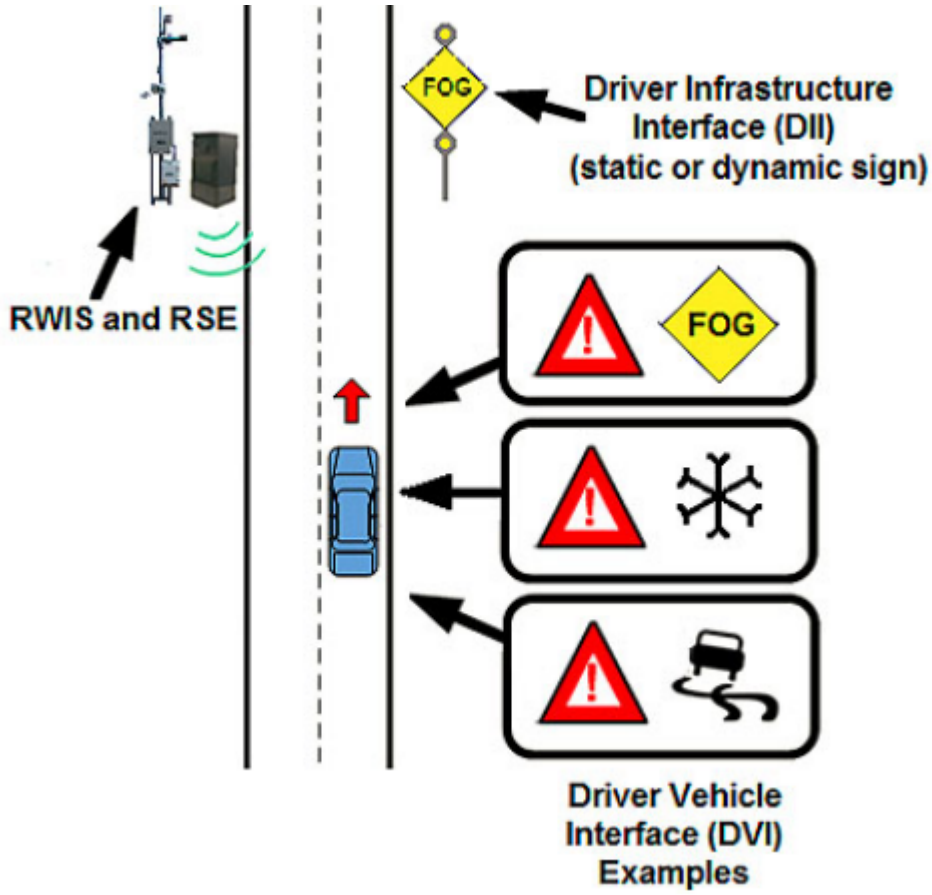
LADOTD ITS Section (Section 56) will oversee and ensure that the Statewide architecture is maintained. The guidelines contained within FHWA's Regional ITS Architecture Maintenance White Paper will be helpful in guiding the maintenance effort. In addition to detailing the recommended maintenance process, the White Paper also contains examples of Maintenance Plans developed by a range of agencies and regions throughout the country.

APPENDIX A – CONNECTED VEHICLE CONCEPTS

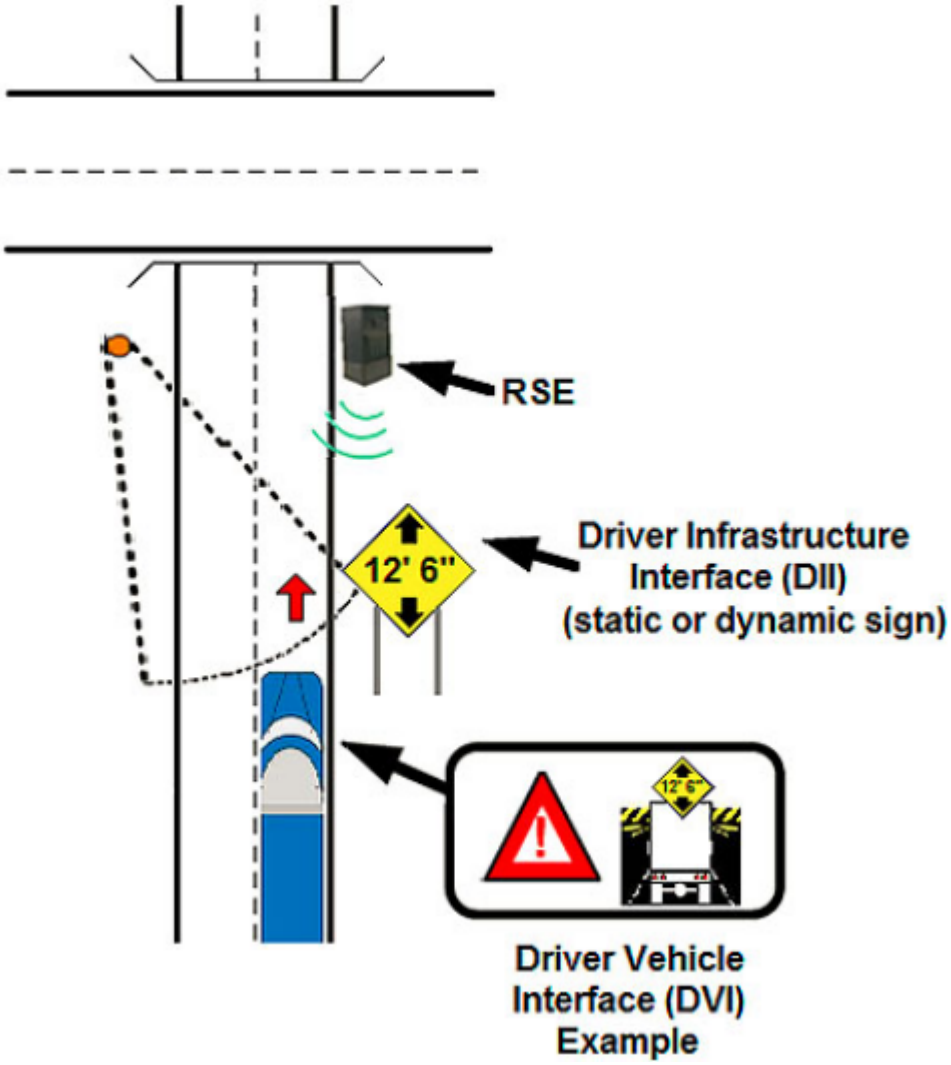
This section illustrates some connected vehicle applications for safety and mobility and also presents potential communications between entities for various functions including support functions for the connected vehicle environment. These are only intended to illustrate the applications of connected vehicle and connected vehicle reference implementation architecture (CVRIA).



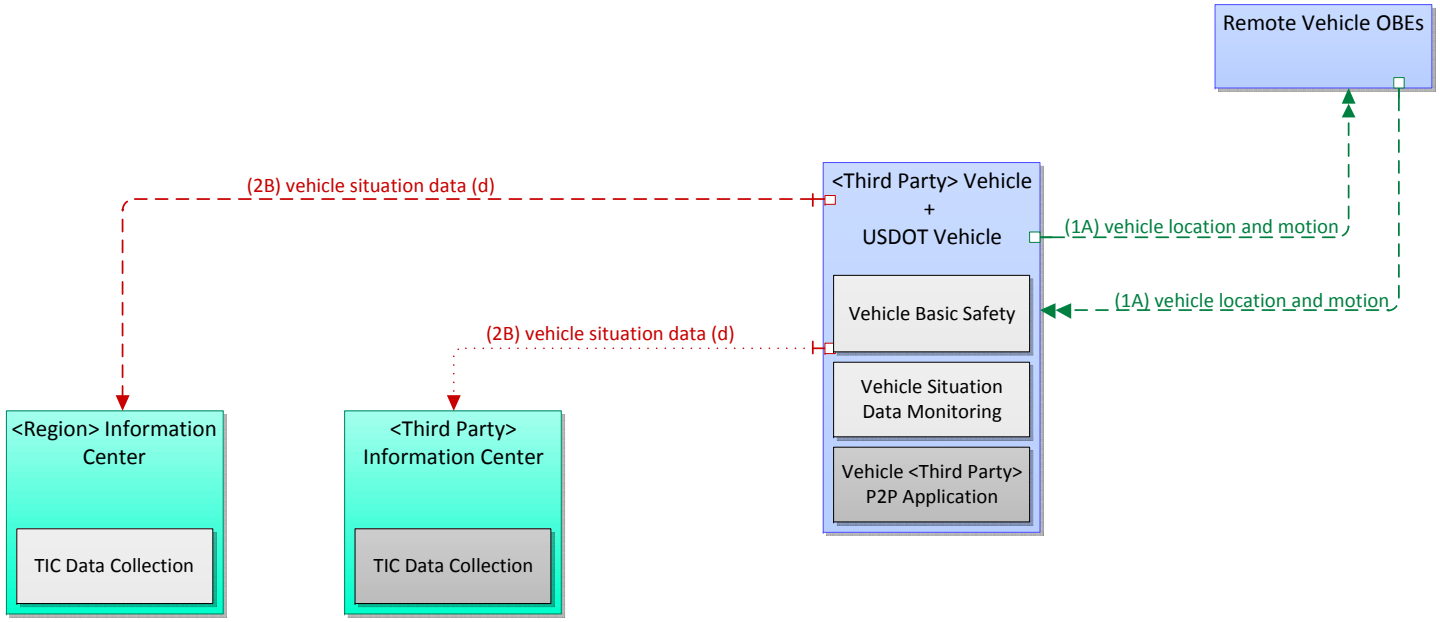
App Figure A-1: Rail Crossing Violation Warning Concept (Source: USDOT)

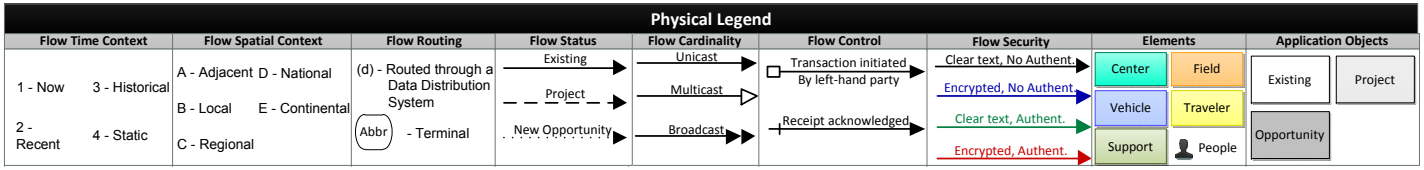


App Figure A-2: Spot Weather Impact Warning Concept (Source: USDOT)

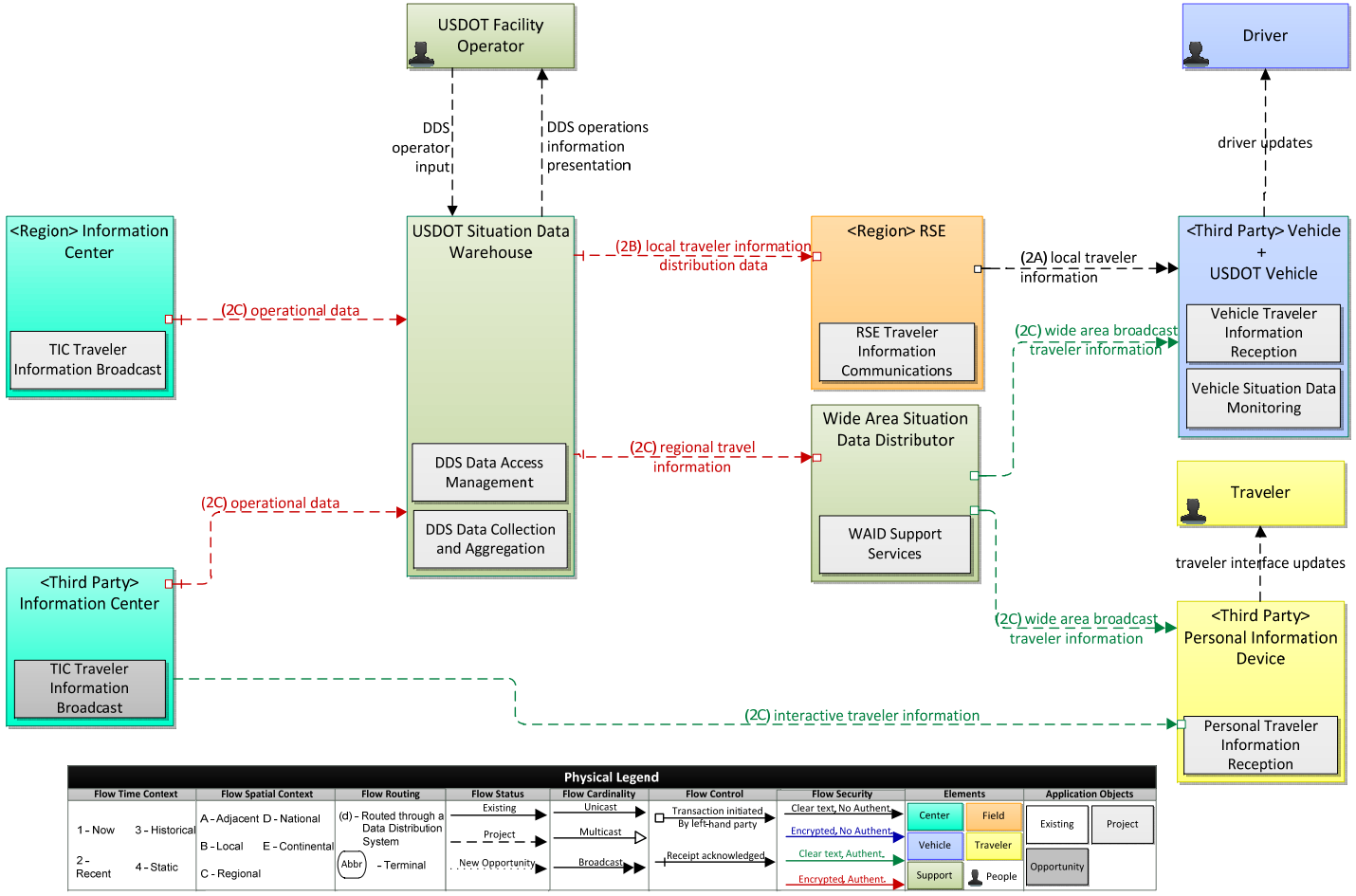


App Figure A-3: Oversize Vehicle Warning Concept (Source: USDOT)

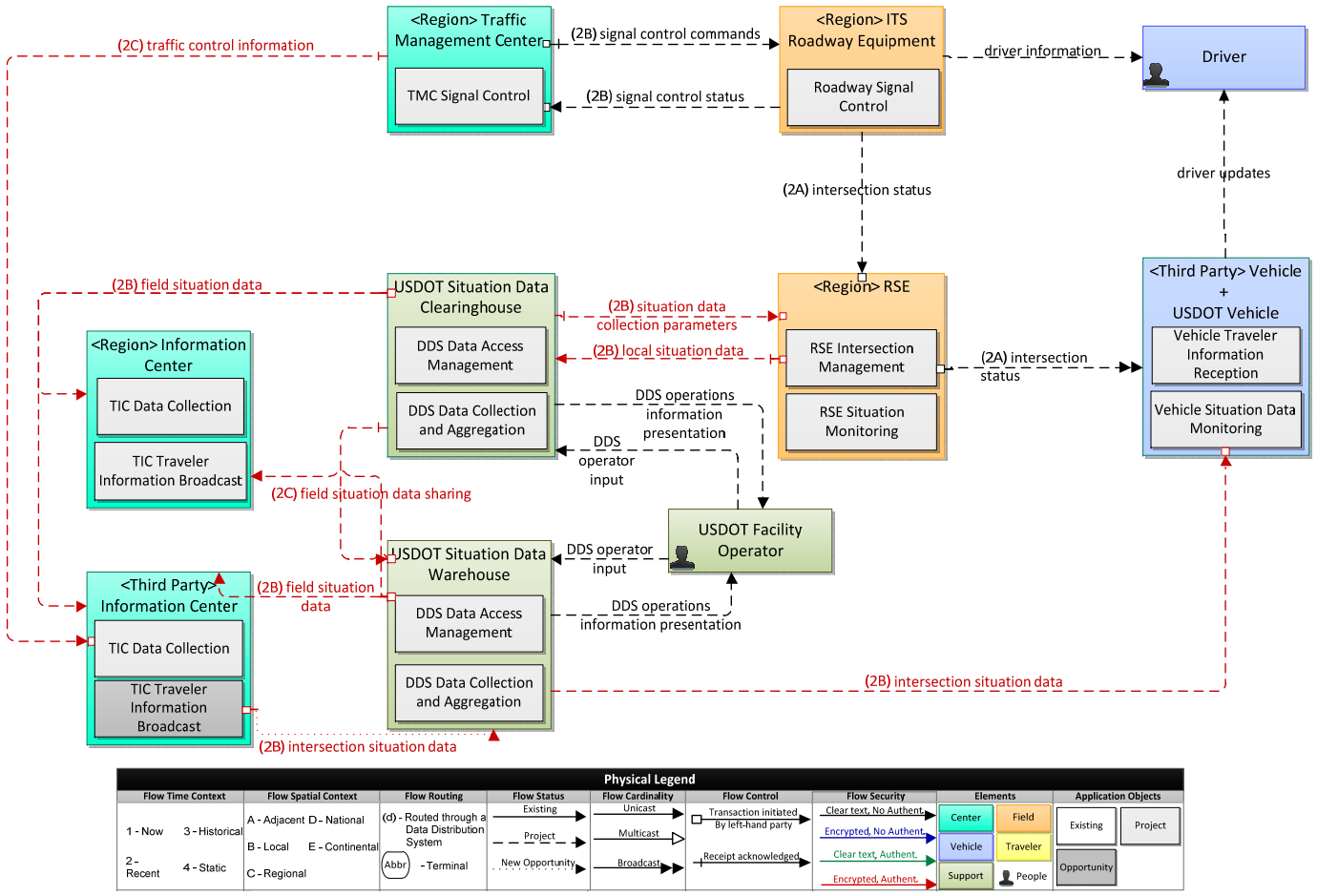




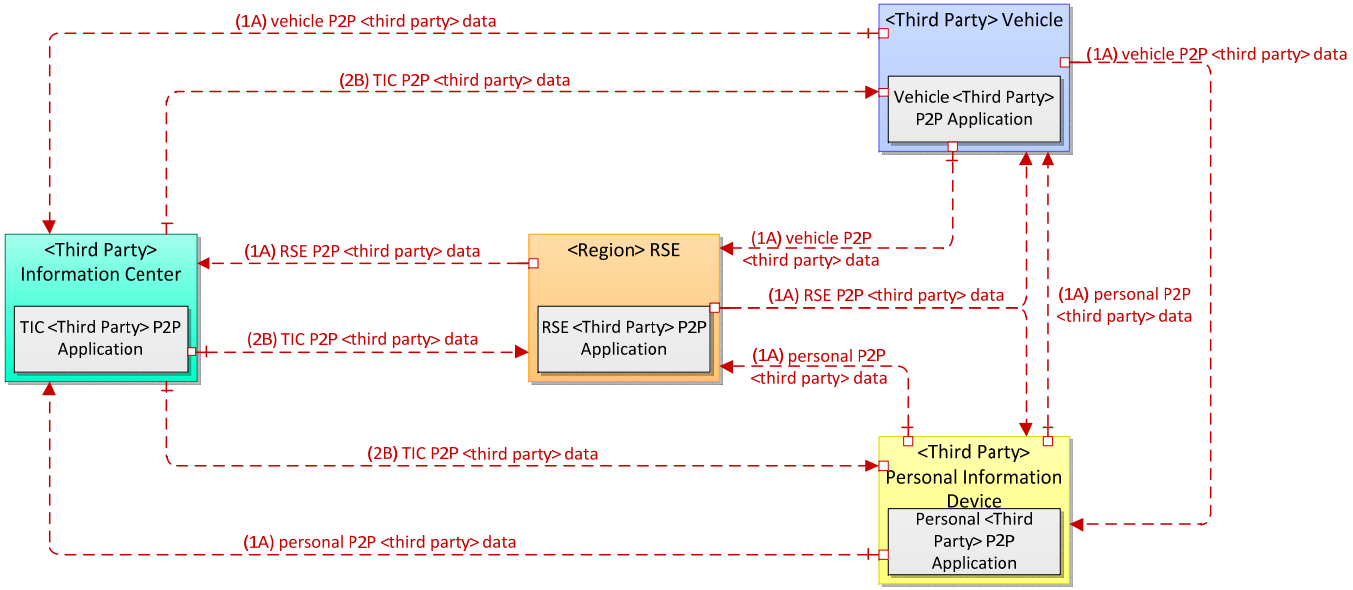
App Figure A-4: Vehicle Situation Data Collection

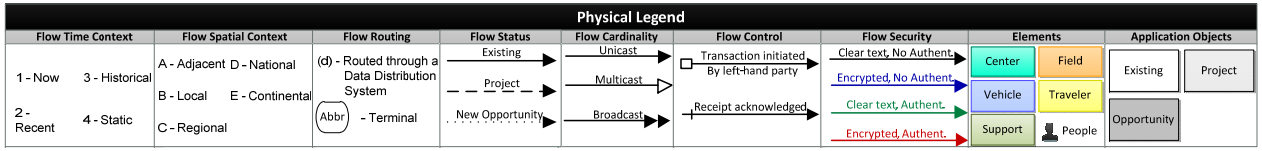


App Figure A-5: Traveler Situation Data Distribution

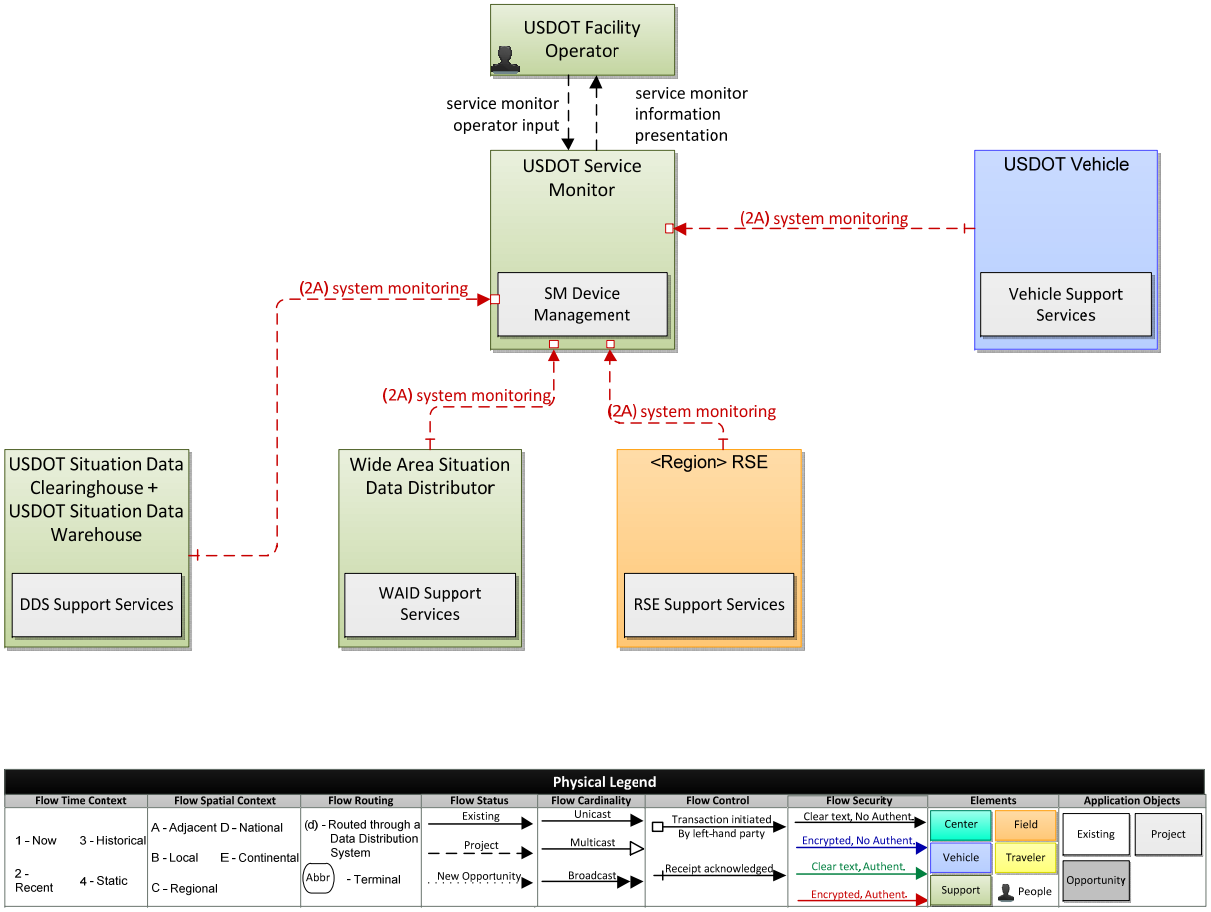


App Figure A-6: Field Situation Data Distribution

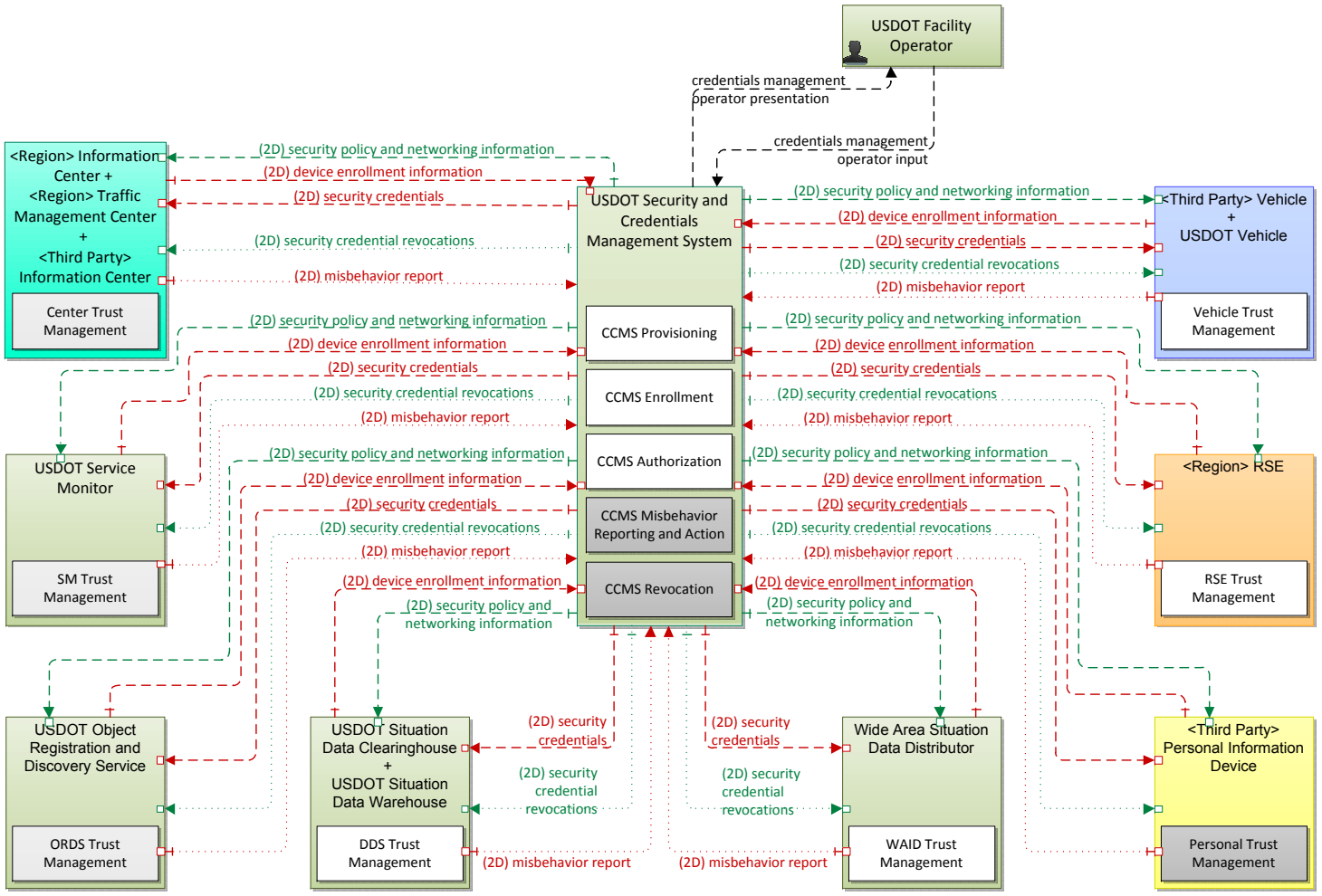




App Figure A-7: Third Party Peer-to-Peer Application



App Figure A-8: System Monitoring for CVRIA-RS



App Figure A-9: Security Credentials Management for CVRIA-RS

APPENDIX B **– SIGNAL SYSTEMS WITH FIBER OPTICS**

Location	Corridor	Access Points
District 02	US 61	US 61 (Airline Hwy @ LA 48 (Apple St)
		US 61 (Airline Hwy @ Shell Oil
		US 61 (Airline Hwy @ LA 627 (Prospect Road)
		US 61 (Airline Hwy @ Ormond Blvd
		US 61 (Airline Hwy @ LA 50 Almedia Road
		US 61 (Airline Hwy @ Riverbend Blvd
		US 61 (Airline Hwy @ James Park Blvd.
		US 61 (Airline Hwy @ Alliance Street
		US 61 (Airline Hwy) @ Farrar ST /Cargo Road
		US 61 (Airline Hwy) @ Airport Road
		US 61 (Airline Hwy) @ Hollandey St
		US 61 (Airline HWY) @ Airport Access Road
		US 61 (Airline Hwy) @ Daniel St
		US 61 (Airline Hwy) @ LA 49 Williams Blvd
District 02H	LA 24	LA 24 SB (Main St.) @ US 90 EB
		LA 24 NB (W. Park Ave) @ US 90 EB
		LA 24 SB (Main St.) @ US 90 WB
		LA 24 NB (W. Park Ave) @ US 90 WB
		LA 24 SB (Main St.) @ Coteau Rd
		LA 24 NB (Par Rd 33 or Park Ave.) @ Coteau Rd
		LA 24 SB (Main St.) @ Oakshire Dr
		LA 24 NB (Par Rd 33 or Park Ave.) @ Idlewild Dr
		LA 24 SB (Main St.) @ LA 3040 (Martin Luther King Blvd.)
		LA 24 NB (W. Park Ave) @ LA 3040 (Bayou Grandens Blvd.)
		LA 24 SB (Maint St.) @ Southland Mall Bridge
		LA 24 SB (Park Rd 33 or Park Ave.) @ Southland Mall Bridge
		LA 24 SB (Main St.) @ Funderburk Ave
		LA 24 NB (W. Park Ave.) @ Funderburk Ave
		LA 24 SB (Main St.) @ Westside Blvd
		LA 24 NB (W. Park Ave.) @ Westside Blvd
		LA 24 SB (Main St.) @ Buquet St
		LA 24 SB (Main St.) @ Duet St

Location	Corridor	Access Points
		LA 24 NB (W. Park Ave.) @ Duet St (or Everest St.)
		LA 24 SB (Main St.) @ Roy St
		LA 24 NB (W. Park Ave.) @ Holiday Dr
		LA 24 SB (Main St.) @ S. Hollywood Rd
		LA 24 NB (W. Park Ave.) @ N. Hollywood Rd
District 61	LA 44	LA 44 (S. Burnside Ave.) @ i10
		LA 44 @Edenborn Parkway
District 62	US 61	US 61 (Airline Hwy)@ US51 (OLD) & LA 44 (Main St)
		US 61 (Airline Hwy)@ Ormond Blvd
		US 61 (Airline Hwy) @ LA 53 (Central Ave)
		US 61 (Airline Hwy)@ LA 3224 (Hemlock& Carrollwood
		US 61 (Airline Hwy) @ US 51 NEW
		US 61 (Airline Hwy) @ Riverforest Subdivison (Winsor)
		US 61 (Airline Hwy) @ LA 636-1 McReine Rd.)
		US 61 (Airline Hwy) @ Cambridge Place
		US 61 (Airline Hwy) @ LA 3188 (Belle Terre Blvd)
		US 61 (Airline Hwy) @ LA 3223 (Elm St)
		US 61 (Airline Hwy) @ LA 637
		US 61 (Airline Hwy) @ Rue De Sante
		US 61 (Airline Hwy) @ Entrance to Marathon Oil
		US 61 (Airline Hwy) @ Belle Point Blvd
		US 61 (Airline Hwy) @ Magnolia St
		US 61 (Airline Hwy) @ Terre Haute

APPENDIX C – FLOW DEFINITIONS

This section will define the architecture information flows used in the Statewide ITS architecture. **App Table C-1** shows all the flow types and definitions used in this architecture.

App Table C-1: Statewide ITS Architecture Flow Definitions

Flow Name	Flow Description
air quality information	Aggregated region-wide measured air quality data and possible pollution incident information.
alert notification	Notification of a major emergency such as a natural or man-made disaster, civil emergency, or child abduction for distribution to the public. The flow identifies the alert originator, the nature of the emergency, the geographic area affected by the emergency, the effective time period, and information and instructions necessary for the public to respond to the alert. This flow may also identify specific information that should not be released to the public.
alert notification coordination	Coordination of emergency alerts to be distributed to the public. This includes notification of a major emergency such as a natural or man-made disaster, civil emergency, or child abduction for distribution to the public and status of the public notification.
alert status	Information indicating the current status of the emergency alert including identification of the traveler and driver information systems that are being used to provide the alert.
archive analysis requests	A user request that initiates data mining, analytical processing, aggregation or summarization, report formulation, or other advanced processing and analysis of archived data. The request also includes information that is used to identify and authenticate the user and support electronic payment requirements, if any.
archive analysis results	Processed information products, supporting meta data, and any associated transaction information resulting from data mining, analytical processing, aggregation or summarization, report formulation, or other on-line processing and analysis of archived data.
archive management data	Presentation of information to the administrator to support the management of an ITS archive including database reports on the condition and quality of the archived data, status of the import and collection process, reports that monitor archive usage, and any special requests that require direct action by the administrator (e.g., requests for access to new data sources).
archive management requests	User input from the administrator including commands, requests, and queries that support data collection, administration, and management of an ITS data archive.
archive request confirmation	Confirmation that an archive request has been received and processed with information on the disposition of the request.

Flow Name	Flow Description
archive requests	A request to a data source for information on available data (i.e. "catalog") or a request that defines the data to be archived. The request can be a general subscription intended to initiate a continuous or regular data stream or a specific request intended to initiate a one-time response from the recipient.
archive status	Notification that data provided to an archive contains erroneous, missing, or suspicious data or verification that the data provided appears valid. If an error has been detected, the offending data and the nature of the potential problem are identified.
archived data product requests	A user-specified request for archived data products (i.e. data, meta data, or data catalogs). The request also includes information that is used to identify and authenticate the user and support electronic payment requirements, if any.
archived data products	Raw or processed data, meta data, data catalogs and other data products provided to a user system upon request. The response may also include any associated transaction information.
asset archive data	Information describing transportation assets including pavements, bridges, and all other infrastructure included in the transportation network. In addition, information can cover support assets (support equipment and systems, software, etc.). Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
asset restrictions	Restrictions levied on transportation asset usage based on infrastructure design, surveys, tests, or analyses. This includes standard height, width, and weight restrictions by facility as well as special restrictions such as spring weight restrictions and temporary bridge weight restrictions.
asset status update	Changes to status of pavement, bridges, signs and other assets resulting from maintenance or construction activities or infrastructure monitoring. The updates may include changes in installation information, materials information, vendor/contractor information, condition, and current maintenance status. In addition to infrastructure asset updates, the information provided may also include status of the maintenance and construction support assets, including vehicle and equipment utilization and repair records.
barrier system control	Information used to configure and control barrier systems that are represented by gates, barriers and other automated or remotely controlled systems used to manage entry to roadways.
booking status	Status of the freight transport booking that includes the identities of the Commercial Vehicle and driver who will pick-up the freight or a request for more information from the originator.
broadcast traveler information	General traveler information that contains traffic and road conditions, link travel times, incidents, advisories, restrictions, transit service information, weather information, parking information, and other related traveler information.
carrier participation report	Report that summarizes motor carrier participation in CVO programs. Used to identify the level of active participation and to report which enrolled carriers are not participating as expected.
commercial vehicle permit	Permit for oversize, overweight, or hazmat shipments.
credentials information	Response containing full vehicle fuel tax and registration credentials information. "Response" may be provided in reaction to a real-time query or a standing request for updated information. The query flow is not explicitly shown.

Flow Name	Flow Description
credentials status information	Credentials information such as registration, licensing, insurance, check flags, and electronic screening enrollment data. A unique identifier is included. Corresponds to the credentials portion of CVISN "snapshots." The status information may be provided as a response to a real-time query or as a result of a standing request for updated information (subscription). This may also include information about non-U.S. fleets for use by U.S. authorities, and information regarding U.S. fleets made available to Mexican and Canadian authorities. The query flow is not explicitly shown.
current asset restrictions	Restrictions levied on transportation asset usage based on infrastructure design, surveys, tests, or analyses. This includes standard facility design height, width, and weight restrictions, special restrictions such as spring weight restrictions, and temporary facility restrictions that are imposed during maintenance and construction.
cv driver record	Information typically maintained by a state driver licensing agency about a driver of a commercial vehicle including driver identification data, license data, permit data, and driving history details. Information can correspond to a 'driver snapshot' as described by the CVISN program. The query flow is not explicitly shown.
data collection and monitoring control	Information used to configure and control data collection and monitoring systems.
decision support information	Information provided to support effective and safe incident response, including local traffic, road, and weather conditions, hazardous material information, and the current status of resources that have been allocated to an incident.
device control request	Request for device control action
device data	Data from detectors, environmental sensor stations, and traffic control devices including device inventory information.
device status	Status information from devices
emergency archive data	Logged emergency information including information that characterizes identified incidents (routine highway incidents through disasters), corresponding incident response information, evacuation information, surveillance data, threat data, and resource information. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
emergency operations inputs	Emergency operator inputs supporting call taking, dispatch, emergency operations, security monitoring, and other operations and communications center operator functions.
emergency operations status	Presentation of information to the operator including emergency operations data, supporting a range of emergency operating positions including call taker, dispatch, emergency operations, security monitoring, and various other operations and communications center operator positions.
emergency personnel information presentation	Presentation of information to emergency personnel in the field including dispatch information, incident information, current road network conditions, device status, and other supporting information.

Flow Name	Flow Description
emergency personnel inputs	User input from emergency personnel in the field including dispatch coordination, incident status information, and remote device control requests.
emergency plan coordination	Information that supports coordination of emergency management plans, continuity of operations plans, emergency response and recovery plans, evacuation plans, and other emergency plans between agencies. This includes general plans that are coordinated prior to an incident and shorter duration tactical plans that are prepared during an incident.
emergency traffic control information	Status of a special traffic control strategy or system activation implemented in response to an emergency traffic control request, a request for emergency access routes, a request for evacuation, a request to activate closure systems, a request to employ driver information systems to support public safety objectives, or other special requests. Identifies the selected traffic control strategy and system control status.
emergency traffic control request	Special request to preempt the current traffic control strategy in effect at one or more signalized intersections or highway segments, activate traffic control and closure systems such as gates and barriers, activate safeguard systems, or use driver information systems. For example, this flow can request all signals to red-flash, request a progression of traffic control preemptions along an emergency vehicle route, request a specific evacuation traffic control plan, request activation of a road closure barrier system, or place a public safety or emergency-related message on a dynamic message sign.
emergency traffic coordination	Coordination supporting disaster response including evacuation and reentry. Includes coordination of special traffic control strategies that support efficient evacuation and reentry while protecting and optimizing movement of response vehicles and other resources responding to the emergency.
emergency transit schedule information	Information on transit schedule and service changes that adapt the service to better meet needs of responders and the general public in an emergency situation, including special service schedules supporting evacuation.
emergency transit service request	Request to modify transit service and fare schedules to address emergencies, including requests for transit services to evacuate people from and/or deploy response agency personnel to an emergency scene. The request may poll for resource availability or request pre-staging, staging, or immediate dispatch of transit resources.
emergency transit service response	Response indicating changes to transit service, fares, and/or restrictions that will be made and status of transit resources to be deployed to support emergency response and/or evacuation.
emergency traveler information	Public notification of an emergency such as a natural or man-made disaster, civil emergency, or child abduction. This flow also includes evacuation information including evacuation instructions, evacuation zones, recommended evacuation times, tailored evacuation routes and destinations, traffic and road conditions along the evacuation routes, traveler services and shelter information, and reentry times and instructions.
emissions archive data	Air quality and vehicle emissions information that is collected by sensors or derived from models. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
environmental conditions data	Current road conditions (e.g., surface temperature, subsurface temperature, moisture, icing, treatment status) and surface weather conditions (e.g., air temperature, wind speed, precipitation, visibility) as measured and reported by fixed and/or mobile environmental sensors and aggregated by the data collector. Attributes relating to the data collection (and aggregation) are also included.

Flow Name	Flow Description
environmental probe data	Data from vehicle safety and convenience systems that can be used to estimate environmental conditions, including measured air temperature, exterior light status, wiper status, sun sensor status, rain sensor status, traction control status, anti-lock brake status, and other collected vehicle system status and sensor information. The collected data is reported along with the location, heading, and time that the data was collected. Both current data and snapshots of recent events (e.g., traction control or anti-lock brake system activations) may be reported.
environmental sensor data	Current road conditions (e.g., surface temperature, subsurface temperature, moisture, icing, treatment status) and surface weather conditions (e.g., air temperature, wind speed, precipitation, visibility) as measured and reported by fixed and/or mobile environmental sensors. Operational status of the sensors is also included.
environmental sensors control	Data used to configure and control environmental sensors.
evacuation coordination	Coordination of information regarding a pending or in-process evacuation. Includes evacuation zones, evacuation times, evacuation routes, forecast network conditions, and reentry times.
evacuation information	Evacuation instructions and information including evacuation zones, evacuation times, and reentry times.
event confirmation	Confirmation that special event details have been received and processed.
event information	Special event information for travelers. This would include a broader array of information than the similar "event plans" that conveys only information necessary to support traffic management for the event.
event plans	Plans for major events possibly impacting traffic.
external reports	Traffic and incident information that is collected by the media through a variety of mechanisms (e.g., radio station call-in programs, air surveillance).
fare and price information	Current transit, parking, and toll fee schedule information.
freight equipment information	Container, trailer, or chassis information regarding identity, type, location, brake wear data, mileage, seal #, seal type, door open/close status, chassis bare/covered status, tethered / untethered status, Bill of Lading, and sensor status.
identities	Identification information for the Commercial Vehicle (e.g., license plate number or USDOT number), Freight Equipment (e.g., container, chassis, or trailer identification), and Driver.
incident command information coordination	Information that supports local management of an incident. It includes resource deployment status, hazardous material information, traffic, road, and weather conditions, evacuation advice, and other information that enables emergency or maintenance personnel in the field to implement an effective, safe incident response.
incident command information presentation	Presentation of information to emergency personnel in the field that supports local tactical decision-making within an incident command system structure.

Flow Name	Flow Description
incident command inputs	User input from emergency personnel including incident command status, incident information and resource coordination.
incident information	Notification of existence of incident and expected severity, location, time and nature of incident. As additional information is gathered and the incident evolves, updated incident information is provided. Incidents include any event that impacts transportation system operation ranging from routine incidents (e.g., disabled vehicle at the side of the road) through large-scale natural or human-caused disasters that involve loss of life, injuries, extensive property damage, and multi-jurisdictional response. This also includes special events, closures, and other planned events that may impact the transportation system.
incident information for media	Report of current desensitized incident information prepared for public dissemination through the media.
incident response coordination	Incident response procedures and current incident response status that are shared between allied response agencies to support a coordinated response to incidents. This flow provides current situation information, including a summary of incident status and its impact on the transportation system and other infrastructure, and current and planned response activities. This flow also coordinates a positive hand off of responsibility for all or part of an incident response between agencies.
incident response status	Status of the current incident response including a summary of incident status and its impact on the transportation system, traffic management strategies implemented at the site (e.g., closures, diversions, traffic signal control overrides), and current and planned response activities.
infrastructure monitoring sensor control	Data used to configure and control infrastructure monitoring sensors.
infrastructure monitoring sensor data	Data read from infrastructure-based sensors that monitor the condition or integrity of transportation infrastructure including bridges, tunnels, interchanges, pavement, culverts, signs, transit rail or guideway, and other roadway infrastructure. Includes sensor data and the operational status of the sensors.
interactive traveler information	Traveler information provided in response to a traveler request. The provided information includes traffic and road conditions, advisories, incidents, payment information, transit services, parking information, weather information, and other travel-related data updates and confirmations.
intermodal freight archive data	Information describing demand at intermodal freight terminals including loading/unloading activities of trailers and containers. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
logged vehicle routes	Anticipated route information for guided vehicles, special vehicles (e.g., oversize vehicles) or groups of vehicles (e.g., governor's motorcade) that may require changes in traffic control strategy.
maint and constr archive data	Information describing road construction and maintenance activities identifying the type of activity, the work performed, and work zone information including work zone configuration and safety (e.g., a record of intrusions and vehicle speeds) information. For construction activities, this information also includes a description of the completed infrastructure, including as-built plans as applicable. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.

Flow Name	Flow Description
maint and constr resource request	Request for road maintenance and construction resources that can be used in the diversion of traffic (cones, portable signs), clearance of a road hazard, repair of ancillary damage, or any other incident response. The request may poll for resource availability or request pre-staging, staging, or immediate dispatch of resources.
maint and constr resource response	Current status of maintenance and construction resources including availability and deployment status. General resource inventory information covering vehicles, equipment, materials, and people and specific resource deployment status may be included.
maint and constr work plans	Future construction and maintenance work schedules and activities including anticipated closures with anticipated impact to the roadway, alternate routes, anticipated delays, closure times, and durations.
maintenance and repair needs	Recommended strategies and schedules for maintenance of the transportation infrastructure.
multimodal information	Schedule information for alternate mode transportation providers such as train, ferry, air and bus.
parking archive data	Data used to analyze and monitor trends in parking demand, pricing, and operational actions. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
parking information	General parking information and status, including current parking availability.
parking lot data request	Request for parking lot occupancy, fares, and availability. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.
personal transit information	General and personalized transit information for a particular fixed route, flexible route, or paratransit system.
probe archive data	Probe data that allows calculation of travel times, volumes, and other measures that support transportation planning. Optionally, this flow also includes origin and destination information for vehicles that opt to provide this information.
remote surveillance control	The control commands used to remotely operate another center's sensors or surveillance equipment so that roadside surveillance assets can be shared by more than one agency.
resource coordination	Coordination of resource inventory information, specific resource status information, resource prioritization and reallocation between jurisdictions, and specific requests for resources and responses that service those requests.
resource deployment status	Status of resource deployment identifying the resources (vehicles, equipment, materials, and personnel) available and their current status. General resource inventory information and specific status of deployed resources may be included.
resource request	A request for resources to implement special traffic control measures, assist in clean up, verify an incident, etc. The request may poll for resource availability or request pre-staging, staging, or immediate deployment of resources. Resources may be explicitly requested or a service may be requested and the specific resource deployment may be determined by the responding agency.

Flow Name	Flow Description
road network conditions	Current and forecasted traffic information, road and weather conditions, and other road network status. Either raw data, processed data, or some combination of both may be provided by this architecture flow. Information on diversions and alternate routes, closures, and special traffic restrictions (lane/shoulder use, weight restrictions, width restrictions, HOV requirements) in effect is included along with a definition of the links, nodes, and routes that make up the road network.
road network status assessment	Assessment of damage sustained by the road network including location and extent of the damage, estimate of remaining capacity, required closures, alternate routes, necessary restrictions, and time frame for repair and recovery.
road weather information	Road conditions and weather information that are made available by road maintenance operations to other transportation system operators.
roadside archive data	A broad set of data derived from roadside sensors that includes current traffic conditions, environmental conditions, and any other data that can be directly collected by roadside sensors. This data also indicates the status of the sensors and reports of any identified sensor faults.
roadway equipment coordination	The direct flow of information between field equipment. This includes transfer of information between sensors and driver information systems (e.g., DMS, HAR, variable speed limit signs, dynamic lane signs) or control devices (e.g., traffic signals, ramp meters), direct coordination between adjacent control devices, interfaces between detection and warning or alarm systems, and any other direct communications between field equipment.
roadway information system data	Information used to initialize, configure, and control roadside systems that provide driver information (e.g., dynamic message signs, highway advisory radio, beacon systems). This flow can provide message content and delivery attributes, local message store maintenance requests, control mode commands, status queries, and all other commands and associated parameters that support remote management of these systems.
roadway information system status	Current operating status of dynamic message signs, highway advisory radios, beacon systems, or other configurable field equipment that provides dynamic information to the driver.
roadway maintenance status	Summary of maintenance fleet operations affecting the road network. This includes the status of winter maintenance (snow plow schedule and current status).
safety status information	Safety information such as safety ratings, security ratings or flags, inspection summaries, and violation summaries. A unique identifier is included. Corresponds to the safety and security portion of CVISN "snapshots." The status information may be provided as a response to a real-time query or as a result of a standing request for updated information (subscription). This may also include information about non-U.S. fleets for use by U.S. authorities, and information regarding U.S. fleets made available to Mexican and Canadian authorities. The query flow is not explicitly shown.
signal control commands	Control of traffic signal controllers or field masters including clock synchronization.
signal control device configuration	Data used to configure traffic signal control equipment including local controllers and system masters.

Flow Name	Flow Description
signal control plans	Traffic signal timing parameters including minimum green time and interval durations for basic operation and cycle length, splits, offset, phase sequence, etc. for coordinated systems.
signal control status	Operational and status data of traffic signal control equipment including operating condition and current indications.
signal fault data	Faults from traffic signal control equipment.
signal system configuration	Data used to configure traffic signal systems including configuring control sections and mode of operation (time based or traffic responsive).
toll archive data	Data indicating toll facility usage and pricing schedules. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
toll instructions	Information provided to configure and support toll plaza operations including toll pricing information.
toll transactions	Detailed list of transactions from a toll station.
traffic archive data	Information describing the use and vehicle composition on transportation facilities and the traffic control strategies employed. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
traffic control priority status	Status of signal priority request functions at the roadside (e.g. enabled or disabled).
traffic flow	Raw and/or processed traffic detector data which allows derivation of traffic flow variables (e.g., speed, volume, and density measures) and associated information (e.g., congestion, potential incidents). This flow includes the traffic data and the operational status of the traffic detectors.
traffic images	High fidelity, real-time traffic images suitable for surveillance monitoring by the operator or for use in machine vision applications.
traffic information for media	Report of traffic conditions including traffic incident reports and traffic images for public dissemination through the media. The reports may also include information on diversions and alternate routes, closures, and special traffic restrictions in effect.
traffic metering status	Current operational status and operating parameters for ramp meters, interchange meters, mainline meters and other control equipment associated with roadway metering operations.
traffic operator data	Presentation of traffic operations data to the operator including traffic conditions, current operating status of field equipment, maintenance activity status, incident status, video images, security alerts, emergency response plan updates and other information. This data keeps the operator appraised of current road network status, provides feedback to the operator as traffic control actions are implemented, provides transportation security inputs, and supports review of historical data and preparation for future traffic operations activities.

Flow Name	Flow Description
traffic operator inputs	User input from traffic operations personnel including requests for information, configuration changes, commands to adjust current traffic control strategies (e.g., adjust signal timing plans, change DMS messages), and other traffic operations data entry.
traffic sensor control	Information used to configure and control traffic sensor systems.
transit and fare schedules	Transit service information including routes, schedules, and fare information.
transit information request	Request for transit operations information including schedule and fare information. The request can be a subscription that initiates as-needed information updates as well as a one-time request for information.
transit information user request	Request for special transit routing, real-time schedule information, and availability information.
transit request confirmation	Confirmation of a request for transit information or service.
transit schedule adherence information	Dynamic transit schedule adherence and transit vehicle location information.
transportation information for operations	Information on the state of transportation system operations including traffic and road conditions, advisories, incidents, transit service information, weather information, parking information, and other related data.
transportation system status	Current status and condition of transportation infrastructure (e.g., tunnels, bridges, interchanges, TMC offices, maintenance facilities). In case of disaster or major incident, this flow provides an assessment of damage sustained by the surface transportation system including location and extent of the damage, estimate of remaining capacity and necessary restrictions, and time frame for repair and recovery.
traveler alerts	Traveler information alerts reporting congestion, incidents, adverse road or weather conditions, parking availability, transit service delays or interruptions, and other information that may impact the traveler. Relevant alerts are provided based on traveler-supplied profile information including trip characteristics and preferences.
traveler archive data	Data associated with traveler information services including service requests, facility usage, rideshare, routing, and traveler payment transaction data. Content may include a catalog of available information, the actual information to be archived, and associated meta data that describes the archived information.
traveler information for media	General traveler information regarding incidents, unusual traffic conditions, transit issues, or other advisory information that has been desensitized and provided to the media.
traveler profile	Information about a traveler including equipment capabilities, personal preferences, and traveler alert subscriptions.
traveler request	A request for traveler information including traffic, transit, toll, parking, road weather conditions, event, and passenger rail information. The request identifies the type of information, the area of interest, parameters that are used to prioritize or filter the returned information, and sorting preferences.

Flow Name	Flow Description
vehicle payment information	Information provided for payment of tolls and parking fees including identification that can be used to identify the payment account or source and related vehicle and service information that are used to determine the type and price of service requested.
vehicle payment request	Request for information supporting toll and parking payments.
vehicle payment update	Data written to vehicle equipment to support electronic toll collection or parking payment.
video surveillance control	Information used to configure and control video surveillance systems.
work plan feedback	Comments and suggested changes to proposed construction and maintenance work schedules and activities. This information influences work plan schedules so that they minimize impact to other system operations and the overall transportation system.
work zone information	Summary of maintenance and construction work zone activities affecting the road network including the nature of the maintenance or construction activity, location, impact to the roadway, expected time(s) and duration of impact, anticipated delays, alternate routes, and suggested speed limits. This information may be augmented with images that provide a visual indication of current work zone status and traffic impacts.

APPENDIX D **– DETECTION DEPLOYMENT DETAILS**

The locations and detection systems recommended below are based on strategies previously discussed in **Section 6.3.5**. This is only illustrative and the number of detectors actually deployed in each DOTD district will depend on need, maintenance resources and staff availability.

LADOTD DISTRICT 02 (New Orleans/Houma)				
		BLUETOOTH	RVD	NOTE
1	US 90 @ LA 24 (LA -659)	•	•	Houma Sub-District
2	LA 24 @ Martin Luther King Blvd	•		Houma Sub-District
3	LA 24 @ LA 3040 (S Hollywood Rd)	•		Houma Sub-District
4	LA 24 (Park Ave.) @ LA 3040 (N Hollywood Rd)	•		Houma Sub-District
5	LA 24 @ US 90 (New Orleans Blvd)	•		Houma Sub-District
6	US 90 @ N Hollywood Rd	•		Houma Sub-District
7	LA 24 @ LA 3087 (Prospect Blvd)	•		Houma Sub-District
8	LA 659 @ LA 3087 (Prospect Blvd)	•		Houma Sub-District
1	I-10 @ Spillway Levee	•	•	
2	I-10 @ I-310	•	•	
3	I-310 @ US 61 (Airline Hwy)	•		
4	I-310 @ US 90	•	•	
5	I-10 @ LA 49 (Williams Blvd)	•		
6	I-10 @ Veterans Blvd	•		
7	I-10 @ N Causeway Blvd	•	•	
8	I-10 @ I-610 (Split)	•		
9	I-10 @ S Claiborne Ave	•		
10	I-610 @ LA 3021 (Elysian Fields Ave)	•	•	
11	US 90 @ Port of New Orleans (CCCD Bridge)	•		
12	US 90 @ LA 428 (General De Gaulle Dr)	•	•	
13	US 90 @ Manhattan Blvd	•		
14	US 90 @ Huey P Long Bridge	•	•	
15	US 90 @ Westbank Expy	•		
16	I-10 @ US 90 (Chef Menteur Blvd)	•		
17	I-10 @ I-510	•		
18	I-10 @ US 11	•	•	

LADOTD DISTRICT 03 (Lafayette)				
		BLUETOOTH	RVD	NOTE
1	US 190 @ LA 103 (Saizan Ave)	•	•	
2	I-49 @ US 190	•	•	
3	I-49 @ LA 3233	•		
4	I-49 @ LA 93	•		
5	I-49 @ LA 182	•	•	
6	I-49 @ LA 98	•		
7	I-49 @ I-10	•	•	
8	US 167 @ Willow St	•		
9	US 167/90 @ Louisiana Ave	•		
10	US 90 @ E University Ave	•	•	
11	I-10 @ LA 95	•	•	
12	I-10 @ Mill St	•		
13	I-10 @ Louisiana Ave	•		
14	I-10 @ LA 31 (Weight Scale)	•		
15	I-10 @ LA 328	•		
16	I-10 @ LA 347 (Grand Point Hwy)	•	•	

LADOTD DISTRICT 04 (Shreveport)				
		BLUETOOTH	RVD	NOTE
1	I-20 @ LA 526	•	•	
2	I-20 @ I-220 West	•		
3	I-220 @ South Lakeshore Dr	•	•	
4	I-220 @ LA 173	•		
5	I-220 @ US 71 (N Market St)	•	•	
6	I-220 @ LA 3 (Benton Rd)	•		
7	I-220 @ Swan Lake Rd	•		
8	I-220 @ I-20 East	•	•	
9	I-20 @ LA 782 (Industrial Dr)	•		
10	I-20 @ US 71 (Barksdale Blvd)	•	•	
11	I-20 @ Spring St	•		
12	I-20 @ I-49	•	•	
13	I-20 @ Linwood Ave	•		
14	I-20 @ Greenwood Rd	•		
15	I-20 @ Jewella Ave	•		
16	I-220 @ Dean Rd	•		
17	I-49 @ LA 3132 (Inner Loop Expy)	•	•	
18	I-49 @ Hollywood Ave/Pierremont Rd	•		

LADOTD DISTRICT 05 (Monroe)				
		BLUETOOTH	RVD	NOTE
1	I-20 @ Vancil Rd	•	•	
2	I-20 @ WLA 3429 (Well Rd)	•		
3	I-20 @ LA 617 (Thomas Rd)	•		
4	I-20 @ Stella St	•		
5	I-20 @ Linderman Ave	•	•	
6	US 80 (Bridge St) @ Cypress St	•	•	
7	I-20 @ Jackson St	•		
8	I-20 @ LA 594 (Texas Ave)	•		
9	I-20 @ US 165 (Martin Luther King Dr)	•	•	
10	I-20 @ Garrett Rd	•		
11	I-20 @ Millhaven	•	•	
12	US 165 @ LA 15 (Winnsboro Rd)	•		
13	US 165 @ Rochwood Road 1	•		
14	US 80 (Louisville Ave) @ LA 840 (N 18th St)	•		
15	US 165 @ Desiard St	•	•	
16	US 165 @ Forsythe Byp	•		

LADOTD DISTRICT 07 (Lake Charles)				
		BLUETOOTH	RVD	NOTE
1	I-10 @ LA-27 (Beglis Pkwy)	•	•	
2	I-10 @ I-210 West	•	•	
3	I-10 @ US 90	•		
4	I-10 @ LA 378 (Sampson St)	•		
5	I-10 @ LA 385 (Veteran Memorial Blvd)	•	•	
6	I-10 @ US 90 (Fruge St)	•		
7	I-10 @ US 171 (Martin Luther King Hwy)	•		
8	I-10 @ I-210 East	•	•	
9	I-10 @ LA 397 (E Ward Line Rd)	•	•	
10	I-210 @ Fruge Street	•		
11	I-210 @ Legion St	•		
12	I-210 @ LA 14	•	•	
13	I-210 @ LA 385 (Ryan St)	•		
14	I-210 @ Kiwanis Ln	•		
15	I-210 @ Prien Lake	•		

LADOTD DISTRICT 08 (Alexandria)				
		BLUETOOTH	RVD	NOTE
1	I-49 @ LA-498 (Airbase Rd)	•	•	
2	I-49 @ Industrial Park Site Rd	•		
3	I-49 @ US 165/US 71	•		
4	US 165 @ LA-1	•		
5	LA-28 @ Virginia Ave.	•		
6	US 165/US71 @ Rainbow Dr	•	•	
7	US 165 @ Shreveport Hwy	•		
8	LA-3100 @ US 167	•		
9	US 167 @ Greer St	•	•	
10	I-49 @ LA 1	•		
11	I-49 @ Broadway Ave	•		
12	US 165 @ Prescott Dr	•		
13	US 165 @ Lee St	•		
14	I-49 @ US 167	•	•	
15	I-49 @ Gene Ball Dr	•	•	

LADOTD DISTRICT 61 (Baton Rouge)				
		BLUETOOTH	RVD	NOTE
1	I-10 @ LA-415	•	•	
2	I-10 @ LA-1	•		
3	I-10 @ I-110	•		
4	I-10 @ US-61 NORTH	•	•	
5	I-10 @ CHIPPEWA	•		
6	I-10 @ DALRYMPLE	•		
7	I-10 @ COLLEGE	•		
8	I-10 @ I-12	•	•	
9	I-10 @ ESSEN	•		
10	I-10 @ BLUEBONNET	•		
11	I-10 @ SIEGEN	•		
12	I-10 @ HIGHLAND	•	•	
13	I-12 @ US-61 SOUTH	•		EXISTING BLUETOAD
14	I-12 @ SHERWOOD	•		EXISTING BLUETOAD
15	I-12 @ O'NEAL	•	•	EXISTING BLUETOAD

LADOTD DISTRICT 62 (Hammond)				
		BLUETOOTH	RVD	NOTE
1	I-12 @ SOUTH RANGE	•	•	EXISTING BLUETOAD
2	I-12 @ JUBAN	•		EXISTING BLUETOAD
3	I-12 @ WALKER	•		EXISTING BLUETOAD
4	I-12 @ LA 43	•	•	
5	I-12 @ I-55	•		
6	I-55 @ US 190	•		
7	I-55 @ LA 1064	•		
8	I-55 @ US 51 (SW Railroad Ave)	•	•	
9	I-55 @ Akers (Manchac)	•		
10	I-55 @ I-10 (LaPlace)	•	•	
11	I-12 @ LA 3158	•		
12	I-12 @ LA 445	•	•	
13	I-12 @ US 190 (N Causeway)	•	•	
14	N Causeway @ Monroe St	•		
15	I-59 @ Concord Blvd	•	•	
16	I-12 @ I-59 & I-10	•	•	
17	I-10 @ West End Blvd (Oak Harbor)	•		

APPENDIX E – ARCHIVE DATA MANAGEMENT MEETING MINUTES

Stantec

Meeting Minutes

Meeting Title

DOTD Statewide ITS Architecture / Traffic Data & Detection

Date/Time:	November 19, 2014 / 1:00 PM
Place:	DOTD HQR Room 203A
Next Meeting:	TBD
Attendees:	J. Chapman, G. Chike, J. Albritton, C. Washington, J. Fox, S. Mensah
Absentees:	None
Distribution:	See Above

Safety Moment: **Be aware of emergency exits, particularly when in new or unfamiliar settings.**

The purpose of this meeting was to find out how transportation data collected by various stakeholders can be archived in a common data management system to facilitate data sharing among different agencies that need them. The following observations were made:

- Transmetric (Traffic Server) has been under development for several years. GEOCOUNTS portal is ready and available to help facilitate data sharing. The challenge is getting others to share their data. Efforts are ongoing to get other agencies' data. District 61 was used as pilot.
- This system currently houses DOTD's ADT count program (3-yr tube counts and RVDs). No turning movement counts or travel time data has been included yet. However, the system is equipped to manage these types of data.
- Data sources identified for a unified data archive system include MPOs, DPWs, ITS.
- Contracts with Traffic Engineering and ITS Section may require data to be submitted. It is desired that this data be placed into Traffic Server.
- The DOTD ITS RVD units' data may be able to dump directly to Traffic Server. Rather than each field device communicating directly to Traffic Server a system-to-system connection (iNet (ATMS) to Traffic Server)is preferred. Jason will discuss with Carryn Sollie.
- System-to-system interfaces may be used for data sharing with other agencies. ArcGIS.com is another way; GEOCOUNTS is envisioned to become the preferred system to share the data.
- The data is envision to be made available free to the public. Some levels of data access may be restricted and only available upon request (currently ADTs are available to the public).
- Data format (e.g. bin size) may need to be addressed to ensure data is in desired format for multiple users. Traffic Server has several decoders available (e.g., Jamar) for raw data uploading. Stationing schemes (georeference) for data collection may be different for different agencies.
- Data quality will need to be disclaimed (owner/provider of the data is responsible for quality). DOTD Data Section can make procedures for data collection available for outside agencies to follow.
- It is unclear exactly what data the MPOs will want.
- The DOTD Data Section automatic traffic recorders (ATRs; aka Radar Vehicle Detectors [RVDs]) can be used for real-time monitoring however they are not configured to do vehicle classification.

Design with community in mind

ms \\us1515-f01\data\projects\201802224.09\statewide\correspondence\not_data_archives_20141120.docx

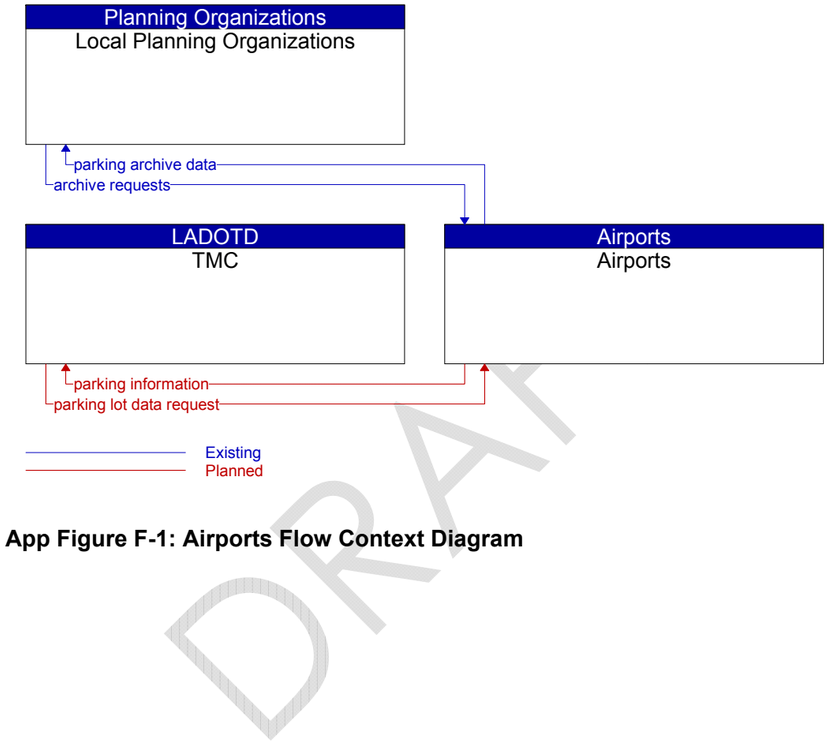
- Speeds and classification counts desired.

The meeting adjourned at 2:30 PM
The foregoing is considered to be a true and accurate record of all items discussed. If any discrepancies or inconsistencies are noted, please contact the writer immediately.

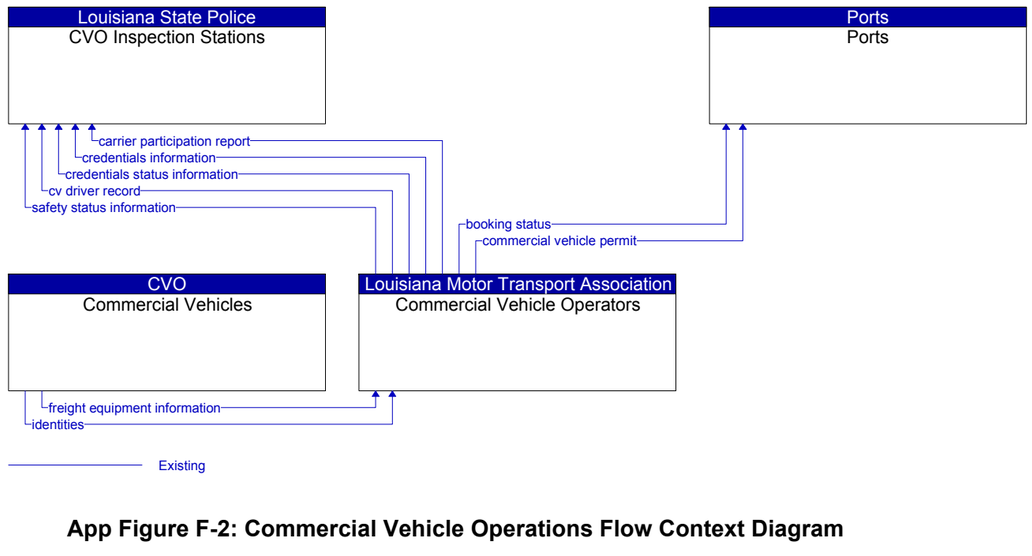
Stantec Consulting Ltd.

Stephen Mensah, EI
Phone: 225-765-7400
Fax: 225-765-7244
stephen.mensah@stantec.com

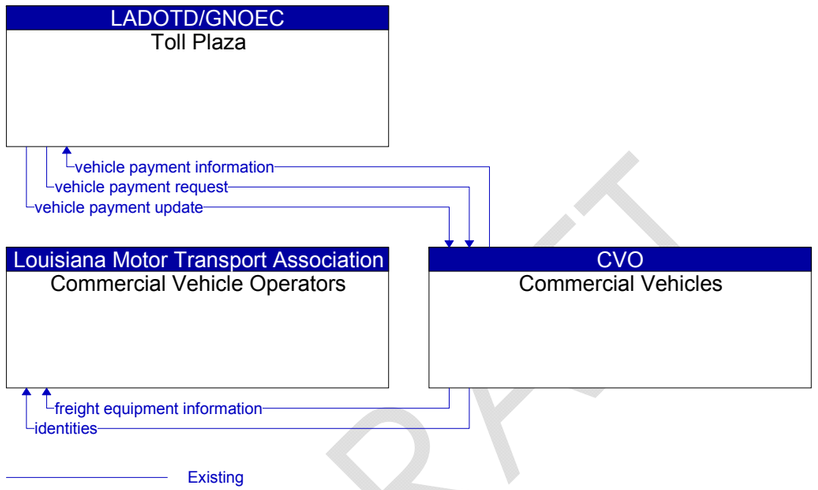
APPENDIX F – ARCHITECTURE FLOW AND CONTEXT DIAGRAMS



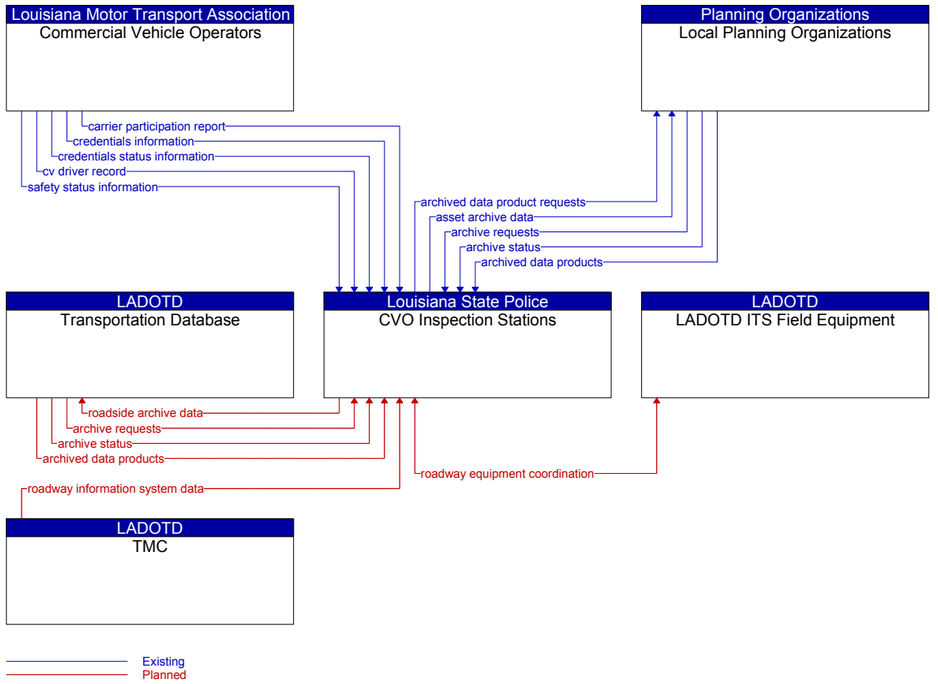
App Figure F-1: Airports Flow Context Diagram



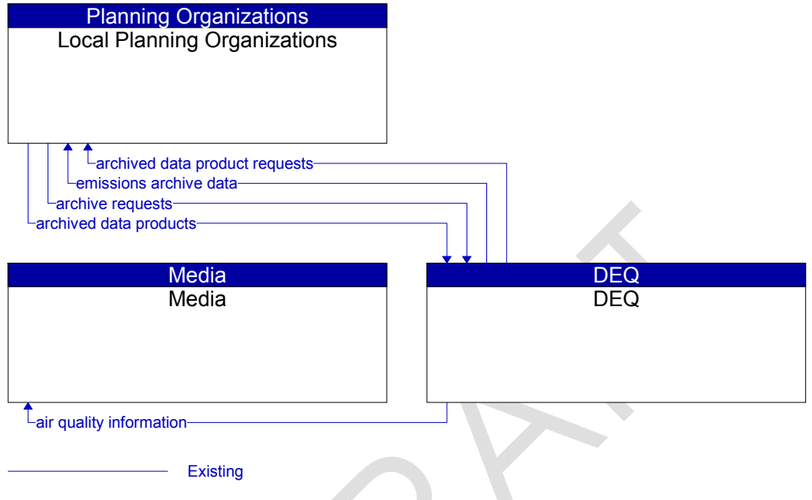
App Figure F-2: Commercial Vehicle Operations Flow Context Diagram



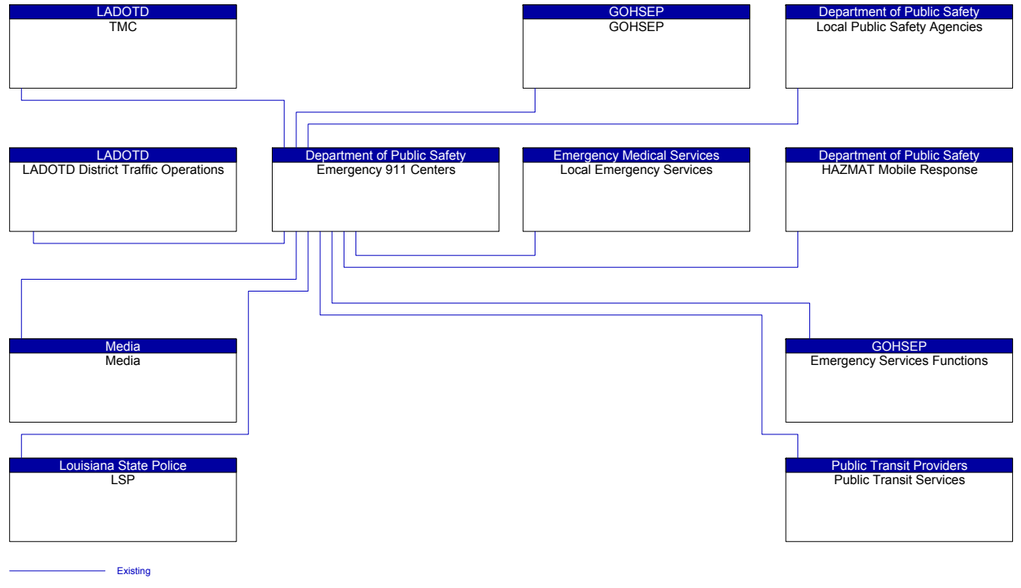
App Figure F-3: Commercial Vehicle Operations Flow Context Diagram



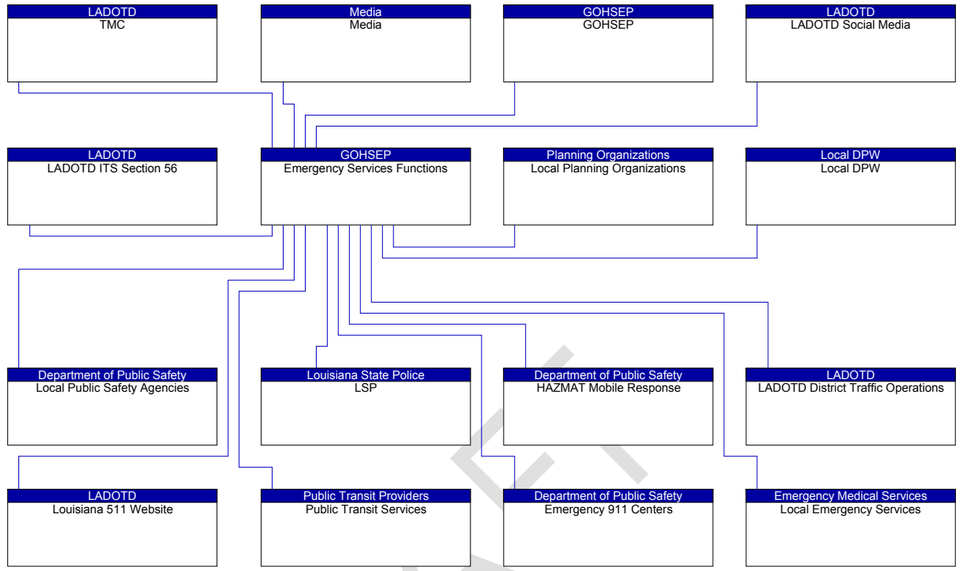
App Figure F-4: Commercial Vehicle Operations Flow Context Diagram



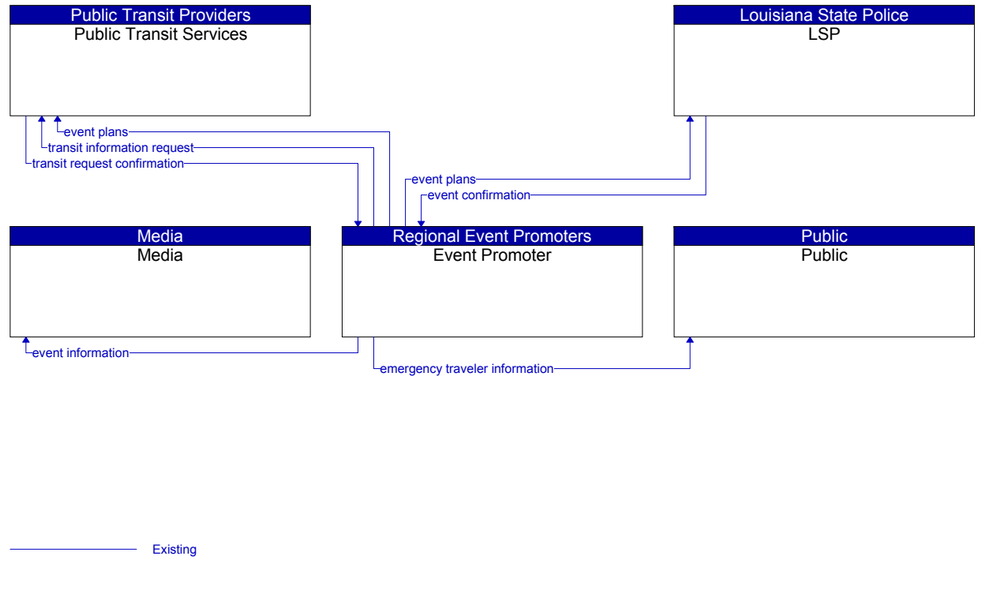
App Figure F-5: Department of Environmental Quality Flow Context Diagram



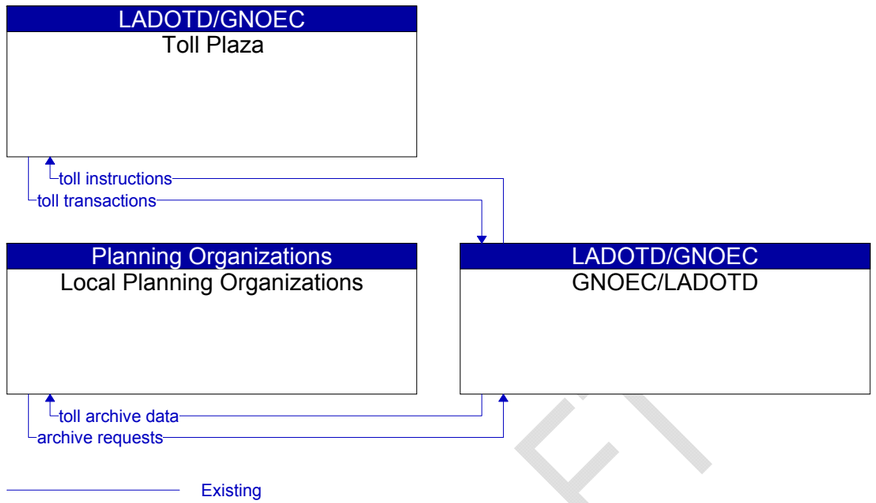
App Figure F-6: 911 Centers Interconnect Context Diagram



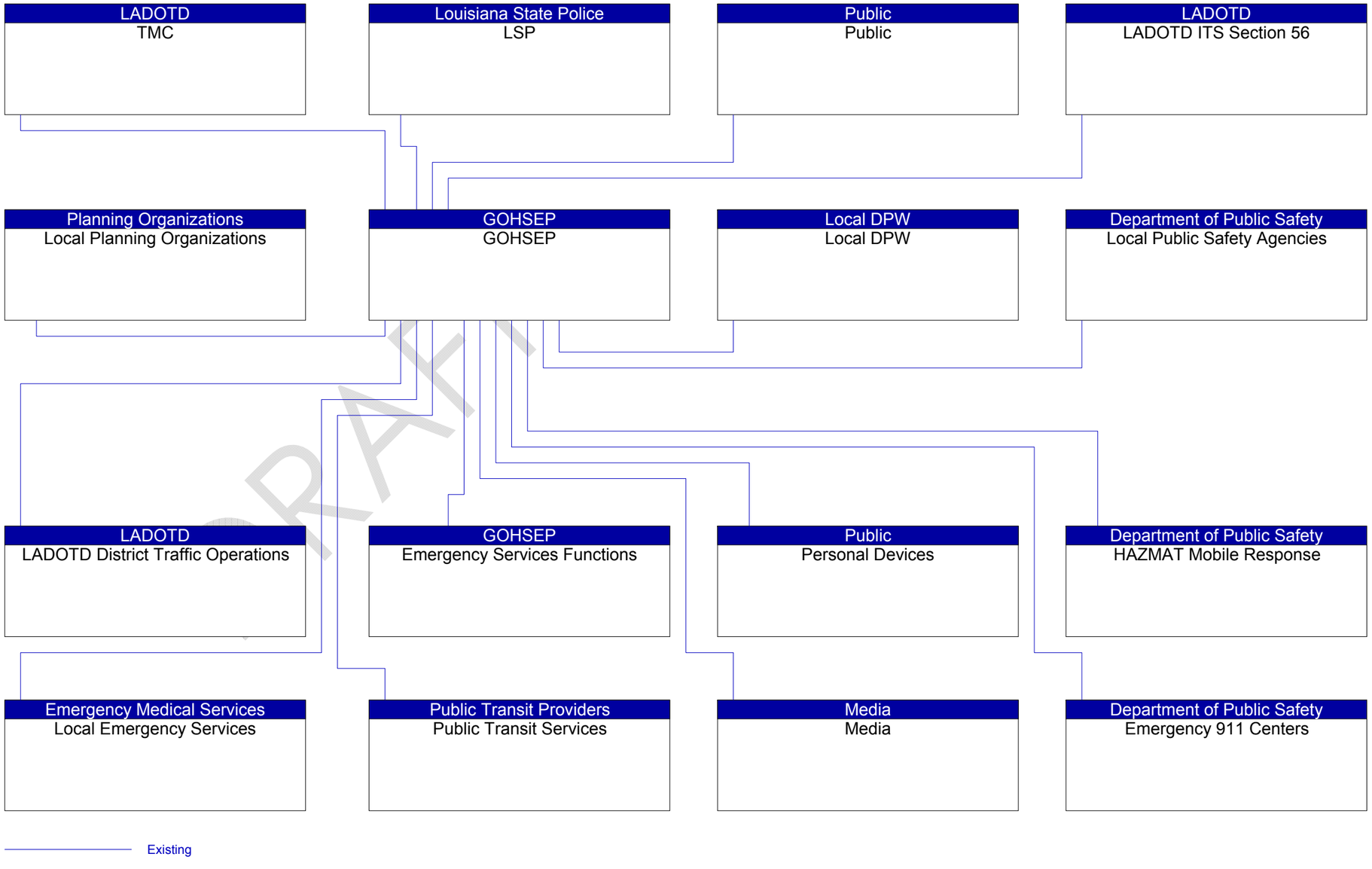
App Figure F-7: Emergency Services Functions Interconnect Context Diagram



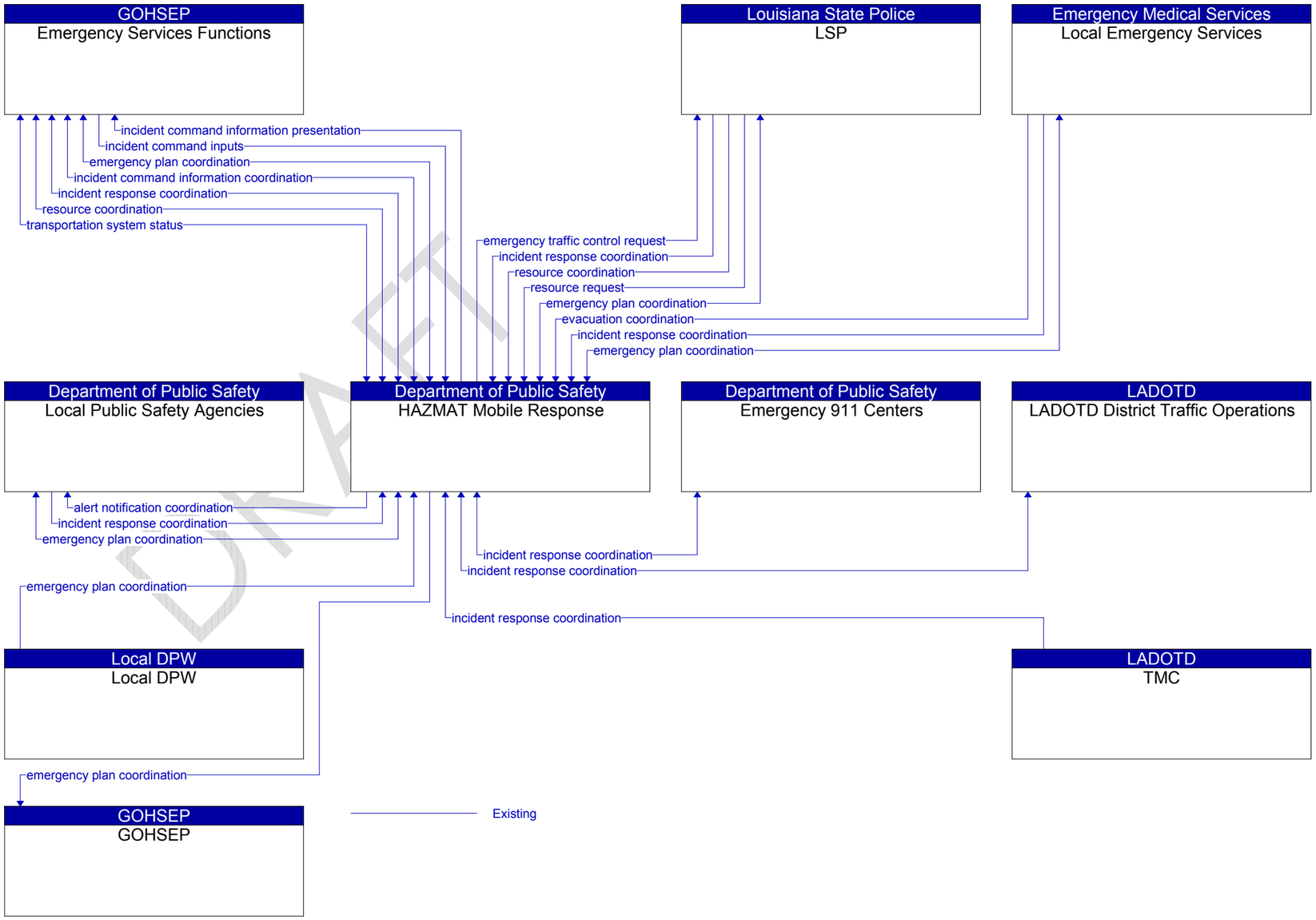
App Figure F-8: Event Promoter Flow Context Diagram



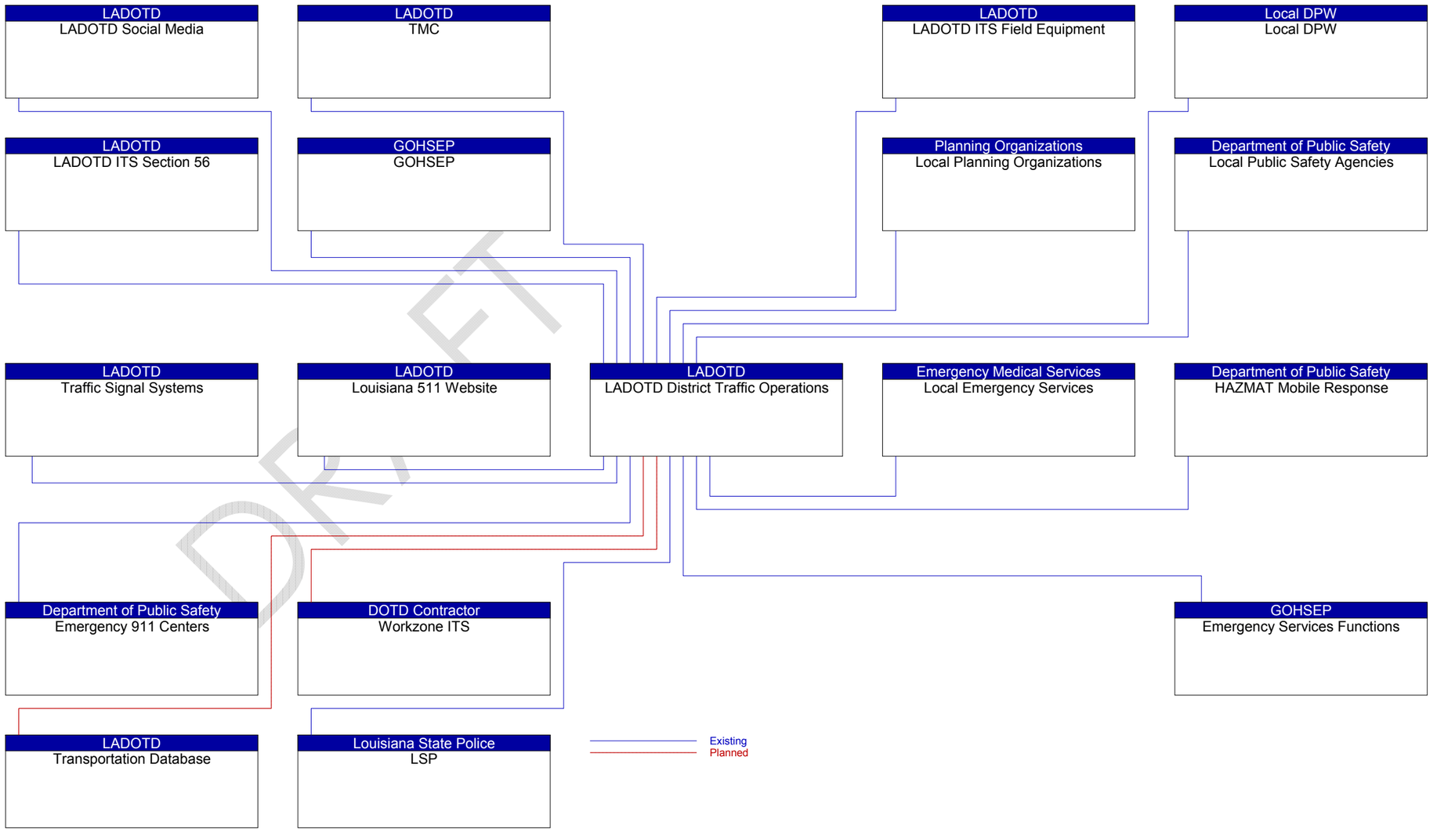
App Figure F-9: GNOEC/LADOTD Flow Context Diagram



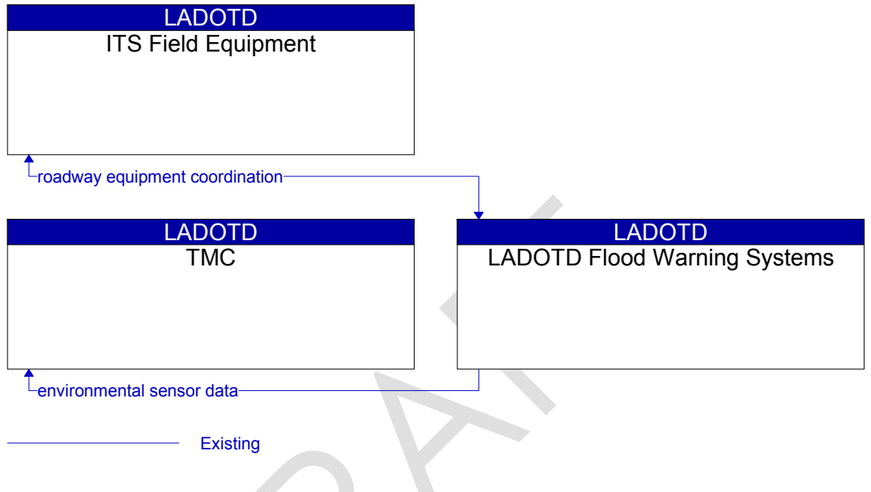
App Figure F-10: GOHSEP Interconnect Context Diagram



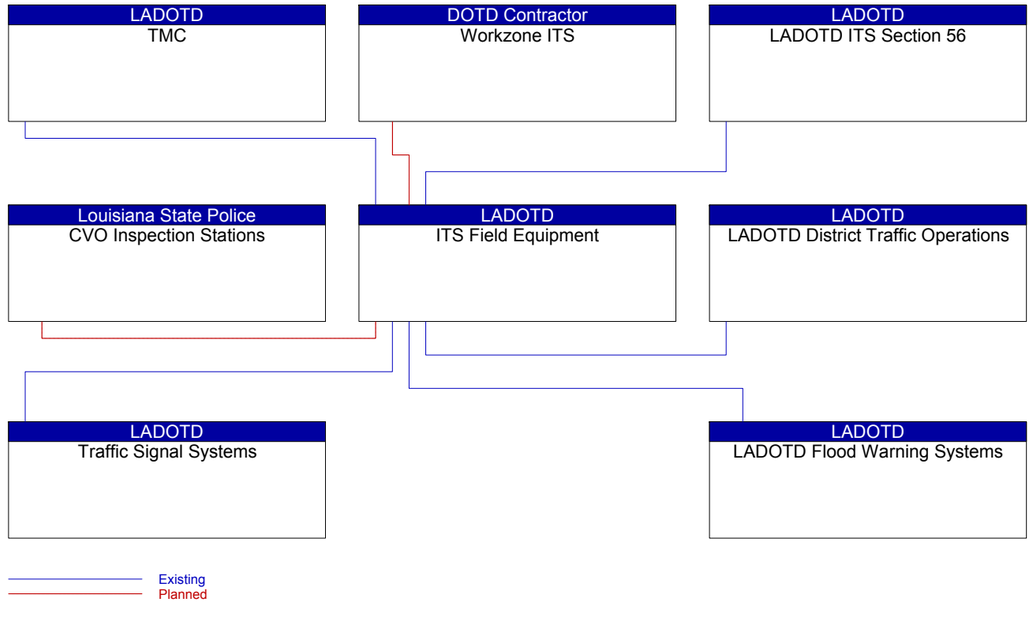
App Figure F-11: HAZMAT Mobile Response Flow Context Diagram



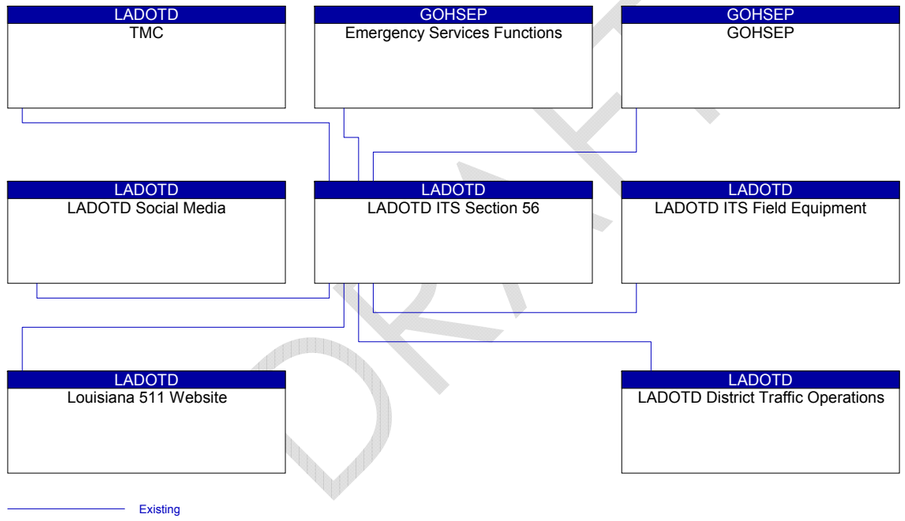
App Figure F-12: LADOTD District Traffic Operations Interconnect Context Diagram



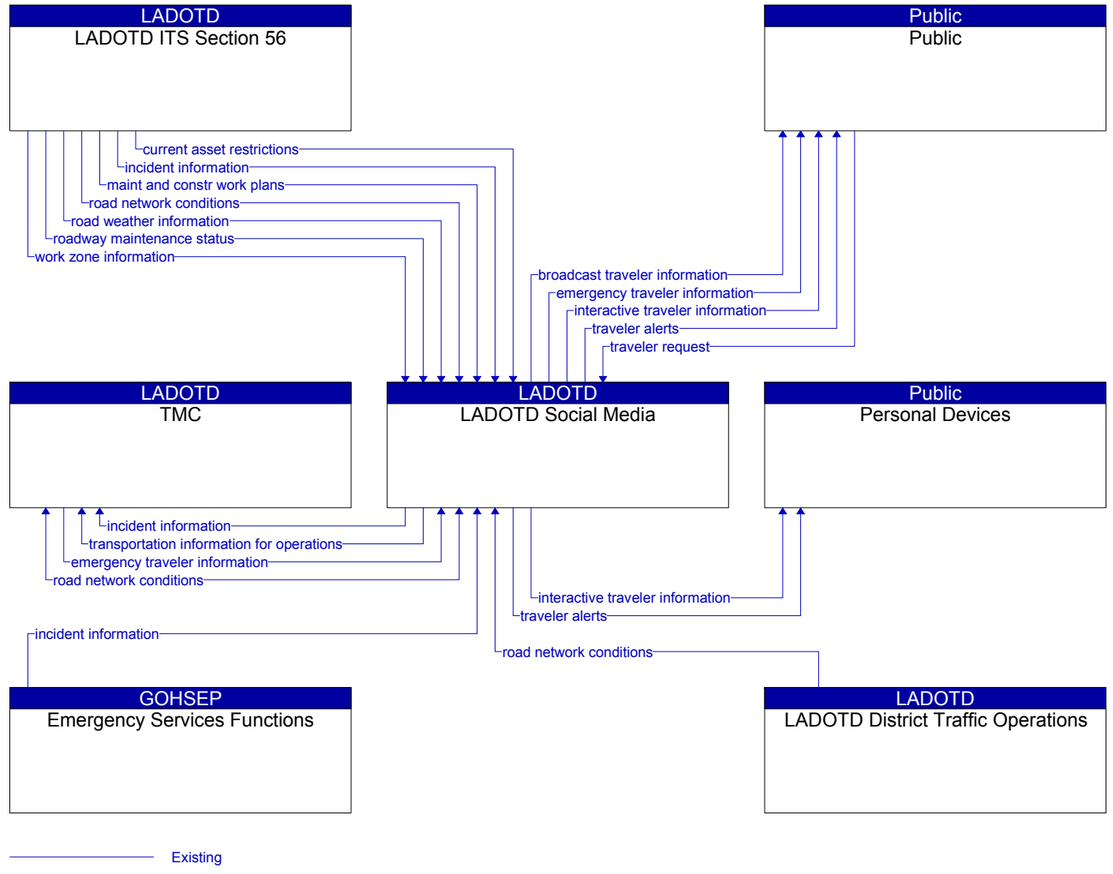
App Figure F-13: LADOTD Flood Warning System Flow Context Diagram



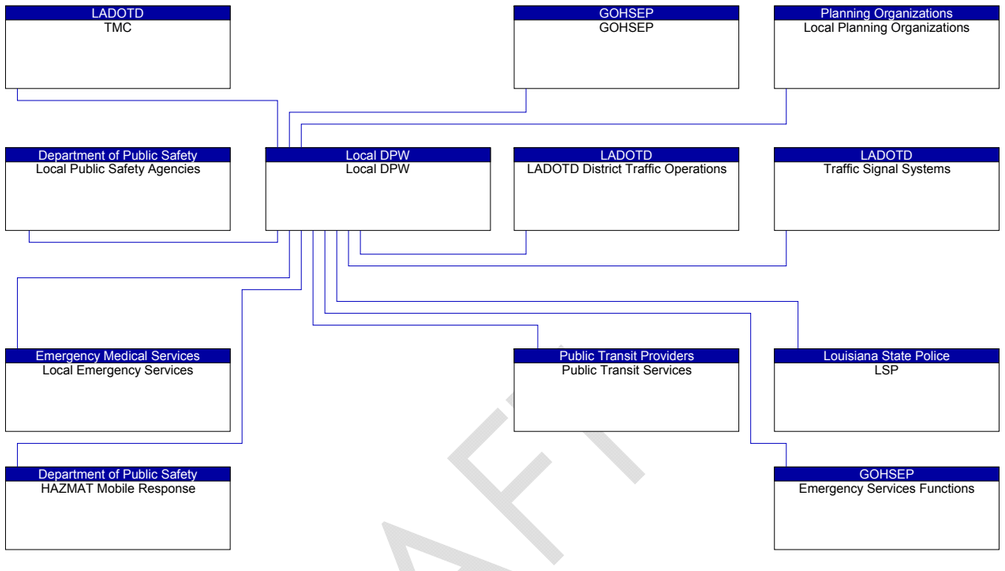
App Figure F-14: LADOTD ITS Field Equipment Interconnect Context Diagram



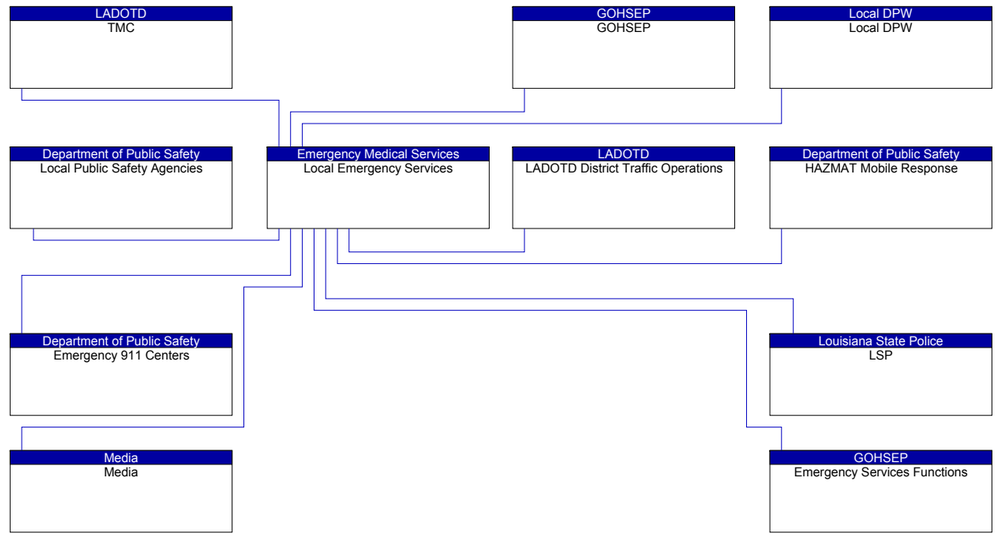
App Figure F-15: LADOTD ITS Section 56 Interconnect Context Diagram



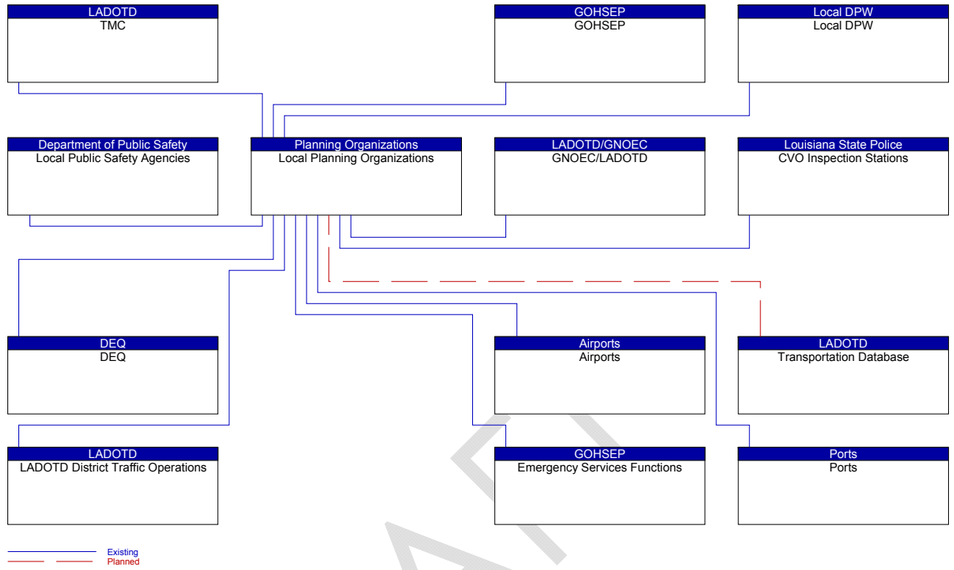
App Figure F-16: LADOTD Social Media Flow Context Diagram



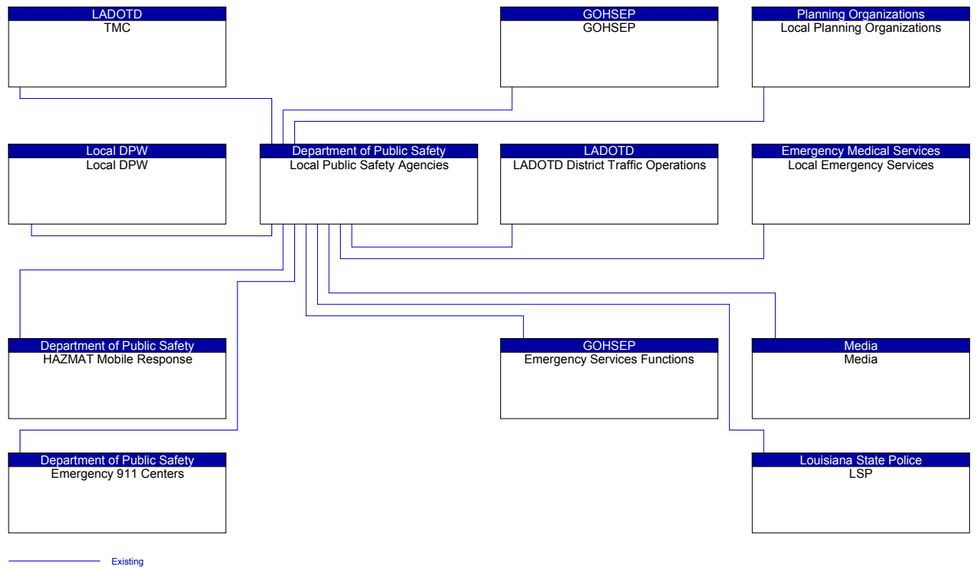
App Figure F-17: Local DPW Interconnect Context Diagram



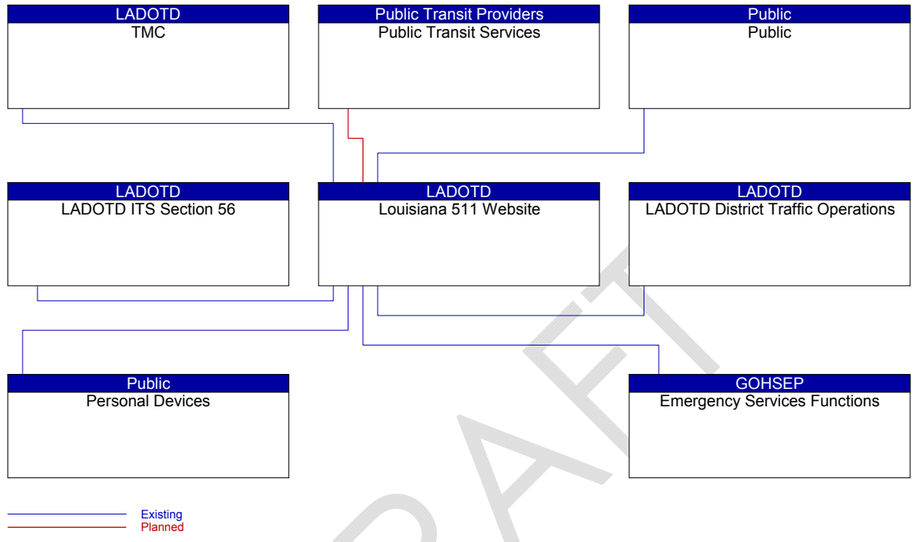
App Figure F-18: Local Emergency Services Interconnect Context Diagram



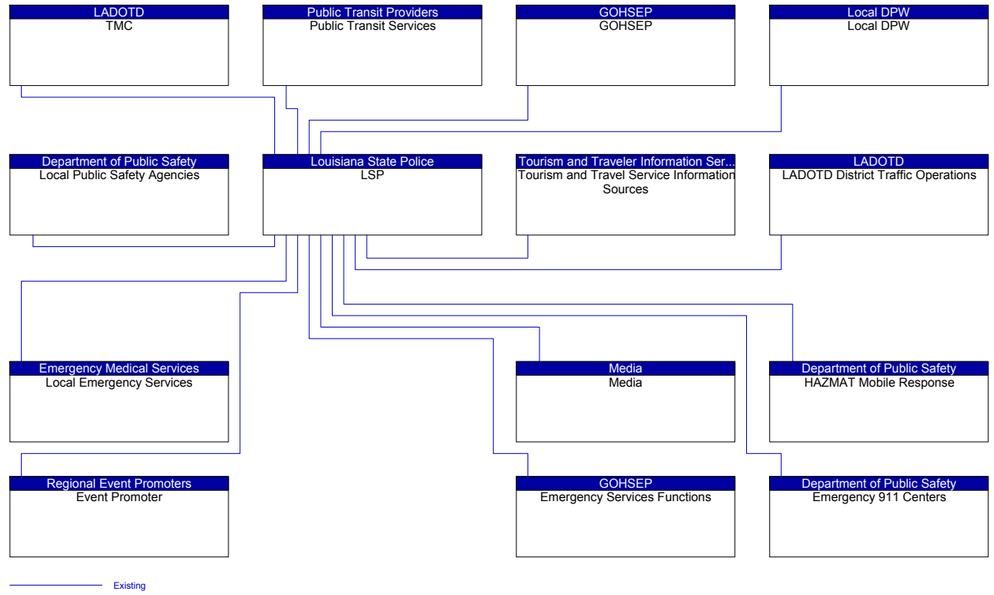
App Figure F-19: Local Planning Organizations Interconnect Context Diagram



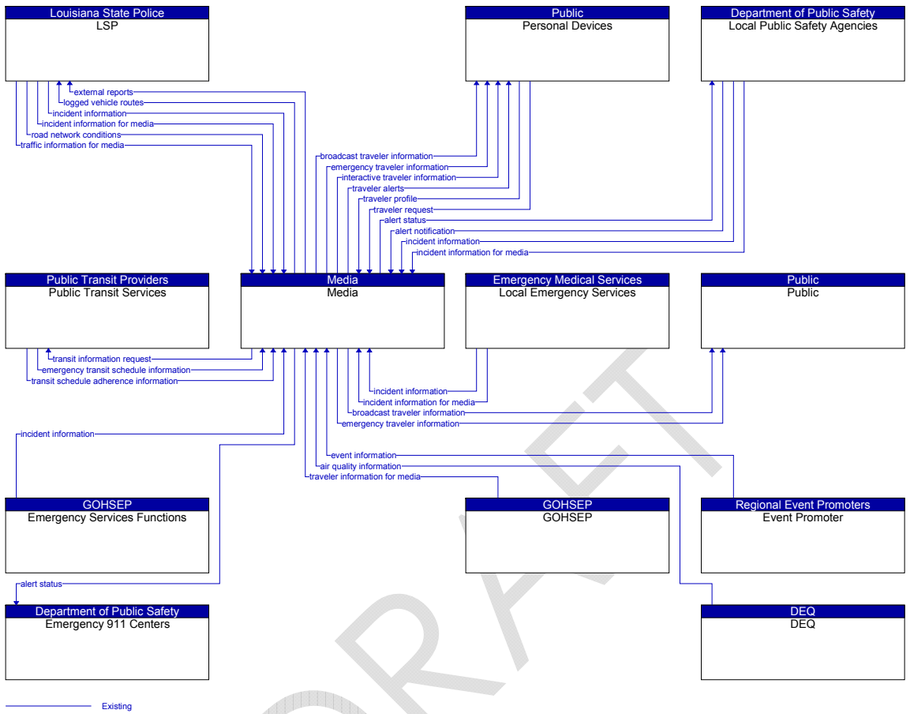
App Figure F-20: Local Public Safety Agency Interconnect Context Diagram



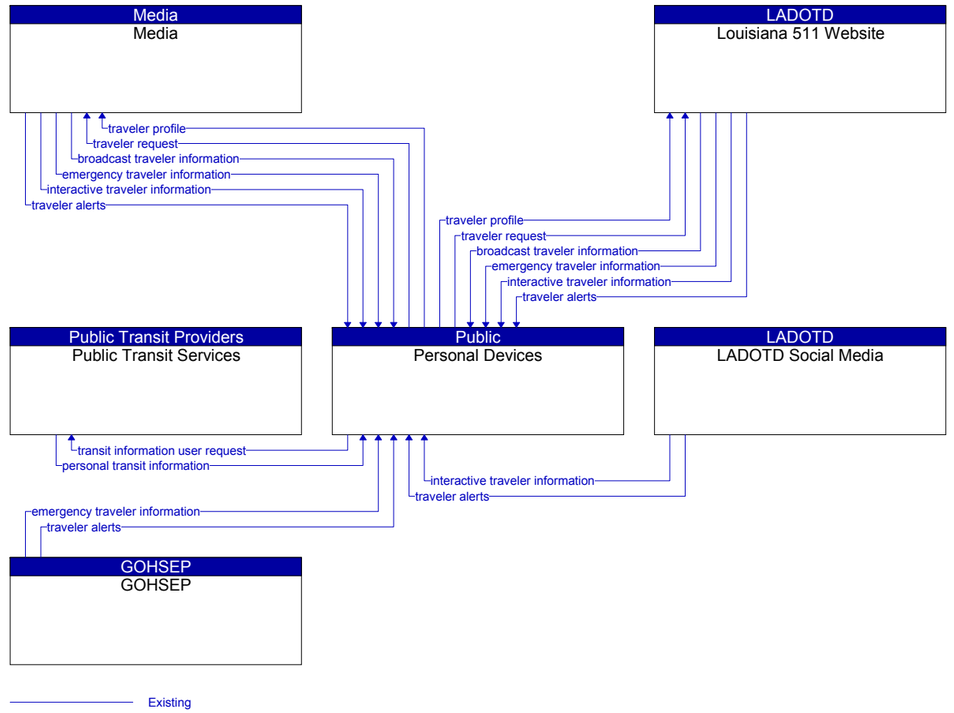
App Figure F-21: Local 511 Website Interconnect Context Diagram



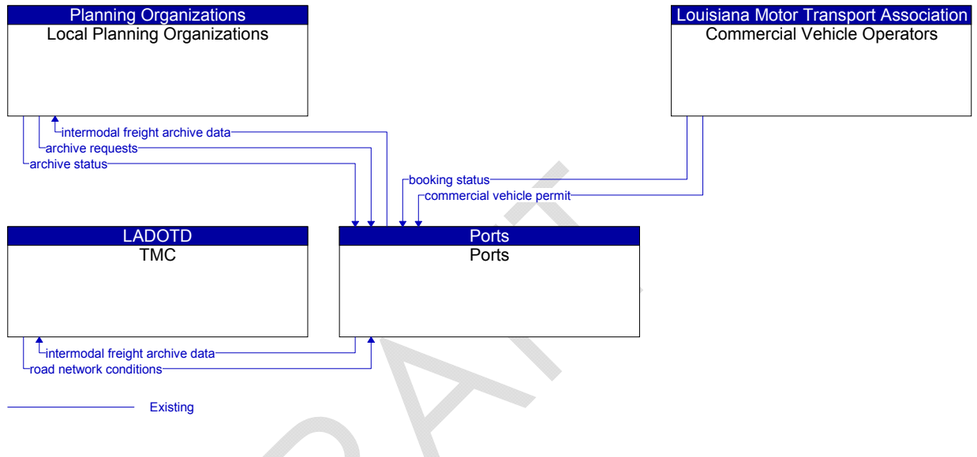
App Figure F-22: LSP Interconnect Context Diagram



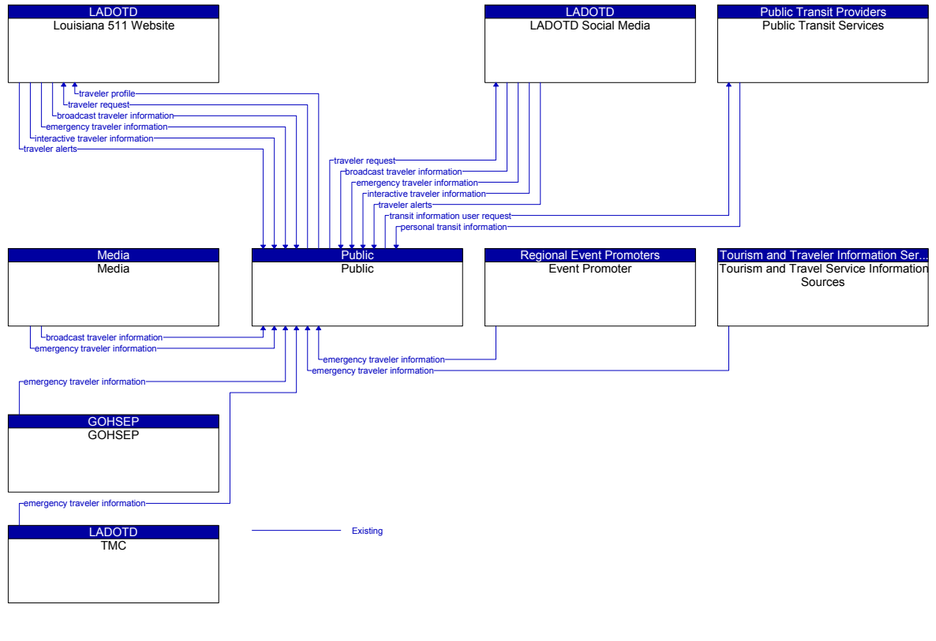
App Figure F-23: Media Flow Context Diagram



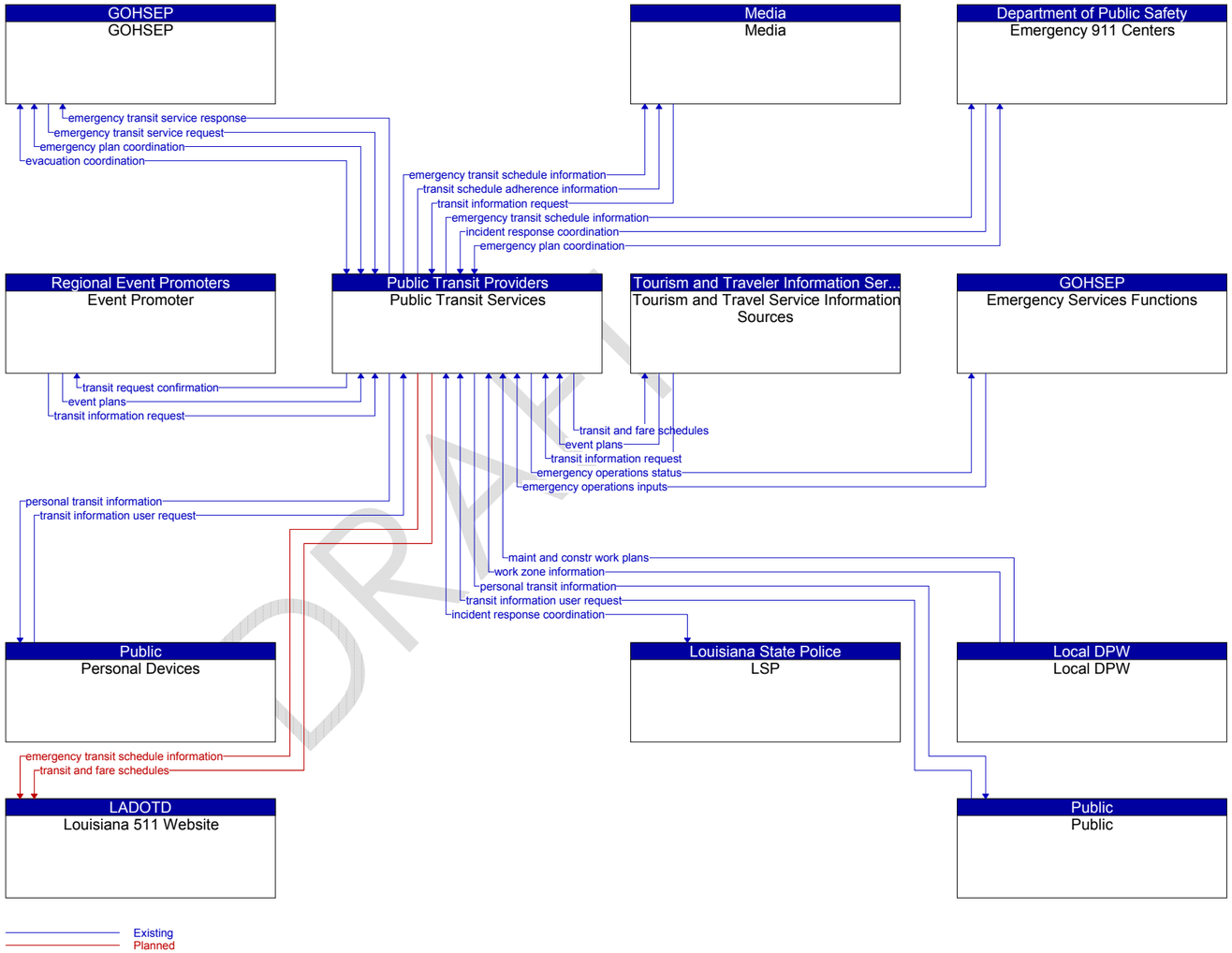
App Figure F-24: Personal Devices Flow Context Diagram



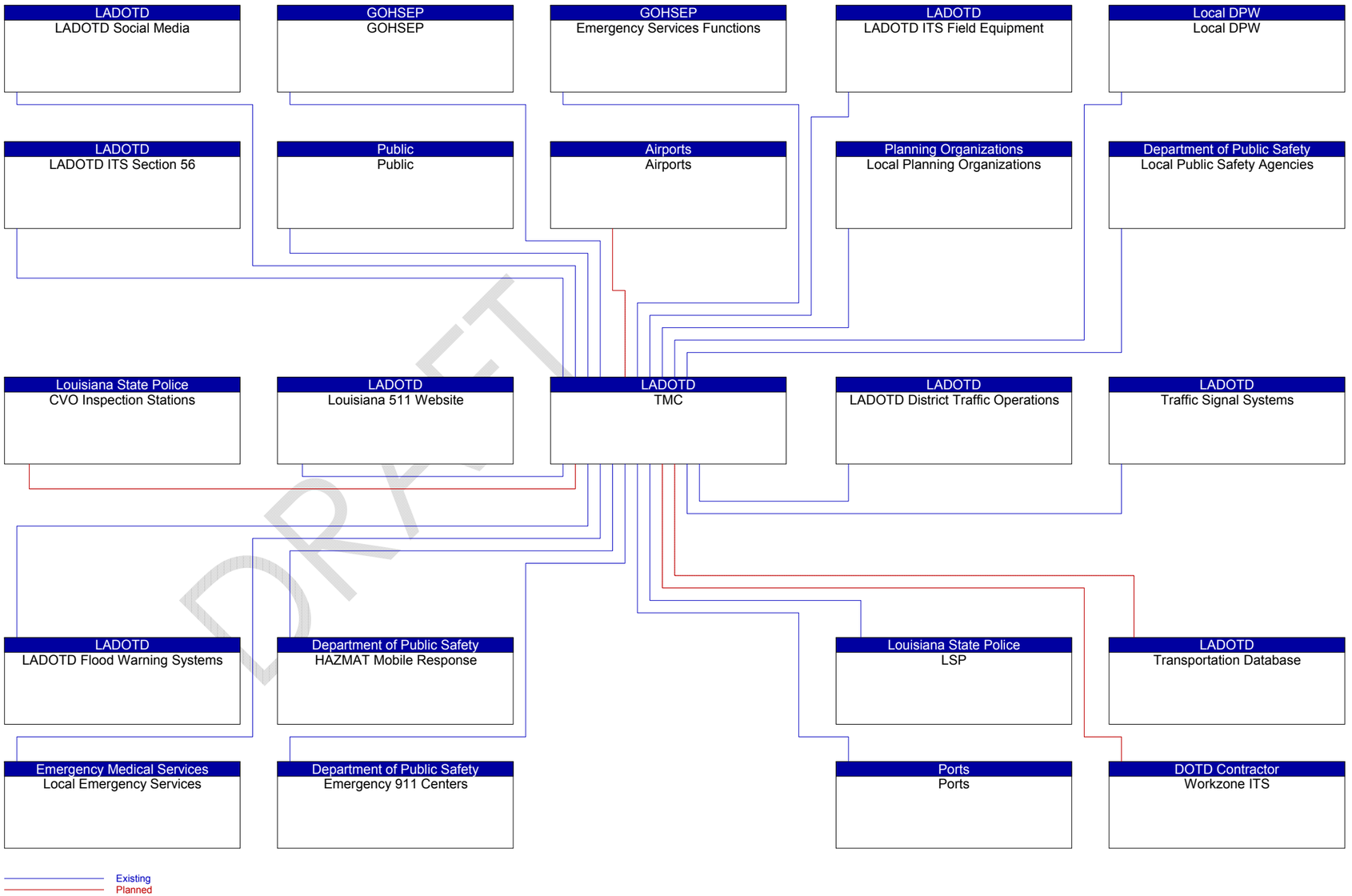
App Figure F-25: Ports Flow Context Diagram



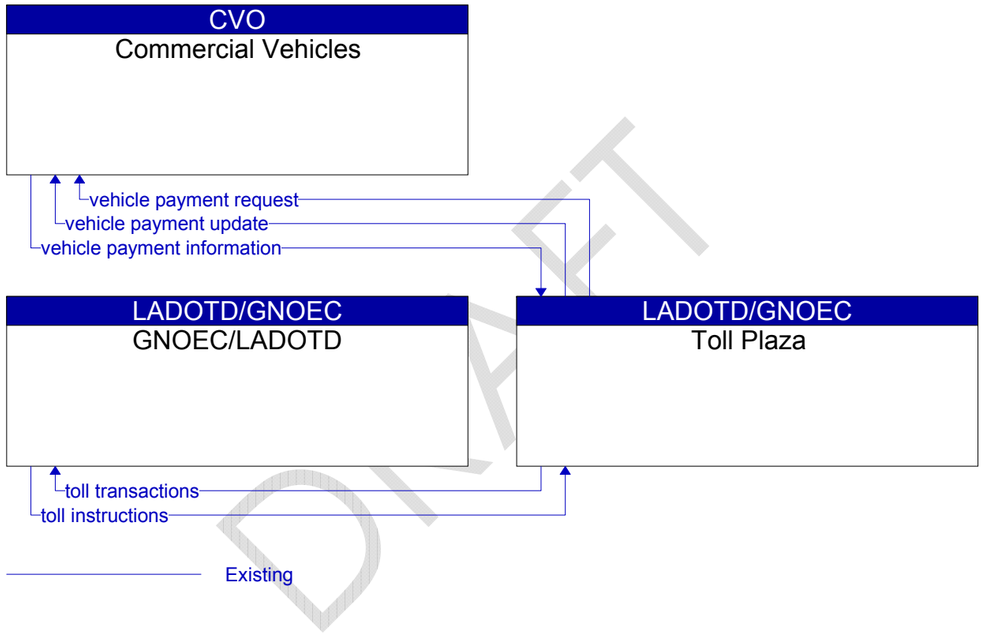
App Figure F-26: Public Flow Context Diagram



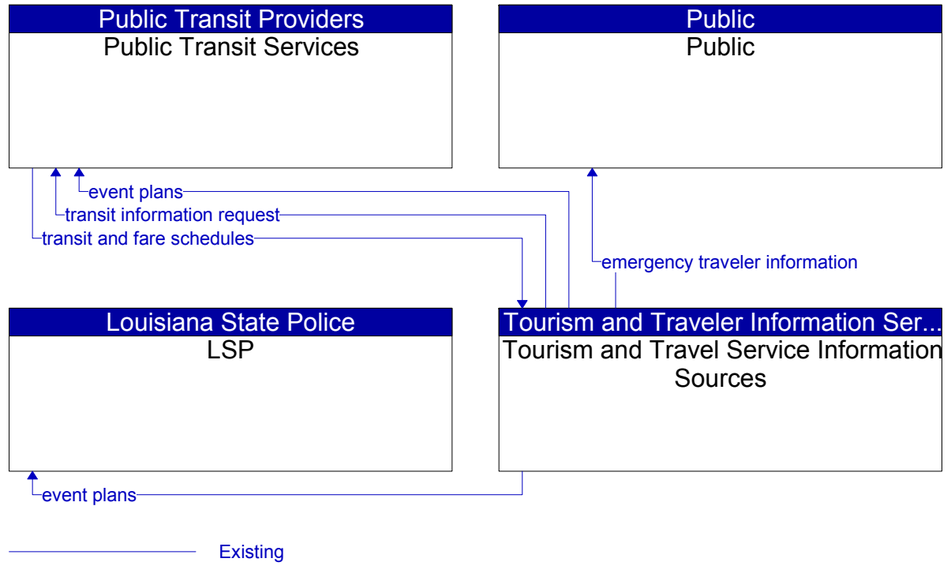
App Figure F-27: Public Transit Services Flow Context Diagram



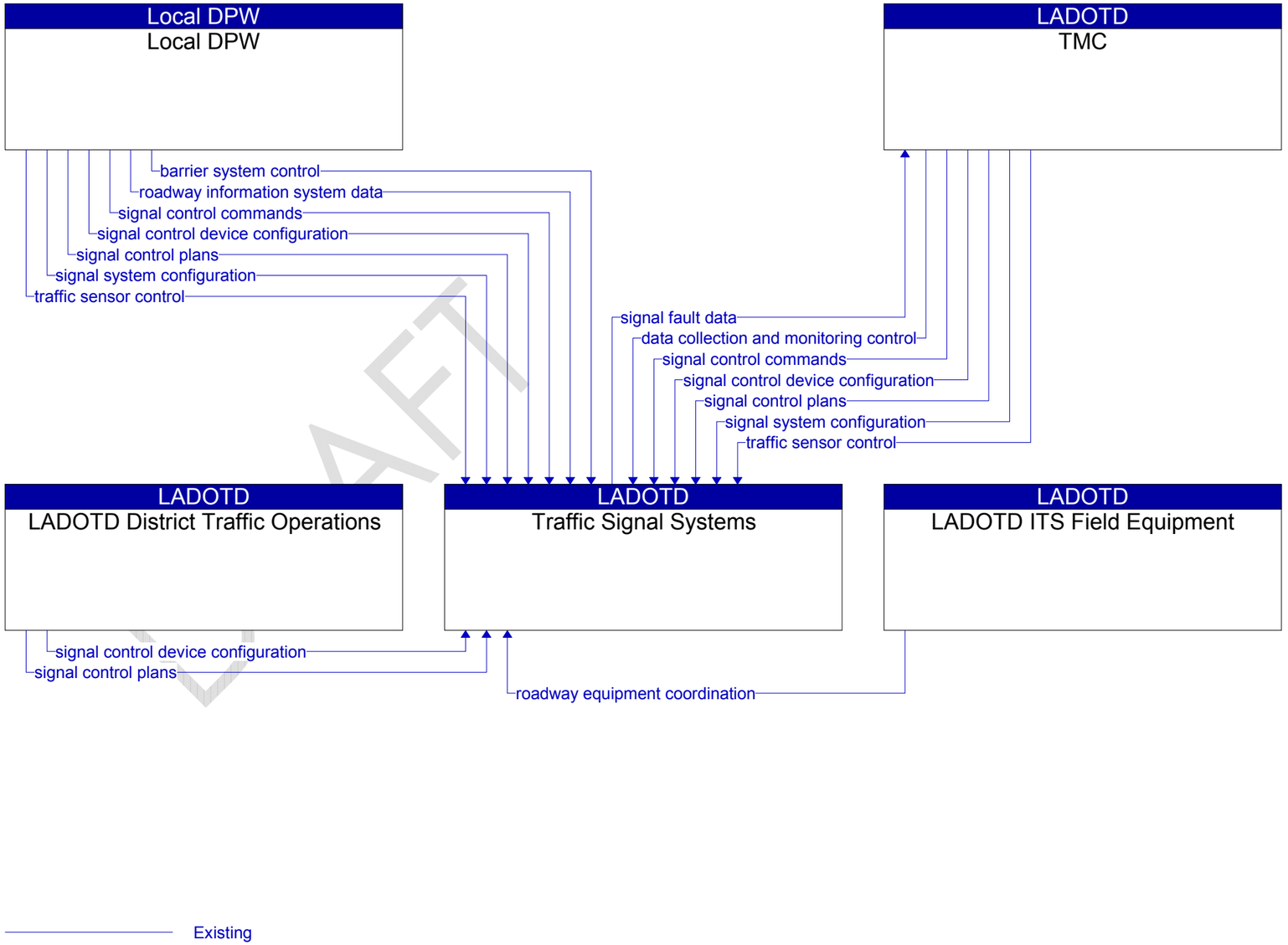
App Figure F-28: TMC Flow Context Diagram



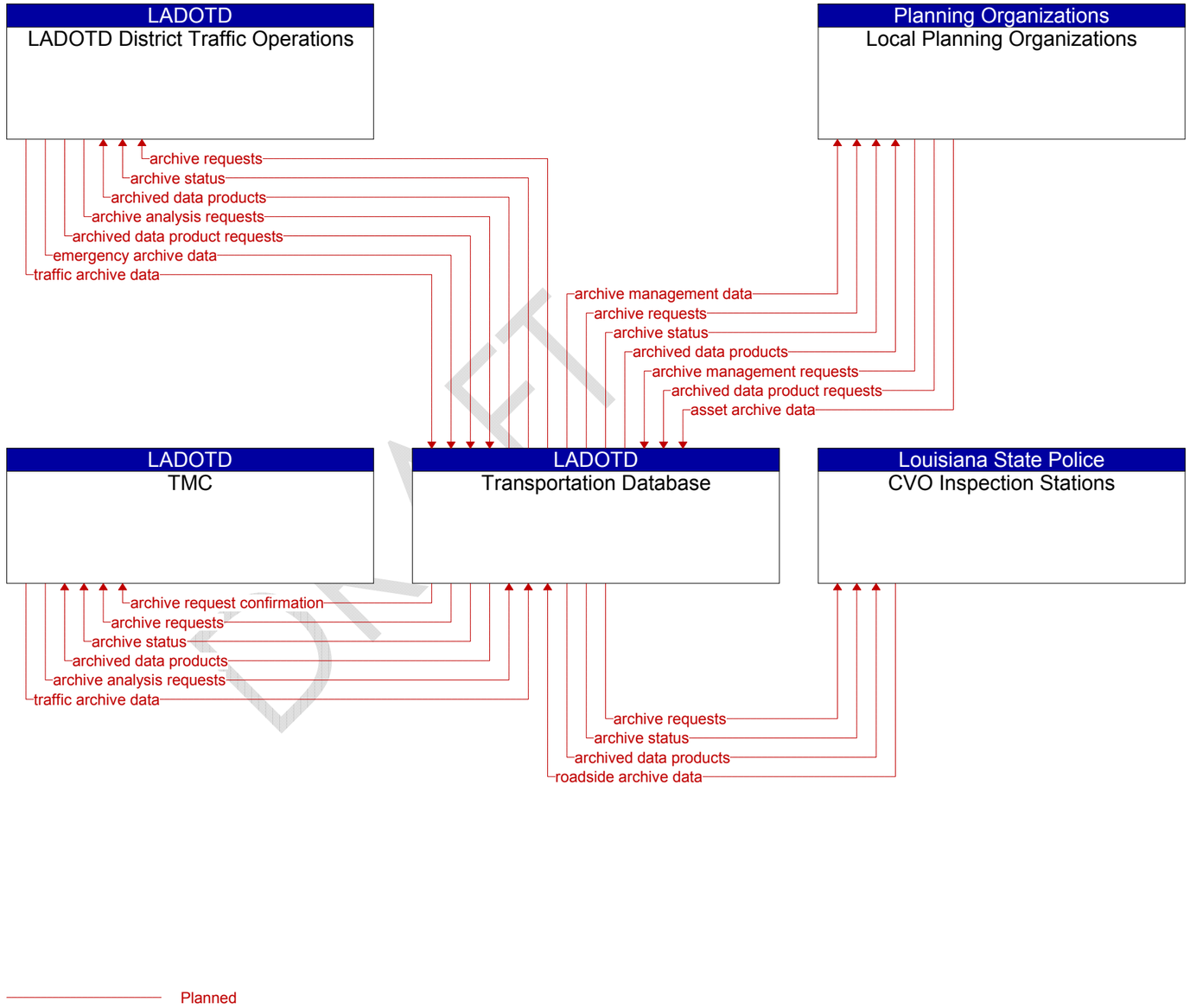
App Figure F-29: Toll Plaza Flow Context Diagram



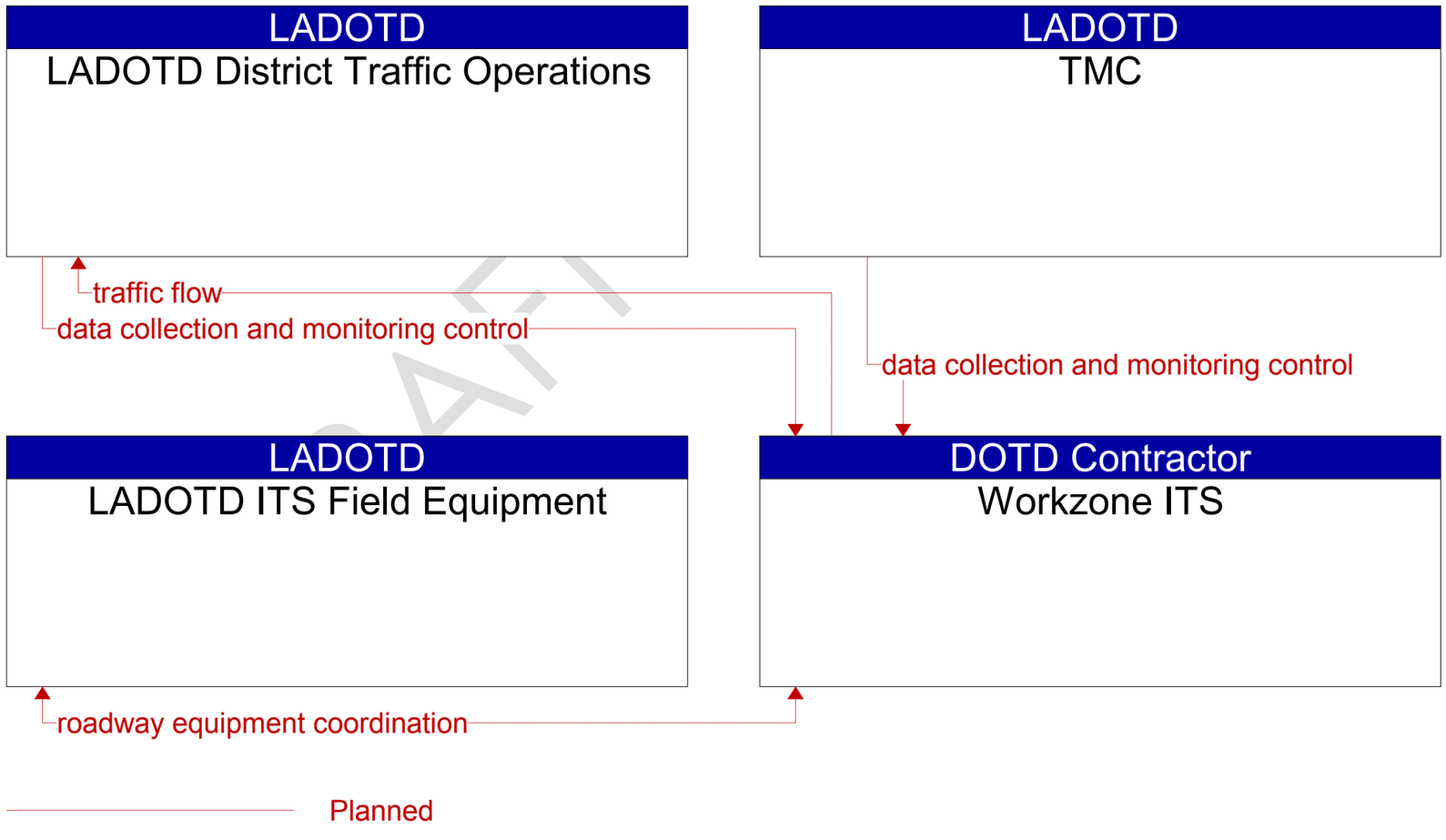
App Figure F-30: Tourism and Travel Service Flow Context Diagram



App Figure F-31: Traffic Signal System Flow Context Diagram

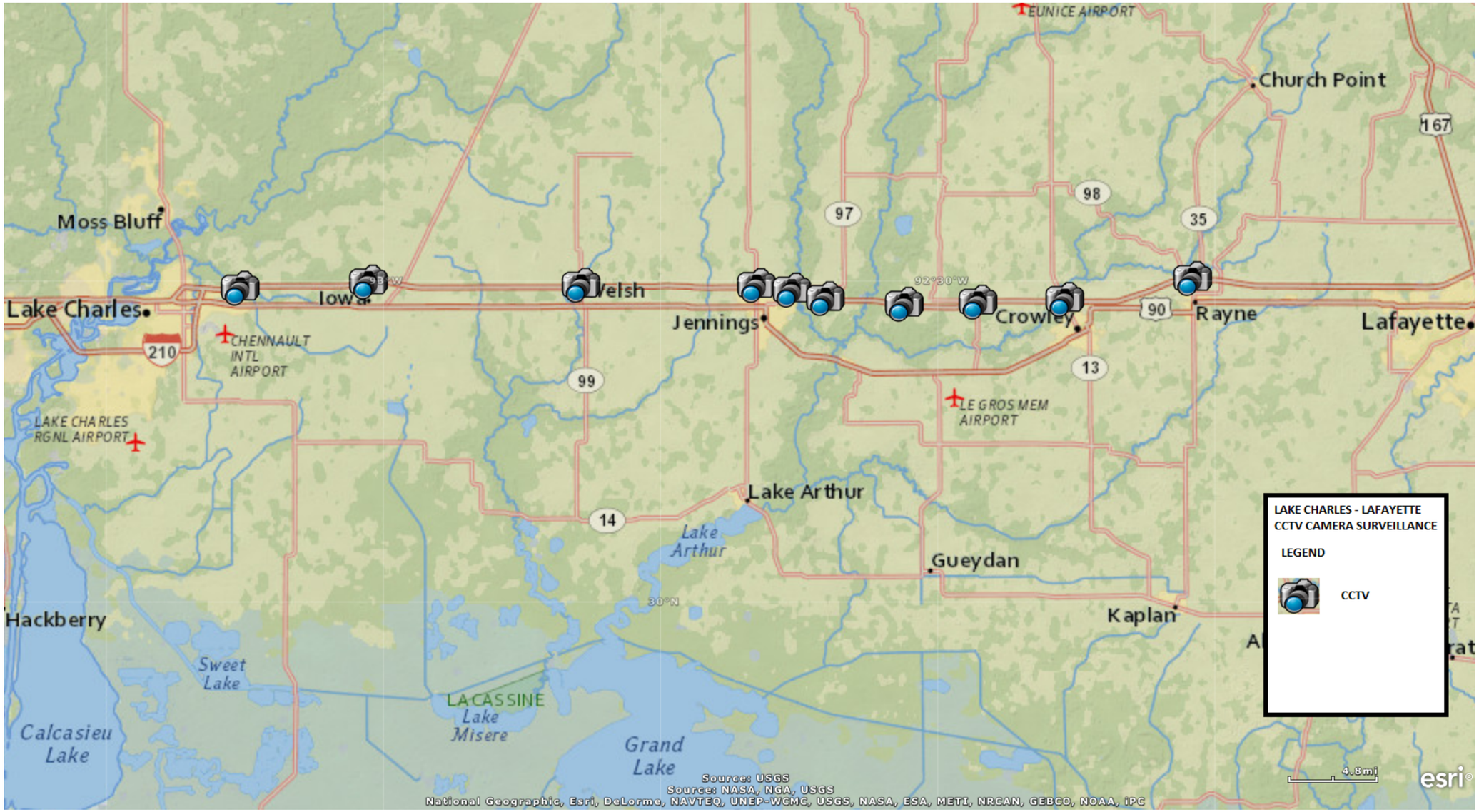


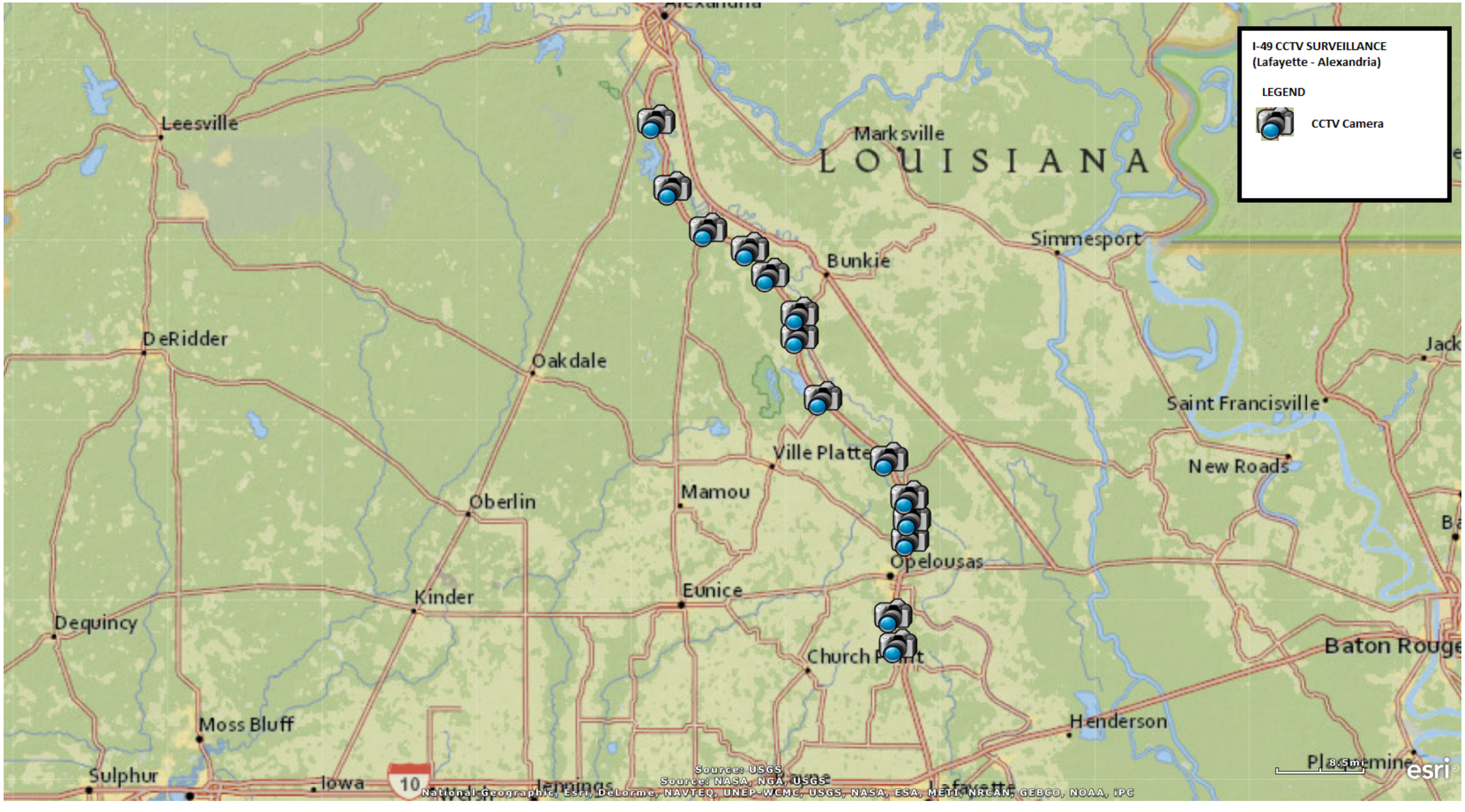
App Figure F-32: Transportation Database Flow Context Diagram

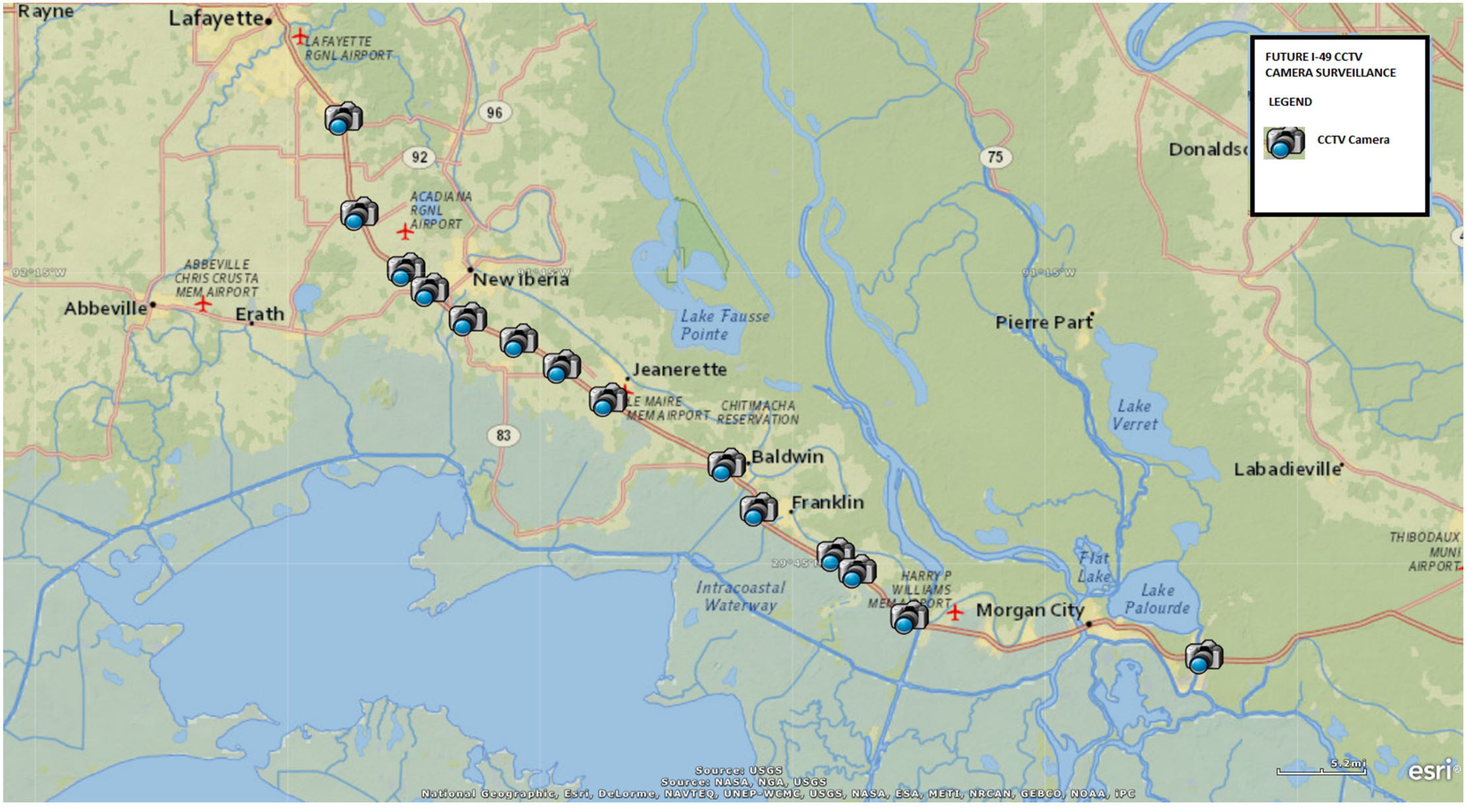


App Figure F-33: Work Zone ITS Flow Context Diagram

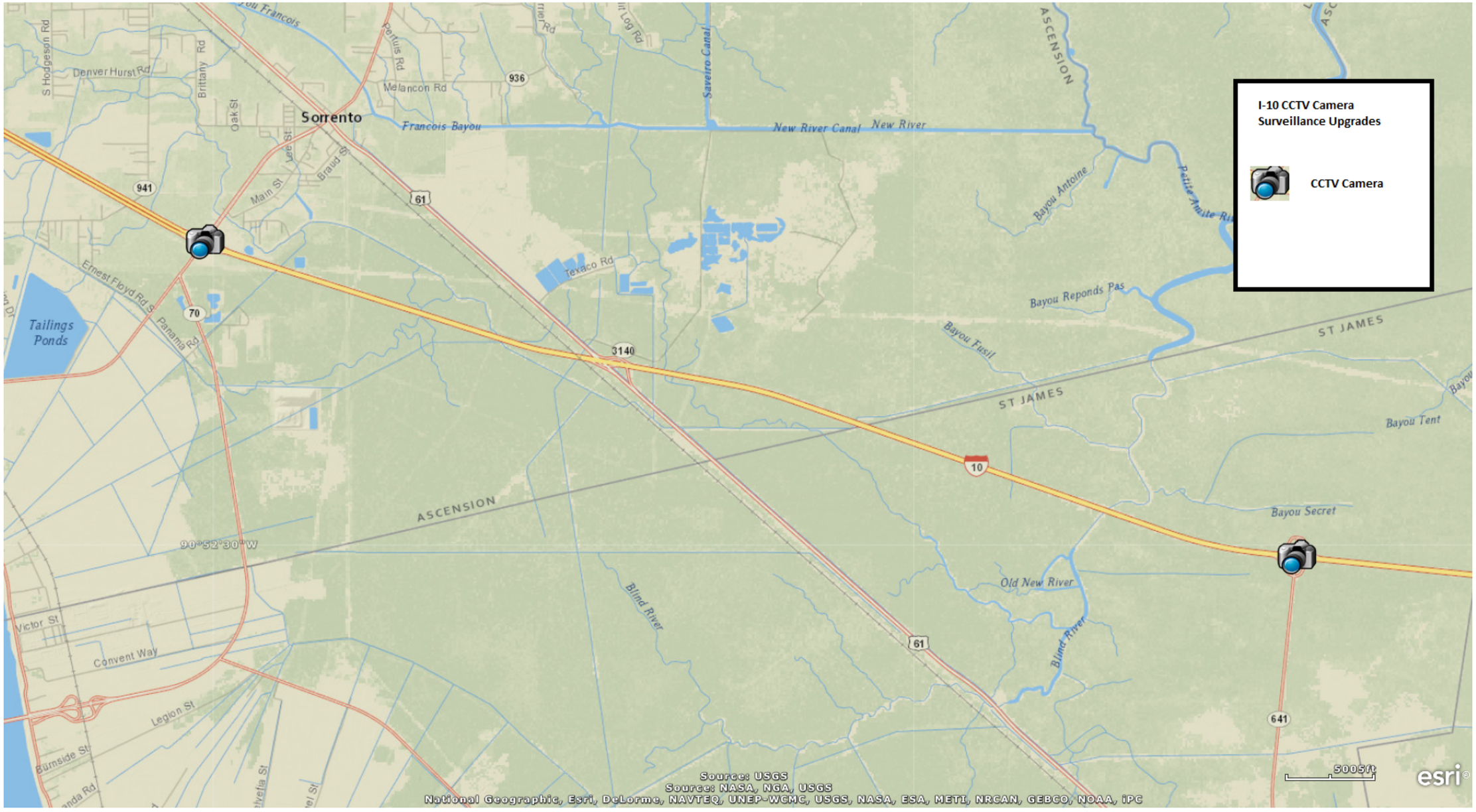
APPENDIX G **– ITS DEPLOYMENT PLAN DETAILS**




I-49 CCTV SURVEILLANCE
(Lafayette - Alexandria)
LEGEND
CCTV Camera
Leesville
Marksville
LOUISIANA
Simmesport
Bunkie
DeRidder
Oakdale
Saint Francisville
Ville Platte
New Roads
Mamou
Oberlin
Opelousas
Eunice
Kinder
Dequincy
Church Point
Baton Rouge
Henderson
Moss Bluff
Sulphur
Iowa
10
Source: USGS
Source: NASA, NGA, USGS
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC
8.5mi
esri

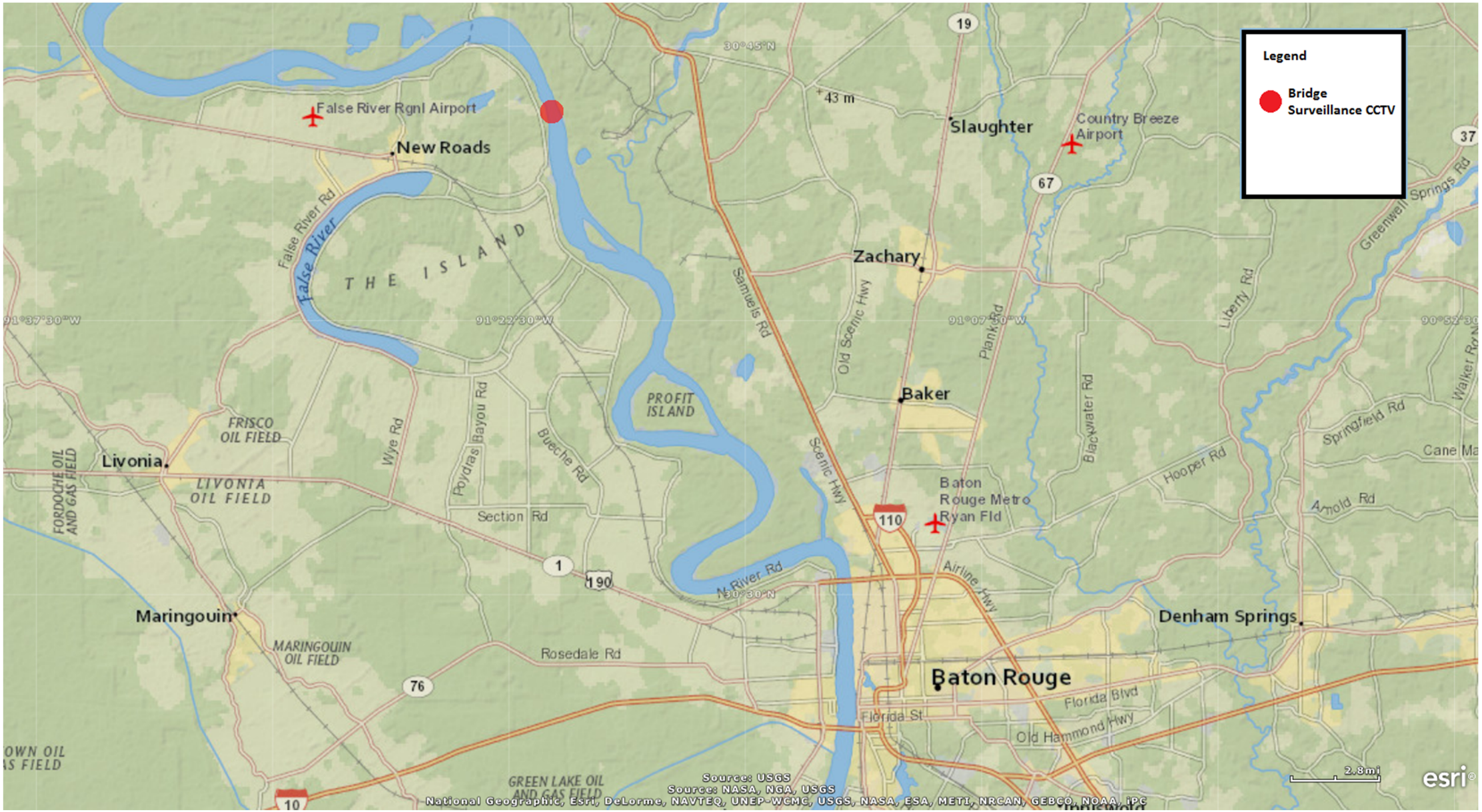

Rayne
Lafayette
LAFAYETTE RGNL AIRPORT
96
92
ACADIANA RGNL AIRPORT
ABBEVILLE CHRIS CRUSTA MEM AIRPORT
Abbeville
Erath
New Iberia
Lake Fausse Pointe
Jeanerette
LE MAIRE MEM AIRPORT
CHITIMACHA RESERVATION
83
Baldwin
Franklin
Intracoastal Waterway
HARRY P WILLIAMS MEM AIRPORT
Morgan City
Flat Lake
Lake Palourde
Pierre Part
Lake Verret
Labadieville
75
Donalds
THIBODAUX MUNI AIRPORT
FUTURE I-49 CCTV CAMERA SURVEILLANCE
LEGEND
CCTV Camera
Source: USGS
Source: NASA, NGA, USGS
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC
5.2mi
esri


LEGEND
SIGNAL UPGRADES
US 61 corridor from LA 641 to I-310
CCTV Camera
10
Baptist
Airport
W Airlin
LAPLACE OIL AND GAS FIELD
New Highway 51
BONNET CARRE OIL AND GAS FIELD
Montegut
LaPlace
E Airline Hwy
Belle Terre Blvd
Ellington St
Fir St
Central
Garyville
Reserve
N Airline Ave
Lutcher Ave
State Route 54
S Church St
E Jefferson Hwy
Mount Airy
Gramercy
Lutcher
Edgard
Paulina
BONNETT CARRE SPILLWAY
NORCO OIL AND GAS FIELD
Cc Rd
River Rd
Apple St
Airline Hwy
GOOD HOPE OIL AND GAS FIELD
Killona
Norco
Prospect Ave
Hahnville
New Sarpy
Home Pl
Amedia Rd
Saint Rose
Destrehan
1.6mi
esri
Source: USGS
Source: NASA, NGA, USGS
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC


I-10 CCTV Camera Surveillance Upgrades
CCTV Camera
Sorrento
Francois Bayou
New River Canal
New River
Saveiro Canal
Melancon Rd
Pentuis Rd
Denver Hurst Rd
S Hodgeson Rd
Brittany Rd
Oak St
Lee St
Braud St
Main St
Texaco Rd
Bayou Antoine
Bayou Reponds Pas
Bayou Fusil
ST JAMES
ASCENSION
Tailings Ponds
Ernest Floyd Rd S
Panama Rd
Victor St
Convent Way
Legion St
Burnside St
90°52'30"W
Blind River
Old New River
Bayou Secret
Bayou Tent
936
941
61
70
3140
10
641
5005ft
Source: USGS
Source: NASA, NGA, USGS
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC
esri


COMMUNICATIONS UPGRADES
LEGEND
Fiber Communications Upgrade (I-49 from Lafayette to Alexandria)
Fiber Communications Upgrade (US 90 from Morgan City to Houma)
Fiber Communications Upgrade (US 90 from Houma to New Orleans
Fiber Communications Upgrades (US 61 from Sorrento to I-310
Alexandria
Marksville
LOUISIANA
Woodville
Centreville
Gloster
McComb
Simmesport
Bunkie
31°N
Kentwood
Clinton
Jackson
Oakdale
Saint Francisville
Amite
Ville Platte
New Roads
Zachary
Mamou
Oberlin
Baker
Opelousas
Picayune
Kinder
Eunice
30°30'N
Walker
Hammond
Abita Springs
Denham Springs
Baton Rouge
Covington
Church Point
Mandeville
Lacombe
Henderson
Plaquemine
Saint Gabriel
Gonzales
Slidell
Iowa
Welsh
Jennings
Rayne
Lafayette
Crowley
91°30'W
LAKE MAUREPAS
LAKE PONTCHARTRAIN
Donaldsonville
LaPlace
Lutcher
Gramercy
Lake Arthur
Gueydan
New Iberia
Kaplan
Abbeville
Erath
Pierre Part
Kenner
New Orleans
Destrehan
Chalmette
Meraux
Jeanerette
Westwego
Violet
Poydras
Estelle
Belle Chasse
Baldwin
Franklin
Labadieville
Thibodaux
Bayou Cane
Raceland
Morgan City
Schriever
LAKE SALVADOR
Lockport
Lafitte
Houma
Larose
Montegut
Chauvin
Galliano
Dulac
Port Sulphur
15.5mi
WHITE LAKE
Atchafalaya Bay
Source: USGS
Source: NASA, NGA, USGS
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC
esri


Legend
Bridge
Surveillance CCTV
LAPLACE OIL AND GAS FIELD
30°07'30"N
10
Saint John The Baptist Parish Airport
W Airline Hwy
Montegut
Reserve
LaPlace
E Airline Hwy
BONNETT CARRE SPILLWAY
Gramercy
Lutcher
Garyville
Edgard
Norco
Airline Hwy
Louis Armstrong New Orleans Intl Airport
Kenner
Metairie
Veterans Memorial Blvd
Airline Dr
Lakefront Airport
Hahnville
New Sarpy
River Rd
Saint Rose
Destrehan
Luling
18
Jefferson Hwy
N Broad St
Lac des Allemands
Waggaman
Avondale
Westwego
Marrero
90
Harvey
Lapalco Blvd
29°52'30"N
PRADIS OIL AND GAS FIELD
Estelle
Des Allemands
Bayou Cane
2.6mi
Source: USGS
Source: NASA, NGA, USGS
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC
esri


Legend
Bridge Surveillance CCTV
False River Rgnl Airport
New Roads
False River Rd
False River
THE ISLAND
PROFIT ISLAND
FRISCO OIL FIELD
LIVONIA OIL FIELD
MARINGOUIN OIL FIELD
GREEN LAKE OIL AND GAS FIELD
FORDOCHE OIL AND GAS FIELD
Livonia
Maringouin
Wye Rd
Poydras Bayou Rd
Bueche Rd
Section Rd
Rosedale Rd
Samuels Rd
Old Scenic Hwy
Scenic Hwy
N River Rd
Zachary
Slaughter
Country Breeze Airport
Baker
Baton Rouge Metro Ryan Fld
Baton Rouge
Denham Springs
Plank Rd
Blackwater Rd
Hooper Rd
Arnold Rd
Springfield Rd
Greenwell Springs Rd
Liberty Rd
Airline Hwy
Florida Blvd
Florida St
Old Hammond Hwy
19
37
67
110
1
190
76
10
30°45'N
30°30'N
91°37'30"W
91°22'30"W
91°07'30"W
43 m
2.8mi
Source: USGS
Source: NASA, NGA, USGS
National Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, iPC
esri

APPENDIX H **– AGREEMENTS**

VIDEO SHARING AGREEMENT (TYPICAL)

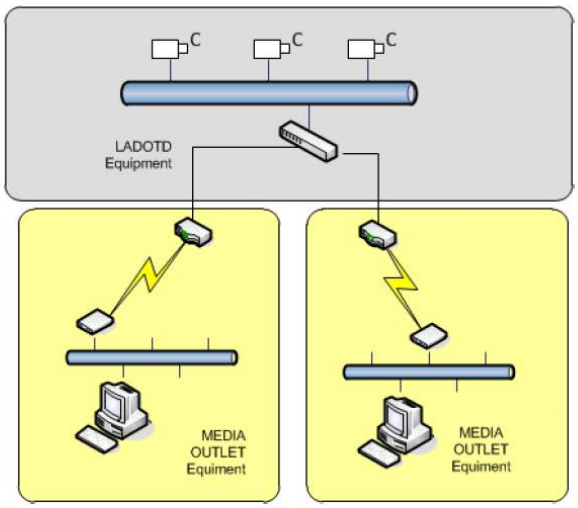
Louisiana Department of Transportation and Development

Traffic Video Sharing Network Plan, Equipment Requirements and Support
High Bandwidth Connection
9/13/2010

Video Sharing Concept:

LADOTD, through a Cooperative Endeavor Agreement with a MEDIA OUTLET, agrees to provide non-exclusive access to the LADOTD Traffic Camera Network. This will provide the MEDIA OUTLET access to all multi-cast video that is available at the Point of Presence (POP) where the MEDIA OUTLET gains access to the LADOTD network. These POP locations will typically be located within LADOTD facilities where the ITS network can be readily accessed (i.e. Regional or Statewide Transportation Management Centers that currently access the backbone Traffic Camera Network). The MEDIA OUTLET will be responsible for arranging the installation and on-going expense associated with the needed telecommunication services and equipment to transport the Traffic Camera Network video signal to their studios for further processing that is required to make the video suitable for broadcasting on TV. The MEDIA OUTLET will also be responsible for any equipment and/or software that are required to decode the digital video into a signal that is suitable for broadcasting on TV. LADOTD will make reasonable space accommodations to the MEDIA OUTLET for any equipment that will need to be installed at the LADOTD POP.

Network Connection Diagram:



Louisiana Department of Transportation and Development
Traffic Video Sharing Network Plan, Equipment Requirements and Support

MEDIA OUTLET Network Capacity, Hardware and Software Requirements:

- 100 mb dedicated link from POP to MEDIA OUTLET facility capable of IP multicast transport (standard MPLS service does NOT meet this requirement). Actual bandwidth requirements will vary depending on the number of concurrently viewed cameras and cycle times. (specify any required details)
- Network Router capable of Multicast routing, suggested 1Gigabit Ethernet port for connection to DOTD in addition to the interface appropriate for the WAN link above (specify make and model)
- PC capable of decoding Traffic Camera video feeds to analog
- Teleste VMX Viewer software to decode Traffic Camera video feeds

Support Responsibilities of LADOTD:

- LADOTD will be responsible for configuration guidance for the Network Router provided by the MEDIA OUTLET.
- LADOTD will be responsible for configuring any and all network equipment owned by LADOTD that is required to complete the connection to the MEDIA OUTLET.
- LADOTD will be responsible for maintaining the network connection between the LADOTD owned network equipment and the MEDIA OUTLET provided network equipment.
- LADOTD will provide MEDIA OUTLET with a list of all IP addresses of the multi-cast Traffic Cameras that are accessible from the POP where the MEDIA OUTLAET gains access to the LADOTD Traffic Camera Network.

Support Responsibilities of MEDIA OUTLET (will begin once the connection to the MEDIA OUTLET is completed and accepted by both LADOTD and the MEDIA OUTLET):

- The MEDIA OUTLET will be responsible for maintaining and troubleshooting any problems associated with the network equipment provided by the MEDIA OUTLET.
- The MEDIA OUTLET will be responsible for troubleshooting and supporting the network services installed between the LADOTD POP and the MEDIA OUTLET.
- The MEDIA OUTLET will be responsible for the PC equipment and all software being used to decode the video at the MEDIA OUTLET.

COOPERATIVE ENDEAVOR AGREEMENT
VIDEO SHARING
between
THE STATE OF LOUISIANA
through the
DEPARTMENT OR TRANSPORTATION AND DEVELOPMENT
and
LOUISIANA TELEVISION BROADCASTING, L.L.C.

This Agreement is made and entered into this 1st day of June, 2016, by and between the Louisiana Department of Transportation and Development (hereinafter referred to as "LADOTD") whose principal place of business is 1201 Capital Access Road, Baton Rouge, Louisiana, 70804 and Louisiana Television Broadcasting, L.L.C., hereinafter referred to as "MEDIA OUTLET" whose principal place of business is 1650 Highland Rd, Baton Rouge, Louisiana, 70802.

WHEREAS, Article VII, Section 14(C) of the Constitution of the State of Louisiana provides, in pertinent part, that "For a public purpose, the state . . . may engage in cooperative endeavors with . . . any public or private association, corporation or individual"; and

WHEREAS, LADOTD wishes to cooperate with the MEDIA OUTLET in the manner as hereinafter provided; and

WHEREAS, consistent with the statutory purposes contained in Title 48 of the Louisiana Revised Statues of 1950, LADOTD monitors traffic and roadway conditions on and around state highway systems for use in promoting highway safety and relieving highway congestion; and

WHEREAS, LADOTD, through its Advanced Traffic Management System (ATMS)DOTD STATEWIDE TMC, LADOTD operates closed circuit cameras on certain portions of Interstate, US Routes and Louisiana State Highways throughout the state of Louisiana("camera systems") capable of producing real-time traffic video images ("video images"); and

WHEREAS, in furtherance of its statutory purposes, LADOTD routinely provides television stations with information related to traffic and roadway conditions, road closures and construction activity for broadcast to the general public. LADOTD and MEDIA OUTLET wish to enhance the quality of this information by providing MEDIA OUTLET with access to LADOTD's video images; and

WHEREAS, MEDIA OUTLET has expressed a desire to access the Video Images to broadcast traffic information to MEDIA OUTLET's viewers as well as posting same on the MEDIA OUTLET's website. MEDIA OUTLET intends to use the Video Images for traffic and news reporting of events, both live and video tape, when warranted; and

WHEREAS, the actions of LADOTD and MEDIA OUTLET will promote highway safety by enhancing the quality and availability of information disseminated to the general public and the motoring public relative to current traffic and roadway conditions in and throughout the State of Louisiana.

NOW THEREFORE, in consideration of the mutual covenants contained herein, the lawful purposes; the public purpose; and the public benefit the parties hereto agree as follows:

ARTICLE I
SCOPE OF SERVICES

1.1 LADOTD agrees to provide MEDIA OUTLET with video images generated by LADOTD's Camera Systems, without charge. LADOTD ATMS Operations personnel shall have exclusive authority to determine the camera view supplied by each of its cameras.

1.2 MEDIA OUTLET will, at its expense, provide and install all necessary equipment (telephone line, hardware and/or software) at the DOTD STATEWIDE TMC, to access the video feed or seek partnerships with existing media outlets to access the video feed under a negotiated business model.

1.3 LADOTD agrees to provide MEDIA OUTLET with reasonable accommodations within the DOTD STATEWIDE TMC facility to install its equipment. LADOTD will also provide MEDIA OUTLET with reasonable access to service its equipment and MEDIA OUTLET will maintain its equipment throughout the term of this Agreement.

1.4 LADOTD will provide MEDIA OUTLET with a user name and password to access the LADOTD Media Page. MEDIA OUTLET will be allowed 3 simultaneous sessions to the Media Page per user account. MEDIA OUTLET agrees to keep the user name and password to the Media Page confidential for use only by the Media Outlet.

1.5 LADOTD reserves the right to modify, alter, replace, improve and upgrade its equipment and to relocate its operations at any time. In the event LADOTD chooses to exercise this right, MEDIA OUTLET shall, at its own expense, relocate and make the necessary replacements and modifications to its equipment as is necessary to accommodate LADOTD's changes.

1.6 MEDIA OUTLET shall have the right to upgrade its equipment as technology becomes available; provided, however, that installation is at a time convenient to LADOTD; installation does not interfere with LADOTD's operations; and MEDIA OUTLET provides LADOTD with a network diagram, description and basic operations capability of the equipment prior to its installation.

1.7 MEDIA OUTLET shall remove its equipment from the DOTD STATEWIDE TMC facility within thirty (30) days after termination or expiration of this Agreement.

1.8 MEDIA OUTLET agrees to timely and accurately broadcast, transmit and post the video images. MEDIA OUTLET is prohibited from making any misrepresentations relative to the video images, including but not limited to, the actual time, date and location of each video image. MEDIA OUTLET further agrees to visibly display LADOTD's logo during all broadcasts and transmissions and will appropriately credit LADOTD on its website postings in which the video images are used. This logo will be inserted in such a way as to not interfere with the visual content of the image being transmitted.

1.9 MEDIA OUTLET shall provide LADOTD with the name and telephone number of a person within MEDIA OUTLET's organization with the technical skills necessary to address any concerns LADOTD may have and to resolve problems associated with the performance of this Agreement.

1.10 MEDIA OUTLET shall protect the integrity of the Camera System and Video Images by insuring that its reporters and other personnel disseminating information relative to the Video Images possess the knowledge and skills necessary to accurately convey and interpret the information contained in the Video Images. MEDIA OUTLET further agrees to meet with LADOTD on a bi-annual basis to review policies and procedures relative to this Agreement.

1.11 MEDIA OUTLET understands and agrees that the services provided by LADOTD pursuant to this agreement may be interrupted or discontinued for any number of reasons, including but not limited to, equipment malfunctions and repairs, routine maintenance, personnel and funding shortages and ongoing responses to emergency situations. If services are discontinued or if interruptions occur, LADOTD shall not be responsible for providing MEDIA OUTLET with traffic information from any other source nor shall LADOTD be responsible to MEDIA OUTLET for any losses, damages or inconveniences occasioned by MEDIA OUTLET as a result of the interruption or discontinuation of the service.

1.12 MEDIA OUTLET understands that there may be instances when the video images contain graphic depictions of accidents, accident scenes and accident victims. MEDIA OUTLET agrees, whenever possible, to refrain from transmitting, broadcasting, posting on its website or otherwise publishing any video image that may unduly offend, humiliate or cause undue embarrassment to accident victims or their families. Examples of such images would include dead bodies, nudity, exposed undergarments, open wounds, broken bones, the administration of medical treatment and the faces or any other item that could be used to determine the identity of a minor or an accident victim whose family has not yet been notified by appropriate government officials of the accident. LADOTD understands that many of the broadcasts and transmissions will be live leaving MEDIA OUTLET with no opportunity to edit the content.

1.13 MEDIA OUTLET further understands and agrees that, although the ATMS and DOTD STATEWIDE TMC are currently in continuous operation, LADOTD may, at any time and for any reason, reduce or change its hours of operation. If this occurs, LADOTD will make reasonable efforts to notify MEDIA OUTLET in advance of the changes or reduction in its hours of operation.

1.14 MEDIA OUTLET shall insure that the Camera System and Video Images and any other information connected with the performance of this Agreement are used only for the specific purpose stated herein. MEDIA OUTLET agrees not to duplicate, reproduce, sell, or charge a fee for use of the Video Images by others. However, MEDIA OUTLET may charge the costs associated with duplication or reproduction of Video Images produced pursuant to a valid subpoena or court order.

1.15 MEDIA OUTLET understands and agrees that it enjoys a non-exclusive limited right to use the Video Images and agrees not to misrepresent the source or availability of the Video Images to others. MEDIA OUTLET further understands that it is LADOTD's intent to provide other media outlets ("Users") access to its Video Images and desires to do so in a manner that is least disruptive to LADOTD's operations and minimizes the space needed to accommodate User's equipment. In this regard, MEDIA OUTLET agrees to allow any User contracting with LADOTD to tie into MEDIA OUTLET's video distribution amplifier to the extent the video distribution amplifier is capable and for as long as MEDIA OUTLET's video distribution amplifier is housed in the DOTD STATEWIDE TMC facility. MEDIA OUTLET may charge any such User a proportionate share of the maintenance costs.

1.16 Nothing herein shall prevent MEDIA OUTLET from selling sponsorships to its traffic and news segments within its newscasts and website in the normal course of business. However, no advertiser or sponsor content may be superimposed or otherwise displayed on the visual content of the image being transmitted. Nothing herein will prevent MEDIA OUTLET from duplicating or videotaping newscasts containing the Video Images for re-broadcasts, provided that the date, time and location of the Video Image are not misrepresented.

ARTICLE II
TERM OF AGREEMENT

2.1 The term of this agreement shall be 5 years (FIVE YEAR TERM).

2.2 Notwithstanding any other provision to the contrary, this Agreement is contingent upon MEDIA OUTLET providing LADOTD with a network diagram, description and basic operations capability of all equipment that will be tied to or in any way connected to LADOTD's DOTD STATEWIDE TMC.

ARTICLE III
TAXES

3.1 If applicable, MEDIA OUTLET hereby agrees that the responsibility for payment of taxes for services provide in this Agreement shall be MEDIA OUTLET's obligation and identified under Federal tax identification number 72-0464654.

ARTICLE IV
TERMINATION CLAUSE

4.1 The LADOTD may terminate this Agreement for cause based on the failure of the MEDIA OUTLET to comply with the terms and/or conditions of the Agreement provided that the LADOTD shall give the MEDIA OUTLET written notice specifying MEDIA OUTLET's failure. If within thirty (30) days after receipt of such notice, the MEDIA OUTLET shall not have either corrected such failure or thereafter proceeded diligently to complete such correction, then the LADOTD may, at its option, place the MEDIA OUTLET in default and the Agreement shall terminate on the date specified in such notice. The MEDIA OUTLET may exercise any rights available to it under Louisiana law to terminate for cause upon the failure of the LADOTD to comply with the terms and conditions of this Agreement; provided that the MEDIA OUTLET shall give the LADOTD written notice specifying the LADOTD's failure and reasonable opportunity for the LADOTD to cure the defect.

ARTICLE V
TERMINATION FOR CONVENIENCE

5.1 The LADOTD, or MEDIA OUTLET, may terminate the Agreement at any time by giving thirty (30) days written notice to the other party.

ARTICLE VI
OWNERSHIP

6.1 Any records, reports, documents and other material delivered or transmitted to MEDIA OUTLET by LADOTD shall remain the property of LADOTD, and shall be returned by the MEDIA OUTLET to LADOTD at MEDIA OUTLET's expense, at termination or expiration of this Agreement. Any records, reports, documents, or other material related to this Agreement and/or obtained or prepared by MEDIA OUTLET in connection with the performance of the services contracted for herein shall become the property of LADOTD, and shall, upon request, be returned by MEDIA OUTLET to the LADOTD, at MEDIA OUTLET's expense, at termination or expiration of this Agreement.

ARTICLE VII
NON-ASSIGNABLE

7.1 MEDIA OUTLET shall not assign any interest in this Agreement by assignment, transfer, donation or novation, without prior written consent of the LADOTD. This provision shall not be construed to prohibit the MEDIA OUTLET from assigning his bank, trust company, or other financial institution any money due or to become due from approved agreements or contracts without such prior written consent. Notice of any such assignment or transfer shall be furnished promptly to the LADTOD and the Office of Contractual Review.

ARTICLE VIII
AUDITORS CLAUSE

8.1 MEDIA OUTLET will comply with all applicable laws, rules and regulations, including but not limited to LSA-R.S. 39:1622. Each party acknowledges that it may receive confidential information from the other party in connection with this agreement. Each party agrees that it will not disclose, provide or otherwise make available any such Confidential Information to any person and/or entity other than such party's employees and/or consultants who need to have access thereto carry out their duties and who are under an obligation to keep such information confidential. Any such books and records required to fulfill this requirement must be maintained for a period of five years from the date of termination of this Agreement.

ARTICLE IX
FISCAL FUNDING

9.1 The continuation of this Agreement is contingent upon the appropriation of funds to fulfill the requirements of the Agreement by the Legislature. If the Legislature fails to appropriate sufficient monies to provide for the continuation of the Agreement, or if such appropriation is reduced by the veto of the Governor or by any means provided in the appropriations act to prevent the total appropriation for the year from exceeding revenues for that year, or for any other lawful purpose, and the effect of such reduction is to provide insufficient monies for the continuation of the Agreement, the Agreement shall terminate on the date of the beginning of the first fiscal year for which funds are not appropriated.

ARTICLE X
INDEMNIFICATION - INSURANCE - LIABILITY

10.1 LADOTD does not guarantee continuity of the services provided for in this agreement nor does LADOTD guarantee the accuracy of the information provided. Any reliance on said information or services, or both, shall be solely at the risk of MEDIA OUTLET.

10.2 MEDIA OUTLET hereby agrees to indemnify and save harmless LADOTD, its officers, agents, employees and assigns, against any and all claims, losses, liabilities, demands, suits, causes of action, damages, and judgments of sums of money to any party accruing against the LADOTD growing out of, resulting from, or by reason of any act or omission of MEDIA OUTLET, its agents, servants, independent contractors, or employees while engaged in, about, or in connection with the discharge or performance of the terms of this agreement. Such indemnification shall include the LADOTD's fees and costs of litigation, including, but not limited to, reasonable attorney's fees. MEDIA OUTLET shall provide and bear the expense of all personal and professional insurance related to its duties arising under this Agreement.

ARTICLE XI
DISCRIMINATION CLAUSE

11.1 The MEDIA OUTLET agrees to abide by the requirements of the following as applicable: Title VI of the Civil Rights Act of 1964 and Title VII of the Civil Rights Act of 1964, as amended by the Equal Employment Opportunity Act of 1972, Federal Executive Order 11246 as amended, the Rehabilitation Act of 1973, as amended, the Vietnam Era Veteran's Readjustment Assistance Act of 1974, Title IX of the Education Amendments of 1972, the Age Discrimination Act of 1975, the Fair Housing Act of 1968 as amended, and contractor agrees to abide by the requirements of the Americans with Disabilities Act of 1990.

11.2 MEDIA OUTLET agrees not to discriminate in its employment practices, and will render services under the Agreement without regard to race, color, religion, sex, national origin, veteran status, political affiliation, disabilities.

11.3 Any act of discrimination committed by MEDIA OUTLET, or failure to comply with these statutory obligations when applicable shall be grounds for termination of this Agreement.

ARTICLE XII
PARTIAL INVALIDITY; SEVERABILITY

12.1 If any term, covenant, condition, or provision of the Agreement or the application thereof to any person or circumstances shall, at any time or to any extent, be invalid or unenforceable, the remainder of the Agreement, or the application of such term, covenant, condition or provision to persons or circumstances other than those as to which it is held invalid or unenforceable, shall not be affected thereby, and each term, covenant, condition, and provision of the Agreement shall be valid and be enforced to the fullest extent permitted by law.

ARTICLE XIII
ENTIRE AGREEMENT; MODIFICATION

13.1 This Agreement, including any attachments that are expressly referred to in this Agreement, contains the entire agreement between the parties and supersedes any and all agreement or contracts previously entered into between the parties. No representations were made or relied upon by either party, other than those that are expressly set forth. This Agreement may be modified or amended at any time by mutual consent of the parties, provided that, before any modification or amendment shall be operative and valid, it shall be reduced to writing and signed by both parties.

ARTICLE XIV
CONTROLLING LAW

14.1 The validity, interpretation, and performance of this Agreement shall be controlled by and

construed in accordance with the laws of the State of Louisiana.

ARTICLE XV
LEGAL COMPLIANCE

15.1 MEDIA OUTLET shall comply with all federal, state, and local laws and regulations, including, specifically, the Louisiana Code of Governmental Ethics (LSA-R.S. 42:1101, et seq.) in carrying out the provisions of this Agreement.

ARTICLE XVI
REMEDIES FOR DEFAULT

16.1 In the event of default by either party, the aggrieved party shall have all right granted by the general laws of the State of Louisiana.

Cooperative Endeavor Agreement WBRZ
Video Sharing
Page 9 of 9

IN WITNESS THEREOF, the parties have caused these presents to be executed by their respective officers thereunto duly authorized as of the day and year first above written.

WITNESSES:

Dallas Dunn
Johnette B. Bonnie

MEDIA OUTLET

BY: Richard T. Marship
Typed or Printed Name

TITLE: President + CEO

72-0464654
Federal Identification Number

WITNESSES

Geoffrey Rodrigue
Darlene Major

STATE OF LOUISIANA THROUGH THE DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

BY: for Secretary

RECOMMENDED FOR APPROVAL:

BY: Division Head

Region	Media Page Acct	Media Page Network	Agr. #	Initial Date	Start Date	Expiration Date	Company Contact	Contact Phone #	Email	Alt. Contact	Tech Contact	Comments
												Terminate agreement
Statewide				3/28/2008	3/28/2008	3/28/2013	Tony Finocchiaro	(603) 918-6387	tfinocchiaro@trafficland.com			
Baton Rouge/Statewide	y	y	1	6/9/2005	9/29/2010	9/28/2015	Robert Chandler	225-215-4799	rchandler@wafb.com	Dale Russel		
Baton Rouge/Statewide	y	y	1	9/30/2005	6/4/2016	9/28/2015	Chuck Bark	225-336-2341	chuck@wbrz.com	Clyde Pierce		Contract Signed
Baton Rouge/Statewide	y	y	1	5/24/2011	5/24/2011	5/24/2016	Jim Baronet	225-769-0044	jbaronet@brproud.com	cell number	225-405-6787	Shares circuit with WGMB
Baton Rouge/Statewide	y	y	1	5/24/2011	5/24/2011	5/24/2016	Jim Baronet					
Shreveport			1	1/25/2008	3/11/2013	3/10/2018	James Smith	318-677-6730	jamessmith@ksla.com			
Shreveport	y	y	1	9/23/2010	9/23/2010	9/22/2015	Brad Pollitt	318-219-4711	bpollitt@ktbs.com			
							Dale Cassidy	318-861-5802	dcassidy@ktbs.com	Dale Cassidy		
									tlankford@ktbs.com	Trey Lankford		
Shreveport			1	8/1/2008	9/15/2015	9/14/2020	Scott Thomas					
New Orleans			1	3/1/2010	3/1/2010	3/1/2015	Danny	504-908-5537	danny@metroscannetwork.com			They do not want to renew, they don't use the video
New Orleans	y	y	1	3/29/2010	3/29/2010	3/29/2015	Mike Schaffer	504-483-1501	mschaefer@fox8tv.net			
New Orleans	y		1	9/9/2011	9/9/2011	9/8/2016	Bobby Deano	504-812-2004	rdeano@wwltv.com			
New Orleans/NS			1				Rick Loggins					
Lake Charles							Scott Flannigan	337-437-7566	sflannigan@kplctv.com			
New Orleans			1	12/21/2011	12/21/2011	12/20/2016	Ken Hughes	504-658-8716	KCHughes@nola.gov			
New Orleans			1	6/13/2013	6/13/2013	6/12/2018	Warren	504-679-0616	wwstewart@hearst.com	jshelley@hearst.com		

Region	Media Page Acct	Media Page Network	Agr. #	Initial Date	Start Date	Expiration Date	Company Contact	Contact Phone #	Email	Alt. Contact	Tech Contact	Comments
							Stewart					
								504-679-0699	gturner@hearst.com			
Statewide			1	2/4/2015	2/4/2015	2/3/2020	Ray Romero					
New Orleans	y		1	2/21/2013	2/21/2013	2/20/2018	Ronald Hoefeld	504-616-8673	Hoefeld_rd@jpso.com			
Shreveport			1				Bob Walters		bob.walters@knoe.com	Tim Lavigne	Tim.Lavigne@knoe.com	

NORTH SHORE TRAFFIC MANAGEMENT CENTER

DOTD
LOUISIANA DEPARTMENT OF TRANSPORTATION & DEVELOPMENT

Project Development Division
Section 24 Road Design | ph: 225-379-1927,
PO Box 94245 | Baton Rouge, LA 70804-9245

Bobby Jindal, Governor
Sherri H. LeBas, P.E., Secretary

August 13, 2014

Charles Bolinger, Division Administrator
Federal Highway Administration
5304 Flanders Drive, Suite A, Baton Rouge, LA 70808

ATTN: James Hall, FHWA Realty Officer

SUBJECT: Request for Concurrence with the General Concept on Joint-Use Agreement Proposal
Louisiana State Police (LSP) Troop L
NE Quadrant of I-12 at LA 21 Interchange at Covington
Route: I-12 and LA 21, St. Tammany Parish

Dear Mr. Hall:

We received a request for a Joint-Use Agreement (JUA) for use of ROW at the captioned site. We would like to obtain FHWA's concurrence with the general concept before we proceed. Attached is a copy of concurrence email from District 62 (Administrator, Ms. Allison Schilling) regarding the request from the applicant with preliminary drawings and area photos. Also included is a copy of the approval from the DOTD Environmental Administrator. As acknowledged and agreed from our DOTD meeting with you, dated August 5th 2014, this letter is to outline different characteristics from a standard JUA as follows:

1. *A permanent building proposed for the Troop L HQ within the ROW of interstate highway (similar to the Troop A HQ in Baton Rouge on ROW of I-10 and the New Orleans Traffic Management Center (TMC) on ROW of I-610).*
2. *Troop L will provide this proposed building with space for a Northshore TMC rent-free, including all utilities.*
3. *Cooperative Endeavor Agreement (CEA) will be contracted among all appropriate stakeholders such as DOTD, Troop L, and Regional Planning Commission (if applicable). This CEA will cover funding, maintenance, DOTD ITS role and any other issues significantly necessary.*
4. *Proposed right-in/right-out driveway from LA 21.*
5. *Area needed for future interchange improvements will be excluded from the JUA area*
6. *The use of the facility will be in compliance with the Northshore Regional ITS Architecture Plan for the area revised from the one of New Orleans TMC on I-610.*

Based on the information provided in this letter, we are in agreement with this request. If this request is satisfactory to you, please return your concurrence with the general concept to this office for further oversight. If you require any additional information, please contact me at (225) 379-1927.

Sincerely,

Beyong Lim, P.E., DOTD Permit Engineer
Attachment
pc: File

U.S. Department of Transportation
Federal Highway Administration

Louisiana Division Office

5304 Flanders Drive, Suite A
Baton Rouge, LA 70808
225.757.7600
225.757.7601 (fax)

November 14, 2014

In Reply Refer To:
HDA-LA

Sherri H. LeBas, P.E.
Secretary
Louisiana Department of Transportation
and Development
Baton Rouge, LA

Subject: Request for Concurrence with the General Concept on Joint-Use Agreement Proposal
Louisiana State Police (LSP) Troop L
NE Quadrant of I-12 at la 21 Interchange at Covington
Route: I-12 and LA 21, St. Tammany Parish

Attention: Mr. Beyong Lim:

Dear Ms. LaBas:

We concur with the general concept for a Joint-Use Agreement (JUA) for use of ROW at the caption site described in your enclosed letter dated August 13, 2014. Once you have all the requirements for a Conceptual Joint-Use Agreement forward that document to FHWA for approval.

If you need any additional information please contact James R. Hall, Real Officer at 225 757-7625.

Sincerely yours,

Charles Bolinger
Division Administrator

Enclosure (1)

cc: Beyong Lim