SYSTEMS ENGINEERING ANALYSIS
HOUMA ITS
PHASE 3 AND 4

FINAL

April 2010

Presented to:

Louisiana Department of Transportation
And Development

ABMB
ENGINEERS, INC.

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PLANNERS
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Houma ITS Phase 3 and Phase 4
Systems Engineering Analysis

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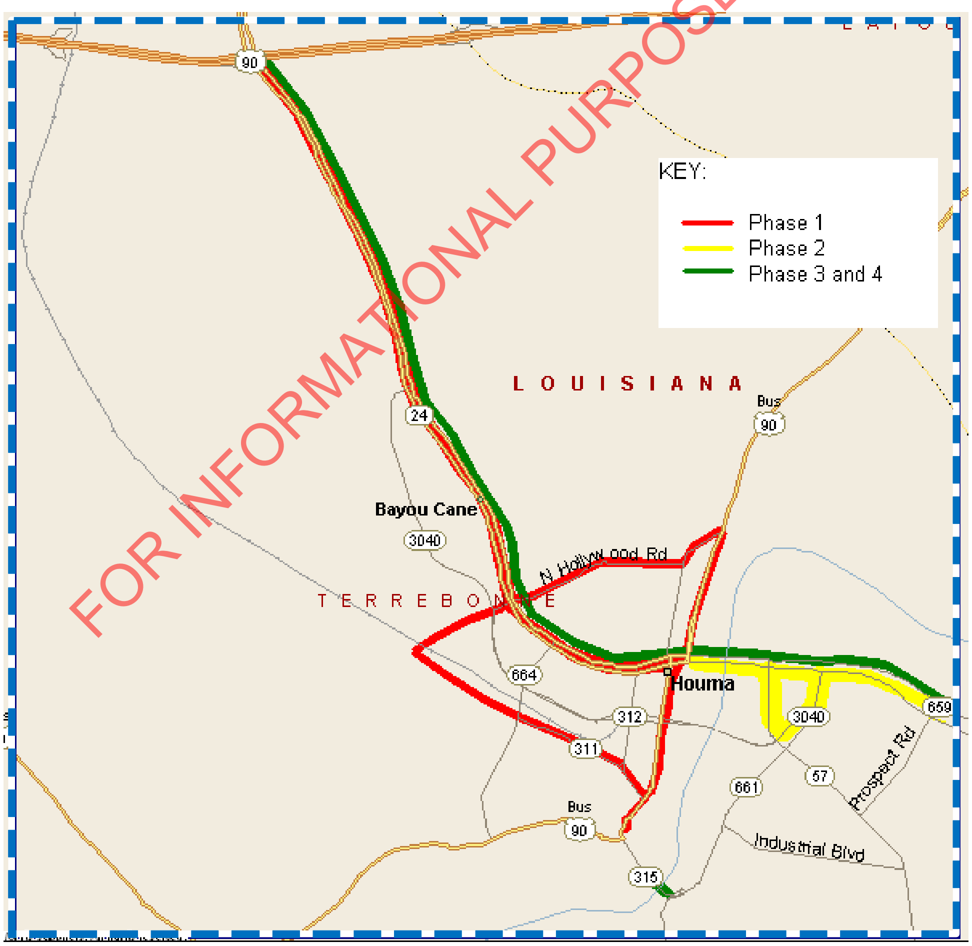
1 Introduction

To assure interoperability of physical systems and a coherent traffic management program, the implementation of an Intelligent Transportation System (ITS) projects requires consideration as to how the project will fit into the national and regional ITS Architecture. The Federal Highway Administration (FHWA) has developed and mandated that a "Systems Engineering" process be used whenever ITS technologies are to be deployed. This process will give the implementing agency confidence that resources are being used optimally, returning the maximum value for transportation dollars spent.

The South Central Planning & Development Commission (SCPDC), through the Department of Transportation and Development (DOTD), has requested the implementation of the next ITS projects from the *Houma ITS Development Plan* (also referred to as the regional ITS plan). The Houma ITS Phase 3 project consists of providing plans for connecting the local government agencies to the previously deployed ITS communications backbone. In addition, the deployment plans will include four status signs to indicate the status of the LA 315 draw bridge. The Houma ITS Phase 4 project will consist of the LA 24 signal design and construction. **Figure 1** shows the limits of the project within the blue dashed box.

Figure 1: Project Limits

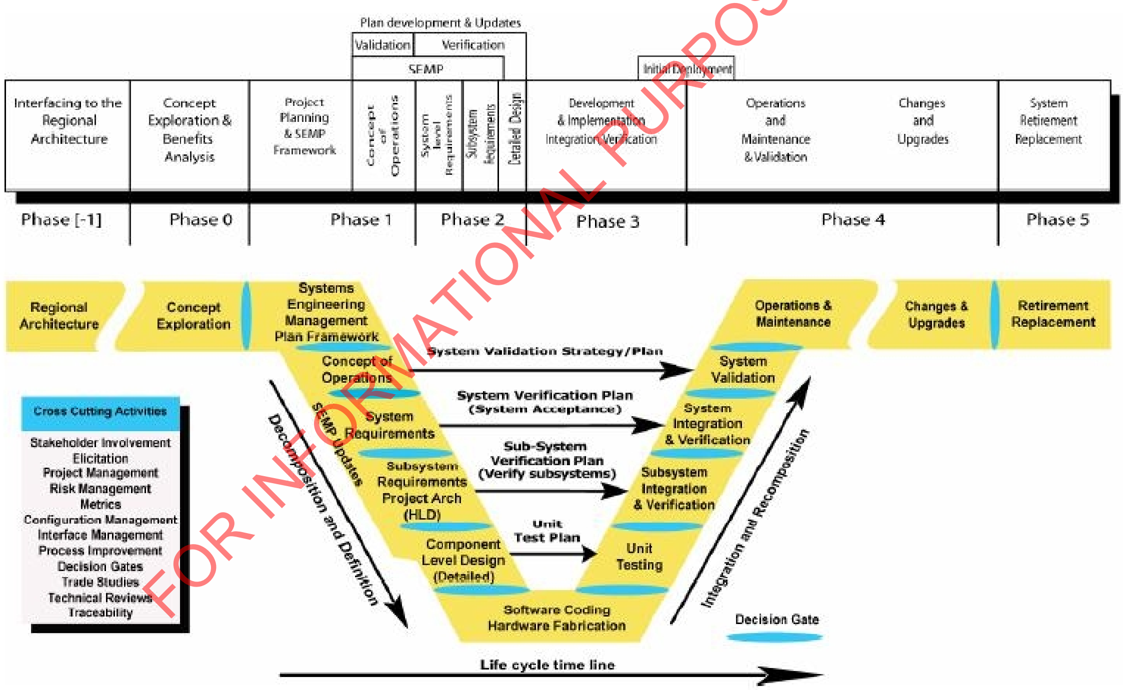


2 Systems Engineering Approach

A Systems Engineering (SE) approach offers a structured way of thinking to achieve project goals and objectives. This approach combines skills associated with engineering, project management and soft sciences (economic, social and legal). It helps address all project issues and provides completeness to a system. Systems Engineering also provides for "traceability", important when considering future changes to the system design, operations, verification and testing. Traceability is the ability to track every requirement in the system to the system component that satisfies it. Through the Systems Engineering approach, a traceability matrix is deployed. This matrix provides the basis for construction testing and acceptance by the Project Engineer, as well as the link between completion of individual pay items and implementation of the basic purpose and scope of the project.

Figure 2, the "V" Diagram or Model, is a visual illustration of the Systems Engineering process used for ITS, with each step involved as the project progresses through development. The "V" diagram was created by the Federal Highway Administration and was taken from *The System Engineering Handbook for ITS* version 2.

Figure 2: "V" Diagram Illustrating Systems Engineering Process



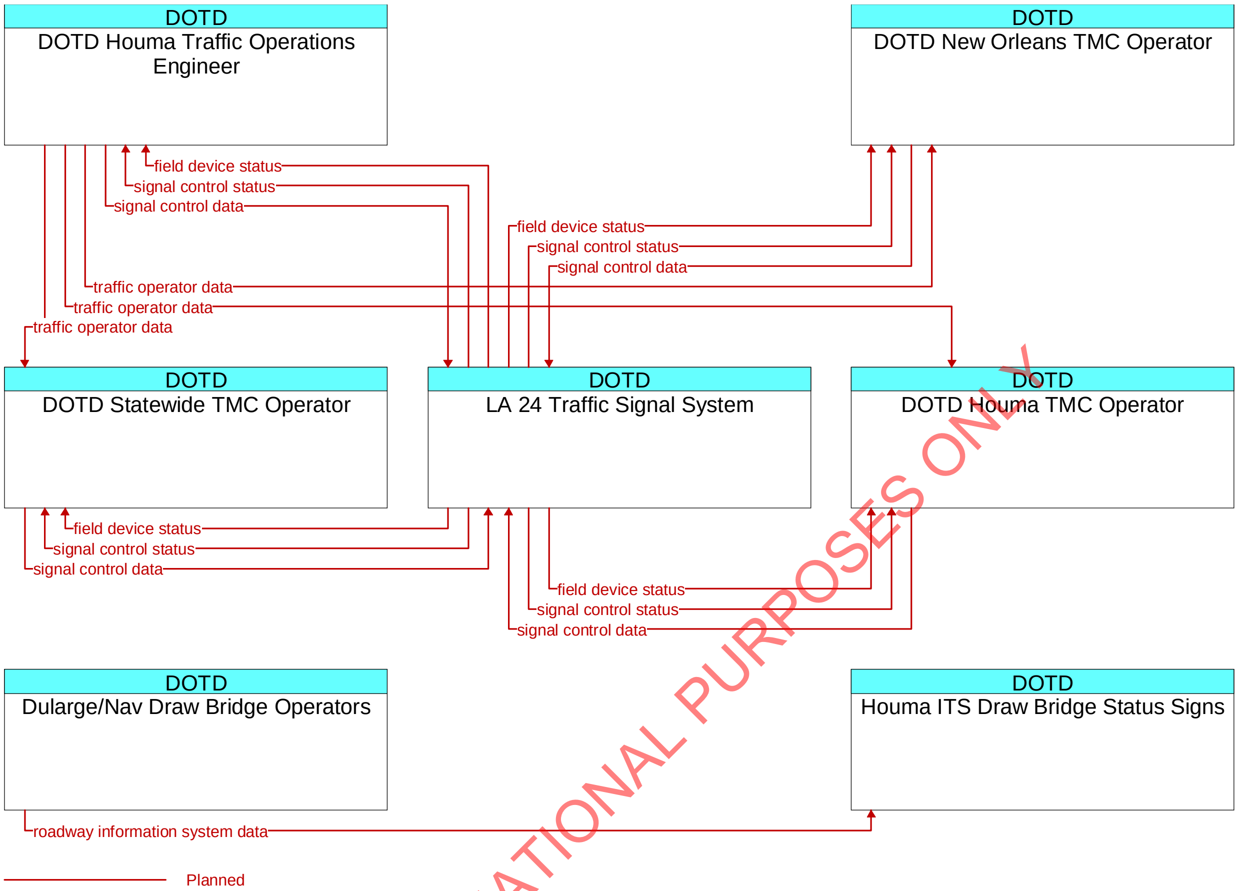
The left side of the "V" Diagram provides a 'top-down' approach for system planning and design development while the right side provides 'bottom-up' implementation approach for systems testing and verification. The left side of the "V" must take into account the corresponding processes across on the right side of the "V". The "V" diagram is a composition of three different perspectives, namely user's perspective, engineer's perspective and contractor's perspective.

A Stakeholder's (user's) perspective helps present a list of requirements. These requirements provide detailed definitions needed to develop a system design. The perspective of a systems engineer is focused on detailed subsystem components designed to achieve stated requirements. The perspective of a contractor is focused on the actual deployment of the system components, which ensures compliance with the designed specifications.

3 Project Physical Architecture

It is essential that a project physical architecture be developed to illustrate the important ITS interfaces and the major system components. The physical architecture assigns processes from the logical architecture to subsystems, and it groups data flows from the logical architecture into architecture flows. These flows and corresponding communication requirements define the interfaces, which are a main focus of the project ITS standards. **Figure 3** illustrates the project physical architecture under consideration. It depicts the overall understanding of the physical architecture components associated with the project. Also, it should be noted that existing ITS equipment and centers connected to the DOTD Sub-district 02/Houma TMC are not being modified or impacted by this project (i.e., no new architectural flows.) Therefore the existing subsystem architecture flows are not shown in the project physical architecture.

Figure 3: Project Physical Architecture (Phases 3 and 4)



4 Concept of Operations

Concept of Operations (ConOps) describes how the proposed system will function, the environment in which it will operate, and the people who will use and support the system. ConOps identifies the stakeholders involved in the project and their responsibilities. It also describes the roles and responsibilities for operations and maintenance of the various system users which must be consistent with the *Houma ITS Development Plan*.

The ConOps is a non-technical discussion of the ITS system that should be understood by everyone involved in the project. It presents a view of the operational system once the project is completed, the intended benefits of the system and how it will impact the region in which it is deployed. This ConOps is a general description of how the Houma Intelligent Transportation System will function and the operational responsibilities of each agency involved. The system, which cannot be used to transfer liability related to operating specific facilities, will appoint operational roles to each agency.

4.1 Purpose

The purpose of the Houma ITS Phases 3 and 4 projects is to improve traffic operations for both normal and abnormal traffic conditions, such as traffic incidents, along LA 24 and LA 315. The ITS system will aid in the operations of traffic, traffic signal control, evacuation support and verification of incidents from the local DOTD Sub-district 02/Houma TMC.

4.2 Scope

The Houma ITS Phase 3 and 4 projects is a continuation of the existing implemented system. These projects will accommodate for the interaction of twenty-seven subsystems consisting of various agencies and field devices. However, architecture flows will only occur between eight subsystems, as shown in the Project Physical Architecture, **Figure 3**. For the full illustration with the twenty-seven subsystems please refer to **Appendix A**.

The scope of the Phase 3 project includes the following deployment components with the responsible stakeholder providing services associated with the referenced subsystems:

- Local agency centers communication accessibility
- LA 315 draw bridge status (Draw bridge status sign, DBMS)

The scope of the Phase 4 project includes the following deployment components with the responsible stakeholder providing services associated with the referenced subsystems:

- Design and construction of the LA 24 Traffic Signal System

4.3 Justification for the New System

The city of Houma is located in the south central region of the state. Numerous bayous that serve as both drainage and navigation are located throughout the city. The unique geographic location greatly influences the area's economy and traffic patterns.

Due to limited highway infrastructure and extensive economic activity, there is extraordinary traffic activity compressed into limited available building space. The bayous and water crossings constrain alternate route options and highway connections. The net result of these conditions is traffic congestion that is significantly more severe than experienced in urban areas with similar populations.

While traffic congestion is a costly nuisance for the region's normal daily activities, it can become a serious barrier for emergency evacuation. This region has to readily facilitate evacuations due to hurricanes that threaten the region and the potential for harmful chemical releases that could be produced by accidents involving large numbers of trucks and barges that transport hazardous materials though the area.

The combination of heavy traffic, limited routes for emergency evacuation traffic, limited ability to expand roadway capacity demands that the area's transportation system operate more efficiently to accommodate economic expansion and safety. The identification of ITS needs for the Terrebonne Parish region was accomplished through a review of previous studies that examined traffic congestion for the area, as well as hurricane evacuation studies that determined mobility needs that can be addressed or improved through ITS technologies. More in-depth needs were obtained through stakeholder interviews with agency representatives who are significantly involved with regional traffic operations or who are directly impacted by the need for increased capacity for the area's limited transportation system (refer to Table 1 for a list of these agencies.) The needs identified included: increase the utilization of LA 24 and LA 315 (DOTD); and have high speed communication between the local agencies (all stakeholders. Though some of these needs have been addressed through Houma ITS Phase 1 and 2, traffic congestion and communication problems remain.

4.4 Existing Operations

The existing Houma ITS system includes user services such as Roadway/Traffic Management, Incident Management and Emergency Management. However, as previously stated, the area's traffic system needs to be updated.

4.4.1 Traffic Management/Roadway

DOTD Sub-district 02/Houma TMC currently operates and maintains over 67 traffic signalized intersections in the region. None of the existing traffic signals have remote communications with the Sub-district 02 office. All timing changes are performed by the Sub-district personnel in the field.

As of the date of this document, Houma ITS Deployment phases 1 and 2, have been completed. The previous two ITS deployment projects were primarily communication deployments, (i.e., fiber optic cable) with minimum field equipment. Phase 1 included over 17 miles of fiber optic cable installed along LA 24 (Main St.), LA 311, Hollywood Rd, and LA 182 (Barrow St. and New Orleans Blvd.). Also included as part of Phase 1 were 9 CCTV sites, 4 RVD sites and 7 total RVDs. The Phase 2 project deployed 3.5 miles of fiber along LA 24 (Park Ave), LA 51 (Grand Caillou Rd.) LA 661 (S. Van Rd./ Howard Ave.) along with 4 CCTV sites, 3 VIDS sites, 1 DMS site and 1 Hub / Node site.

Currently there is one ITS Operator in the DOTD Sub-district/Houma TMC (simply referred to as the Houma TMC Operator). The Houma TMC Operator controls the ITS equipment as needed during normal business hours, 6:00 am to 2:00 pm, Monday through Friday. The control of the ITS equipment is through the traffic management software package, Cameleon ITS v4 developed and marketed by 360 Surveillance. The Houma ITS Operator is assigned to scan the CCTV cameras, monitor congestion, report accidents to the Houma Police Department / Terrebonne Sheriff's Office, post messages to the message boards, and log all occurrences. During business hours emergency calls go the Sub-district 02 office and are forwarded to the ITS operator. After hours, the New Orleans TMC Operators provides operations. Also, after hours and for emergency purposes only, the DOTD Houma Sub-district 02 Traffic Operations Engineer (simply referred to as the District Traffic Operations Engineer, or DTOE) may be contacted via cellular phone.

DOTD provides motorists current traffic and roadway conditions through a statewide 511 Traveler Information System. The voice-activated 511 Traveler Information Service is available to most wireless and landline telephone users. The service allows callers to access up-to-date information about weather-related road conditions, construction activities and other critical incidents simply by dialing 511 from their telephone and stating the route or region about which they are seeking information. LSP provides updates on incidents in the region while the Houma TMC Operator updates 511 and provides updates on weather and road conditions. Construction activities in the Houma area are updated in 511 by a DOTD Statewide TMC Operator.

4.4.2 Incident Management

The Houma TMC ITS Operator provides incident detection and coordination where surveillance is available in the region. Coordination between the ITS operator and the dispatch operators from the local response departments occurs via telephone or parish radio system.

4.4.3 Emergency Management System

During emergencies, coordination between agencies may occur, but there is no publicly owned connection between the agencies (i.e., the agencies are communicating via a privately owned connection such as BellSouth). The Houma TMC ITS Operator provides the same role for Emergency Management as that for Incident Management.

4.5 System Overview

The Houma ITS Phase 3 and 4 projects will facilitate a distributed ITS architecture as opposed to a centralized Traffic Management/Emergency Operations Center. This type of system eliminates the need for emergency management dispatchers and operations personnel to reside in a common center by utilizing communication technology to coordinate operations. However, some co-location of emergency responders may be beneficial during extreme conditions.

Table 1 shows the agencies that will be provided with access to the communications backbone. Agencies listed on this table are used for emergency response according to Emergency Plans as defined by federal and state agencies. **Table 2** shows the agencies responsible for operating and maintaining elements of the various systems affected by this project in accordance with the regional ITS plan.

Table 1: Agencies to be Connected to the Regional Backbone

Center	Address
TPCG, Government Tower	8026 Main St. Gov't Bldg Tower
TPCG, Public Works, Operations and Maintenance, Drainage	1860 Grand Caillou Rd.
TPCG, Utilities	301 Plant Rd.
TPCG, Public Transit, Good Earth Transit	Number 1 McCord Rd.
Louisiana State Police, Troop C	4047 West Park Ave.
Terrebonne Parish Communications District (E911)	112 Capitol Blvd.
Bayou Cane Volunteer Fire Department (W. Main)	6160 W Main St.
Acadian Ambulance	400 Honduras St
Terrebonne Parish Library (Main Branch)	151 Civic Center Blvd.
Terrebonne General Hospital	8166 Main St.
School Board Central Office	201 Stadium Drive
Louisiana Technical College	201 Saint Charles Street
TPCG Information Systems	7868 Main St.
Consolidated Waterworks	8814 Main St.
Houma Terrebonne Airport	10264 East Main St.
TPCG Pollution Control Department	2000 Saint Louis Road
Houma Fire Department Station (Legion)	600 Legion Ave
Houma Fire Department Station (St. Charles)	1430 St. Charles Ave
Houma Fire Department Station (Airport)	120 James Rd.
Bayou Cane Volunteer Fire Department Station (W. Park)	4617 West Park Ave
Bayou Cane Volunteer Fire Department Station (Savanne)	1214 Savanne Rd
Bayou Cane Volunteer Fire Department Station (Hollywood)	123 North Hollywood Rd
Leonard J Chabert Medical Center	1978 Industrial Blvd
Electrical Substation (Cummins)	2551 Cummins Rd
Electrical Substation (Gibb)	1305 Gibb Rd
Electrical Substation (Plant)	221 Plant Rd
Electrical Substation (Belanger)	877 Belanger St
Electrical Substation (Sixth)	528 Sixth St.
Electrical Substation (Mckinley)	438 Mckinley St
Electrical Substation (Valhi)	437 Valhi Blvd

Table 2: Agency Responsibility

System	Agency
Traffic Management System Development	DOTD/TPCG
Traffic Management System Operations	DOTD/TPCG/Police/HSO/E-911/OEP
Traffic Management System Maintenance	DOTD/TPCG
Incident Management Development	DOTD/E-911
Incident Management Incident Operation	DOTD/E-911/Police/HSO/OEP/TPCG
Incident Management System Maintenance	DOTD/E-911
Emergency Management System Development	DOTD/E-911/Police/HSO /OEP/TPCG
Emergency Management System Operation	DOTD/E-911/Police/HSO /OEP/TPCG
Emergency Management System Maintenance	DOTD/E-911/Police/HSO /OEP/TPCG

A distributed traffic and emergency management system requires a highly reliable and robust communications network. As previously stated, a fiber optic communications backbone along LA 24 has been deployed to support the communications needs for the Houma Metropolitan Area. **Table 3** shows the agencies to which the fiber communications network could provide a means of accessibility. Please note that it is intended by the acceptance of this document by the Houma-Thibodaux Metropolitan Planning Organization (HTMPO), the information presented in this table will be updated into the Houma Regional Plan. However, the implementation may not necessarily occur within these two projects. It should also be noted that the centers that facilitate emergency management in the region are required to be included in the local emergency management plan in order for federal highway funds to be available for the connection of the center.

Table 3: Agency Accessibility

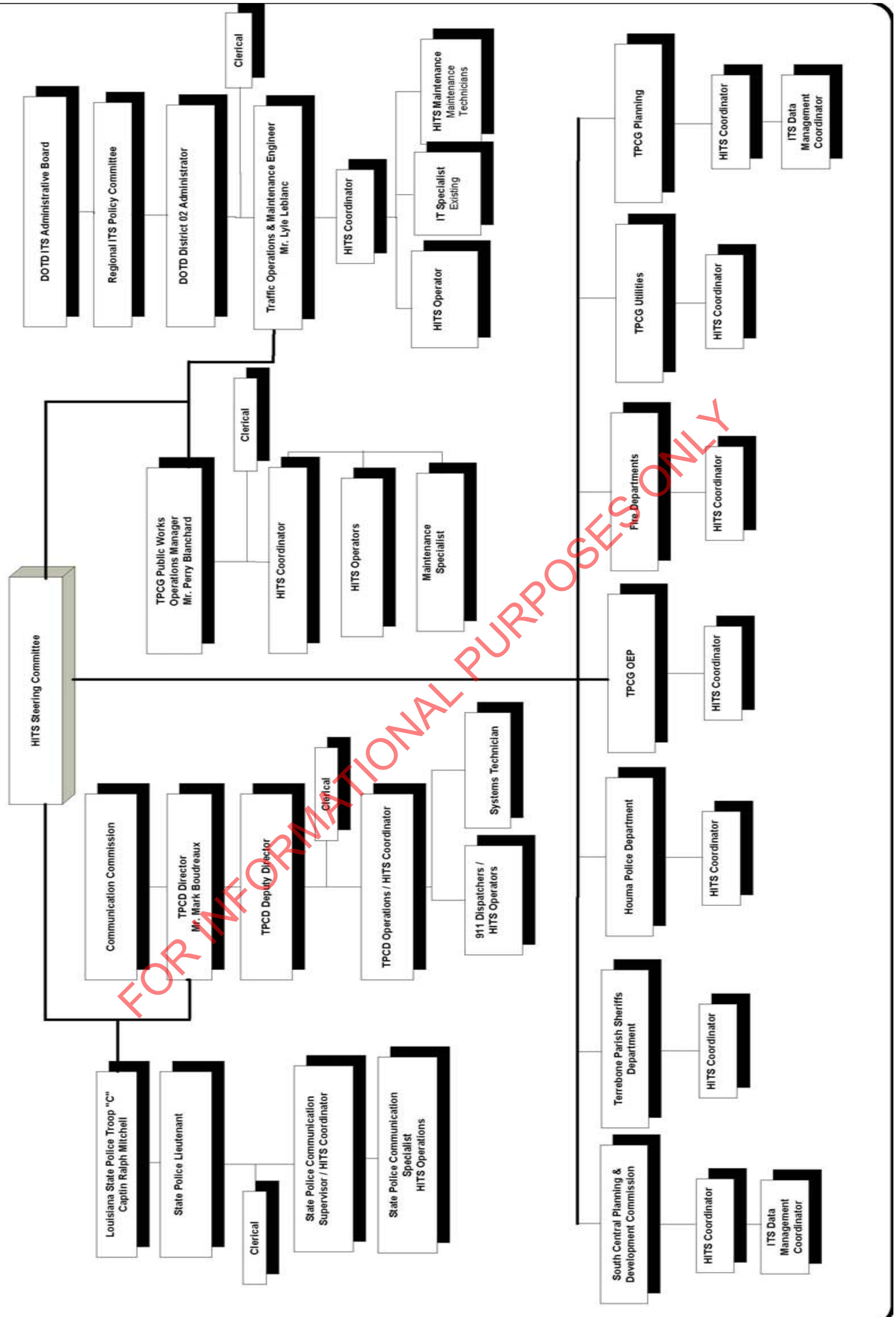
Agency	ITS Access
TPCG, Planning	DM
TPCG, Roads and Bridges Division	
TPCG, Public Works, Operations and Maintenance, Drainage	NS, TIS, IM
TPCG, Utilities	EM, IM
TPCG, Public Transit, Good Earth Transit	NS, EM, IM, TRANS
DOTD Sub-district 02/Houma TMC	SSC,NS,TIS, EM,IM,DM
DOTD Headquarters TMC (ITS Division)	SSC,NS,TIS,EM, IM,DM
Louisiana State Police, Troop C	NS,TIS, EM,IM,DM
Terrebonne Parish Communications District (E-911)	NS, TIS, EM,IM
Bayou Cane Volunteer Fire Department (W. Main)	NS, EM,IM
South Central Planning and Development Commission, MPO	DM
Acadian Ambulance	EM,IM
Terrebonne Parish Library (Main Branch)	EM
Terrebonne General Hospital	EM, IM
School Board Central Office	EM
Louisiana Technical College	EM, NS
TPCG, Information Technology	EM, TIS,DM
Consolidated Waterworks	EM
Houma Terrebonne Airport	EM
TPCG, Pollution Control Department	EM
Houma Fire Department Station (Legion)	NS, EM,IM
Houma Fire Department Station (St. Charles)	NS, EM,IM
Houma Fire Department Station (Airport)	NS, EM,IM
Bayou Cane VFD Station (W. Park)	NS, EM,IM
Bayou Cane VFD Station (Savanne)	NS, EM,IM
Bayou Cane VFD Station (Hollywood)	NS, EM,IM
Leonard J. Chabert Medical Center	EM, IM
Electrical Substations	EM

SSC-Surface Street Control, NS-Network Surveillance, TIS-Traveler Information System, EM-Emergency Management, IM-Incident Management, DM-Data Management, and TRANS-Transit Management System

It is anticipated that the Houma ITS Steering Committee will continue to provide oversight and direction for the Houma ITS Phase 3 and 4 projects, as the projects are designed. Additionally, it is recommended that the Steering Committee expand to be representative of all agencies involved in its improvements for the Houma Metropolitan Area. For further information about the Steering Committee please refer to section 3.6. **Figure 4** depicts a preliminary multi-organizational structure to address day-to-day traffic and incident management as well as emergency operations as taken from the *Houma ITS Development Plan*. It should be noted that this organizational chart and the Regional Architecture to which it belongs, should be updated in the development plan by the HTMPO to show any changes due to the DOTD Statewide District restructuring and local agency personnel changes.

Figure 4:

HITS Traffic Management & Emergency Managment Multi-Agency Organizational Structure



The following section outlines the envisioned operations of the ITS system resulting from the deployment of this project. Operations and maintenance outside of this section are anticipated to remain as currently performed.

4.5.1 Traffic Signal System Operations

The ITS system will provide the Houma TMC Operator and Houma DTOE and his staff the ability to monitor the operations of the signalized intersections on LA 24 from US 90 to LA 3087. This includes uploading and downloading signal timing plans and implementing predefined signal progression patterns in response to incidents as well as priority requests. The traffic signal system will consist of: traffic signal controllers, emergency vehicle detectors, signal heads, vehicle detectors, field masters, the communications systems, and a central traffic signal control system. The level of functionality will evolve from the predominately isolated field access system to an interconnected, centrally managed ("closed loop") system.

Interface with the traffic signal system will be via the LaTIS network through the use of the signal control software, StreetWise. The software will be on the workstations in the Houma TMC as well as on the Houma DTOE's workstation. Interface with the signal system is through the graphical user interface (GUI) which is id and password protected. The DTOE will have full access the traffic signal system directly in the field as well as through Streetwise. Day to day timing operations of the system will be performed by the DTOE and his staff. Developing new timings plans and adjustments to existing timing plans are the responsibility of the traffic operations engineer.

The Houma TMC Operator will monitor the signal system using the existing CCTV cameras on the corridor. The Houma TMC Operator will email the Houma DTOE of any congestion observed due to the traffic signal system. The Houma TMC Operator will call the DOTD's cell phone if there is no email response within 5-minutes. The DTOE may direct the Houma TMC Operator to adjust the traffic signal system to one of the time of day (TOD) plans he has pre-approved. Once directed, the Houma ITS Operator will change the TOD plans using the Streetwise GUI. When the Houma TMC Operator is not on duty, the New Orleans TMC Operators will monitor and make approved adjustments as directed by the DTOE. The DOTD Statewide TMC Operators may also be required to make approved adjustments to the system as directed by the DTOE in any case when the New Orleans TMC or Houma TMC is not operational. Primary TMC control of the signal system will be held by the Houma TMC operator. New Orleans TMC Operators will have secondary control, and Statewide TMC will have tertiary control. Ultimate control of the signal is held by the Houma DOTE as the TMC operators only can implement his approved plans.

4.5.2 ITS Equipment Operations

The operations of the draw bridge status signs will be provided without interface with either of the draw bridge operators. See section 4.8 for details on the operations of the signs.

4.6 Stakeholders

As can be seen from **Table 2**, the resulting envisioned system involves the interaction of more than a dozen individual agencies. It is anticipated that project deployment will provide the tools that will allow these stakeholders to facilitate their traffic and transportation management roles.

Currently, no written agreements have been developed regarding the interaction of the agencies involved in Traffic Management, Incident Management or Emergency Management. All agencies have representatives, known as stakeholders, who make up the Houma ITS Steering Committee. The future operations and utilization of the system by the agencies shall be as directed and agreed upon in the Memorandum of Understanding developed for this project.

4.7 Operational Environment

The operational environment for the Houma ITS Phase 3 and 4 projects include a description of operational procedures, skills and experience of personnel, security issues and processes, communications, data management and ownership. As mentioned previously Houma ITS Phase 3 and 4 projects have a distributed architecture that does not require permanent co-location of agency operations staff. It eliminates the need for appointing a TMC Operations Supervisor to oversee operations between agencies.

The local agencies will be responsible for the termination equipment on its side of the fiber optic/wireless connection. This includes all switches, servers, computers, etc. DOTD will be responsible for the ITS field equipment and the fiber coming into the center. If wireless, DOTD will remain owner/operator of the wireless communications receiver.

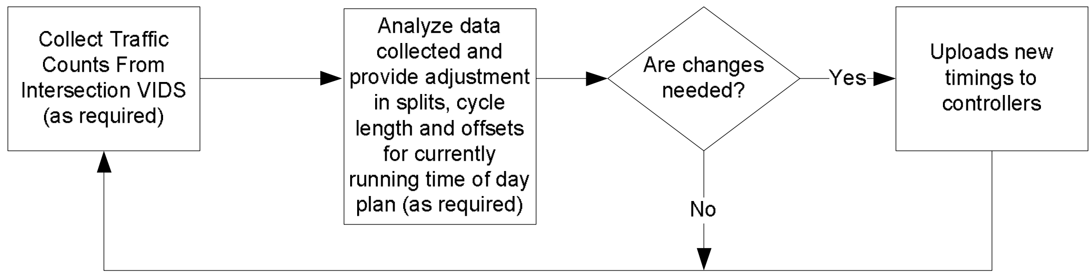
4.8 Operational Scenarios

The Operational Scenarios below describe a sequence of events and activities that are carried out by the user, system and environment. It will also specify what triggers the sequence, who or what performs each step, when communications occur and to whom or what. For this project, each function consists of the steps to operate the traffic signals and access the ITS equipment components.

4.8.1 Traffic Signal System Operations

Monitoring of the LA 24 traffic signal system will be provided by the Houma TMC Operator and the New Orleans TMC Operator after hours. Timing configuration by the traffic operations engineer includes setting up the phasing, time of day schedules, and cycle lengths within the actuated control software. The Houma DTOE will only direct the TMC operators to adjust signal timing to a set TOD plan previously reviewed and approved. **Figure 4** shows how the traffic signals connected interfacing with the software will operate. The traffic signals will operate as an interconnected group. Turning movement counts will be collected as scheduled. The DTOE will use the data collected in the field from the traffic signal system for developing and adjusting existing TOD plans.

Figure 5: Traffic Signal Control Process

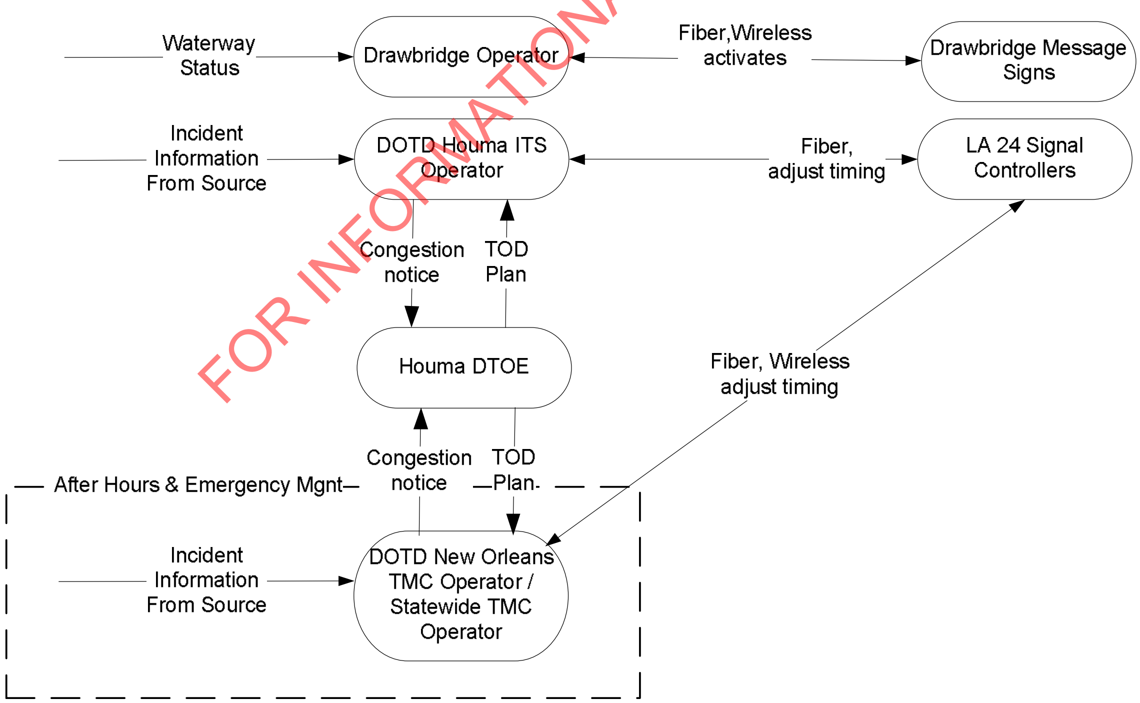


4.8.2 Traffic Incident Management Operations (TIM)

TIM operations in the Houma region are generally a multi-staged approach. **Figure 6** summarizes the TIM primary process as it relates to the phase 3 & 4 projects. Note the existing field elements and communications are not show,

Since the Houma TMC, the New Orleans TMC and Statewide TMC, are connected to the communication backbone, benefits of the deployed system will be gained. In the occurrence of an incident, if the given location is near a CCTV camera, the operator will have the ability to detect and verify the incident without having to go out to the field. Also, the Houma ITS Operator, Statewide TMC Operator, and the New Orleans TMC Operator will have the ability to adjust timing plans of the LA 24 traffic signal system, as directed by the Houma DTOE.

Figure 6: Concept of Operations Functions – Traffic Incident Management



4.8.3 Draw Bridge Status Operations

Draw bridge status will be provided for both draw bridges along LA 315, the Dularge Bridge and the Nav Bridge. The draw bridge status will be displayed by status signs. The operations of the status sign indications (ON/OF) are automated with the bridge controls for raising and lowering the bridges. The draw bridge status signs will be activated upon the bridge operator switching the bridge to open. The draw bridge status signs will be deactivated when the bridge is reopened to traffic. Note the draw bridge operator has no operation requirements for manually turning ON/OFF the signs.

4.8.4 Emergency Management Operations

During emergency situations it is anticipated that the operations of the LA 24 traffic signal system will require local TMC and field operations. For smaller emergencies that can be handled within the Houma region, the Houma TMC will operate the signal system from the Sub-district 02 office. For regional based emergencies (i.e., hurricane evacuation), the New Orleans TMC and/or the Statewide TMC the will remotely operate the signal system once the Sub-district 02 office has evacuated the area.

4.9 Summary of Impacts

The impacts of deployment of the projects resulting from this study document are shown for each agency below. This table only includes the regional to statewide connection, LA 315 draw bridge status signs and the LA 24 traffic signal upgrades. It should be noted that additional operations and maintenance will vary for each agency based on the level of utilization chosen. For example, if TP VFD chooses to purchase and install a network with a server, 2 computers and Cameleon ITS v4 software to access the network and view the CCTV cameras, they will have to maintain this additional equipment and provide the connection. If connections are made to the local and statewide backbone, the regional ITS Architecture will need to be updated to show connection.

Table 4: Summary of Impacts

Center	Impact			
	Access to other centers on local and statewide backbone	Network Surveillance (local CCTV cameras)	Activate draw bridge status signs	Adjust LA 24 Traffic Signal system
DOTD Sub-district 02, Houma	✔	Existing	-	✔
DOTD New Orleans TMC	✔	✔	-	✔
DOTD Statewide TMC	✔	✔	-	✔

5 Requirements

Requirements provide a foundation of information needed to move from the conceptual view presented in the Concept of Operations to the concrete view which defines what must be included in the design of the ITS project. These requirements form the basis for design, implementation, testing and operations.

Requirements definition is a complex process that employs performance analysis, trade studies, constraint evaluation and cost/benefit analysis. It will provide an understanding of the interactions between the various functions in the system. An essential part of the requirements development process is the Concept of Operations, the implicit design that accompanies it, and associated demands of relevant technology. Requirements come from regulations/codes, stakeholders, the state and many other sources. Requirements of the Houma ITS Phase 3 and 4 Project are Functional Requirements. Functional Requirements define what the system shall do.

These project requirements are listed in the following pages. As previously stated in this document, the Houma ITS Phase 3 and 4 projects will improve traffic operations and multi-agency coordination for both normal and abnormal traffic conditions, such as traffic incidents. The implementation of this system contains requirements that will be met in order to provide capabilities that will address improvements to the overall operations of traffic, provide information to motorists, and enhance coordination of agencies involved in transportation and incident management.

5.1 Reference

The Concept of Operations and the National ITS Architecture have been used in order to develop the requirements of this system. Please refer to the above mentioned documents for clarifications on the purpose of the system, system development, operation and maintenance, identification of stakeholders and the current and planned operating sites.

5.2 Traffic Incident Management

Traffic Incident Management monitors and controls traffic in case of an incident (please refer to the ConOps for further details and definitions). The DOTD Statewide TMC, the DOTD New Orleans TMC, and the DOTD Houma TMC serve as traffic management centers that exchange incident command, reports and information through the existing communications backbone. The DOTD Houma DTOE serves as traffic management for directing timing changes to the TMCs. The basic requirements covered in our Houma ITS Phase 3 and 4 projects are, as mentioned previously, functional requirements. In order for efficient information flow to be kept, all of the requirements have been identified as being functional (FR).

FR 1 The system shall provide high speed communications for coordination between the traffic signal system and the:

- DOTD Houma TMC Operators
- DOTD New Orleans TMC Operators
- DOTD Statewide TMC Operators

FR 1.1 The ITS operator shall provide traffic control coordination to the LA 24 traffic signal system during traffic incidents as directed by the DOTD Houma DTOE

5.3 Traffic Signal System Operations

Traffic Signal Operations monitors and controls traffic along the LA 24 traffic signal system (please refer to the ConOps for further details and definitions.) The DOTD Statewide TMC, the DOTD New Orleans TMC, and the DOTD Sub-district 02/Houma TMC all serve as centers that receive information from the LA 24 Traffic Signal System. The requirements of these centers are as follows:

FR 1.2	The ITS Operator shall provide signal control data to the LA 24 traffic signal system
FR 1.2.1	The TMC operator shall adjust approved timing plans of the LA 24 traffic signal system as directed by the DOTD Houma DTOE
FR 1.3	The LA 24 traffic signal system shall provide signal control status to the ITS operator
FR 1.4	The LA 24 traffic signal system shall provide field device status to the ITS operator
FR 2	The system shall provide high speed communications for coordination between the traffic signal system and DOTD Houma DTOE
FR 2.1	The DOTD Houma DTOE shall provide signal control data to the LA 24 traffic signal system
FR 2.1.1	The DOTD Houma DTOE shall establish phasing, for the LA 24 traffic signal system
FR 2.1.2	The DOTD Houma DTOE shall establish time of day schedules, for the LA 24 traffic signal system
FR 2.1.3	The DOTD Houma DTOE shall establish cycle lengths, for the LA 24 traffic signal system
FR 3	The traffic signals shall operate as isolated signals
FR 4	The traffic signals shall operate as an interconnected group

5.4 Draw Bridge Status Operations

As per the Concept of Operations Draw Bridge status will be provided for the draw bridges along LA 315, the Dularge and the Nav Bridge. The draw bridge status sign system must meet the following functional requirements:

FR 5	The draw bridge status sign system shall be activated upon actuation of the draw bridge to be closed to traffic by the draw bridge operator
FR 6	The draw bridge status sign system shall be deactivated upon the draw bridge being fully reopened to traffic by the draw bridge operator

5.5 Emergency Management System

Emergency Management represents public safety and other allied agency systems that support incident management, disaster response and evacuation, security monitoring, and other security and public safety-oriented ITS applications. This system does not operate from a specific center; rather, all of the emergency response centers that are connected to the fiber communication backbone communicate in order to make efficient decisions and allow operability within different organizations.

FR 7	System shall provide access of high speed communication transmission for emergency coordination between connected agencies.

5.6 Requirements Traceability Matrix

The purpose of the requirements traceability matrix is to identify the section of the Concept of Operations document from which the requirement is derived, the high level and associated detailed requirements. The following is a traceability matrix for the requirements of this project:

Table 5: Traceability Matrix

Section	Concept of Operations	Sys Rqmt ID	Description	Sys Rqmt ID	Description	Sys Rqmt ID	Description
4.5	System Overview	FR 1	The system shall provide high speed communications for coordination between the traffic signal system and the: • DOTD Houma TMC Operators • DOTD New Orleans TMC Operators • DOTD Statewide TMC Operators Description				
4.8.2	Traffic Incident Management (TIM)			FR 1.1	The ITS operator shall provide traffic control coordination to the LA 24 traffic signal system during traffic incidents as directed by the DOTD Houma DTOE		
4.8.2	Traffic Incident Management (TIM)			FR 1.2	The ITS Operator shall provide signal control data to the LA 24 traffic signal system	FR 1.2.1	The TMC operator shall adjust approved timing plans of the LA 24 traffic signal system as directed by the DOTD Houma DTOE
4.5.1	Traffic Signal Operations			FR 1.3	The LA 24 traffic signal system shall provide signal control status to the ITS operator		
4.5.1	Traffic Signal Operations			FR 1.4	The LA 24 traffic signal system shall provide field device status to the ITS operator		

Section	Concept of Operations	Sys Rqmt ID	Description	Sys Rqmt ID	Description	Sys Rqmt ID	Description
4.5.1	Traffic Signal Operations	FR 2	The system shall provide high speed communications for coordination between the traffic signal system and DOTD Houma DTOE	FR 2.1	The DOTD Houma DTOE shall provide signal control data to the LA 24 traffic signal system	FR 2.1.1	The DOTD Houma DTOE shall establish phasing, for the LA 24 traffic signal system
4.5.1	Traffic Signal Operations					FR 2.1.2	The DOTD Houma Traffic Operations Engineer shall establish time of day schedules, for the LA 24 traffic signal system
4.5.1	Traffic Signal Operations					FR 2.1.3	The DOTD Houma Traffic Operations Engineer shall establish cycle lengths, for the LA 24 traffic signal system
4.5.1	Traffic Signal Operations	FR 3	The traffic signals shall operate as isolated signals				
4.5.1	Traffic Signal Operations	FR 4	The traffic signals shall operate as an interconnected group				
4.8.3	Draw Bridge Status Operations	FR 5	The draw bridge status sign system shall be activated upon actuation of the draw bridge to be closed to traffic by the draw bridge operator				
4.8.3	Draw Bridge Status Operations	FR 6	The draw bridge status sign system shall be deactivated upon the draw bridge being fully reopened to traffic by the draw bridge operator				

Section	Concept of Operations	Sys Rqmt ID	Description	Sys Rqmt ID	Description	Sys Rqmt ID	Description
4.5	System Overview	FR 7	System shall provide access of high speed communication transmission for emergency coordination between connected agencies.				

6 System Design

As part of a Systems Engineering process, a system design is required for an ITS project. The system design process defines how a system will be built. The design activities supported in a DOTD ITS project result in a design document that contains both high-level and detailed design specifications as well as any supporting information needed to implement and integrate ITS facilities.

A system design is developed from the system requirements. For our Houma ITS Phases 3 and 4 projects, these requirements have been previously defined (please refer to section 5.0). Since the previous requirements section has defined what the system will do, these requirements will be translated into a hardware and software design that can be deployed.

The system design process has two phases. The first phase is High-Level Design where High Level requirements are translated into decisions about how the system will be built, how subsystems are organized and how verification should be handled at a high level. In the High-Level Design process, design concepts are developed. During the second phase of design, plan sets and top-level specifications are defined in detail, at a level where implementation is supported. As part of this project, design concepts are satisfied and detailed design specifications are developed.

6.1 High-Level Design

The high level design process will give way to the development of an overall system design prior to working out the details of an individual system. The Concept of Operations and the Requirements of our project, Houma ITS Phases 3 and 4, have defined the purpose and the need for the ITS project (sections 4 and 0, respectively). Please refer to these sections for clarifications on the purpose of the system, system development, operation and maintenance, identification of stakeholders and the current and planned operating sites.

6.1.1 Scope

The system being implemented by the completion of all phases of the Houma ITS Project will allow centers to communicate with each other, as defined by the regional ITS plan. For the development of this Systems Engineering document, it has been assumed that deployment phases 1 and 2 have been implemented. After the Houma ITS Phases 3 and 4 projects are complete, connectivity will be available for center connection. Thirty-eight subsystems have been identified for this project, most of which do not have architecture flow (refer to **Appendix A**). Architectural flow will be provided for seven subsystems, please refer to the Project Physical Architecture, the Concept of Operations and the Requirements section of this document for further information regarding the organization of subsystems.

6.1.2 Project Organization

This section will describe how the project is divided into subsystems. Each subsystem has its purpose, functionality, and interface with other sub-systems and component parts. As previously stated, subsystem organization can be seen in the Project Physical Architecture.

The Houma ITS Phases 3 and 4 projects will provide communication connection and data flow to six subsystems located in Houma and Baton Rouge, Louisiana. From the Project Physical Architecture, the following have been defined as the subsystems:

1. DOTD Sub-district 02/Houma TMC ITS operator
2. LA 24 Traffic Signal System

3. Houma ITS Draw Bridge Status Signs
4. DOTD Statewide TMC
5. DOTD New Orleans TMC
6. DOTD Dularge/Nav Draw bridge Operators

All of the subsystems communicate through the communications backbone. These subsystems exchange information ranging from traffic flow and incident reports to draw bridge status notifications. The information that these centers exchange has been previously defined in the Concept of Operations and Requirements section of this document. Please refer to these sections and the Project Physical Architecture for further information.

All functional and performance requirements defined in the Requirements, have been traced. Please refer to the Traceability Matrix included at the end of the Requirements section.

6.1.2.1 Hardware and Software Components

The hardware and software component of each subsystem connects to the communication backbone. These components will be further defined during the detail design Technical Specifications component.

A communications alternative section has been developed as part of this System Engineering analysis. Please refer to Alternative Communications Configurations, section 7, for information regarding connections between subsystems, hardware components and software implementation. Please note that different types of communication connectivity were explored.

6.2 Detailed Design

As previously stated, the detailed design specification provides the detailed system technical specifications needed for system implementation. For our Houma ITS Phases 3 and 4 Projects, please refer to section 7.0 for the Alternative Communications Configurations section and to the resulting design plans and detailed specifications.

7 Alternative Communication Configurations

An important component of the SE analysis for the Houma ITS Phases 3 and 4 projects is the communication alternative analysis. This analysis evaluates a number of communication technologies to determine their application to this project. Satisfaction of the project communication needs require the identification of a transmission media that accommodates the current information demand and provides capacity to meet future system demand. The selected transmission media should be capable of handling system communication needs at a high operational performance level.

It must be noted that this project is two of six phases, two of which have already been implemented. This reality does establish certain technologies/cost feasibility parameters regarding communication design options for the project. For example there is existing fiber optic communications plant between the field and the Sub-district 02/Houma TMC. Logically this communication backbone should be used for this office to field devise communications. However this exercise has value for DOTD as it primarily focuses on the communication options for establishing communications with future placement of field devices, not directly on the existing communication backbone, with the TMC.

7.1 Communication Technologies

There are a number of different types of communication technologies available for ITS network applications that DOTD should be aware of. Some of the technologies cited below are not applicable for this project. However it is important that DOTD be aware of the variety of technologies currently being used throughout the communication industry. They are:

- Fiber optic cable (Single Mode);
- Cellular Digital Packet Data (CDPD);
- Global System for Mobile Communication (GSM/EDGE) Enhanced Data for Global Evolution;
- Radio Frequency (Spread Spectrum);
- Terrestrial Microwave Links;
- Area Radio Network (ARN); and
- Telephone Lease Lines.

The critical factors in the selection of a preferred alternative are the following:

- High reliability and availability;
- Low capital and operating (i.e., maintenance) costs;
- Provisions for high bandwidth capacity and transmission speed with flexibility to accommodate future expansion;
- Protection of the interconnected server, workstations and controllers from unauthorized access and malicious intent.

7.1.1 Fiber Optic Cable (Single Mode)

The advantages of single mode fiber optic cable are the following:

- Not susceptible to electro-magnetic and radio frequency interference;
- Allowable distance between transmission equipment, transmission rate and bandwidth capacity is significantly greater than any other communication method, thereby providing nearly unlimited future System expansion;
- Lightning protection devices are not required;
- Ratio of cable diameter to bandwidth capacity is very small;
- Provides highest level of security when properly monitored;
- Not susceptible to corrosion; and
- Provides high transmission reliability if quality materials are specified and testing is performed to verify compliance.

The disadvantages of single mode fiber optic cable are the following:

- Splicing and connector termination requires specialized equipment and skilled technician;
- Technician training required repairing, replacing and testing fiber cable;
- Test equipment is more complex and expensive relative to copper test equipment;
- Susceptible to breaking if the fiber bends are smaller than the recommended bending radius or excessive load is applied;
- Requires devices to convert from optical to electrical end user equipment; and
- Substantial capital cost of installation.

7.1.2 Cellular Digital Packet Data (CDPD)

CDPD is a packet-switched, full duplex data communication system that cellular carriers use specifically for data transmission and as a means of filling unused voice channel capacity. The advantages of CDPD are the following:

- Eliminates need for incurring underground cable installation costs;
- Not susceptible to electro-magnetic interference and limited susceptibility to radio frequency interference; and
- Maximum flexibility in locating and moving the required modem (assuming adequate cell coverage).

The disadvantages of CDPD are the following:

- Requires payment of a recurring service fee (payment is only for data sent and received in packets, not minutes);
- Major carriers plan to discontinue CDPD service with the migration to 3G technologies;
- Transmission Speed limited to 28.8 Kbps;
- Dependent on cellular coverage provided by existing infrastructure. Connection likely to be lost if signal strength falls below –105 dBm;
- Requires separate modem for each controller; and
- Unencrypted data is susceptible to eavesdropping.

7.1.3 Global System for Mobile Communication (GSM) EDGE

GSM is the dominant technology for cellular and/or PCS networks in North America. Cellular and PCS differ primarily in their respective operational frequency bands: 800 MHz for cellular and 1900 MHz for PCS.

The advantages of GSM are the following:

- Lower cost of data rate plans for wireless WANs Prices for these plans have fallen significantly, creating a more compelling reason to switch to wireless data networks for remote device communications;
- New technology gives wireless gateways the ability to maintain an "always on" connection without being charged for total airtime, so users pay only for the data they actually send over the wireless connection;
- Maximum flexibility in locating and moving the required gateway (assuming adequate cell coverage); and
- Transmission speeds of 3.0 Mbs can be achieved with EDGE technology where service is available.

The disadvantages of GSM are the following:

- Airtime cost excessive for continuous communication service;
- Only two providers in one area;
- Actual data throughput reduced due to protocol overhead; and
- Remote areas may not have service.

7.1.4 Radio Frequency (Spread Spectrum)

Spread spectrum uses wideband modulation to impart noise-like characteristics to an RF signal. The bandwidth is spread by means of a code which is independent of the data. The independence of the code distinguishes this from standard modulation schemes in which the data modulation will always spread the spectrum. The receiver synchronizes to the transmitter code to recover the data. The use of an independent code and synchronous reception allows multiple users to access the same frequency band at the same time without interference. Frequency hopping and direct sequence systems are the most widely used implementations of this technology and the associated equipment is commercially available.

The advantages of radio frequency transmission are the following:

- Eliminates need for incurring underground cable installation costs;
- Not susceptible to electro-magnetic interference;
- Provides a low probability of intercept and includes anti-jam features;
- Radio frequency interference with narrowband communications is minimized by use of lower spectral power density and for a frequency hopping implementation, an ability to reconstruct the data when some frequencies are blocked; and
- Does not require a FCC license to operate.

The disadvantages of radio frequency transmission are the following:

- Requires overhead locations to mount antennas that maintain line of sight;
- Requires routing cable and conduit from antenna to modem installed in cabinet;
- Requires separate modem for each controller;

- Limited susceptibility to radio frequency interference;
- Requires the highest equipment expenditure that includes sufficient spares. (Also expected to have the highest total cost consisting of initial capital cost and net present value of operating/maintenance cost);
- Antenna is susceptible to vandalism;
- Requires special skills and equipment to maintain; and
- Requires the most training to maintain.

7.1.5 Terrestrial Microwave Links

The advantages of terrestrial microwave links are as follows:

- Useful as a point-to-point trunk;
- Can transmit data and a limited number of full motion video channels;
- Can control groups of traffic control devices;
- Can use both analog and digital transmission; and
- Offers the highest data throughput rates of any wireless technology.

The disadvantages of terrestrial microwave links are as follows:

- Requires line-of –sight;
- In most cases, requires FCC license;
- Channel availability limited;
- May have little choice in operating frequency;
- Possible interference due to rain, snow and atmospheric effects;
- May require antenna tower;
- Available bandwidth usually limited; and
- Typically most expensive wireless technology to implement.

7.1.6 Area Radio Network (ARN)

The advantages of ARN are as follows:

- Can operate traffic controllers or other devices;
- Can provide voice communications to highway maintenance vehicles;
- Can support 9600 baud data rate; and
- Can prove cost effective depending on application.

The disadvantages of ARN are as follows:

- Terrain may be limited;
- Limited channel availability in urban area;
- Requires antenna at each site;
- Turnaround time excessive for some applications; and
- Service reliability may limit use for some applications (Example, CTV video).

7.1.7 Telephone Lease Lines Line

The advantages of telephone line are as follows:

- Can operate traffic controllers or other devices;
- Can provide video transmission at low fps; and
- Asymmetric Digital Subscriber (ADSL) can support full motion video.

The disadvantages of telephone are as follows:

- ADSL leasing cost; and
- Limited video availability.

After evaluating the availability and feasibility of each of the above communication technologies the following were determined to be applicable for further consideration and analysis for this project:

- Fiber optic cable (Single Mode);
- Radio Frequency (Spread Spectrum);
- Terrestrial Microwave Links; and
- Telephone Lease Lines.

7.2 Area Centers Connection to TPCG Fiber

Forty-four regional agencies have been identified as currently connected to either the TPCG fiber or the DOTD ITS Network, termed Louisiana Transportation Information System (LaTIS), or these agencies have been identified as not currently connected. Those agencies currently not connected will be provided means of access for future connection. **Table 6** shows those agencies currently connect and those that are not currently connected. Additionally the table presents the cost associated with connecting each agency with the TPCG fiber or LaTIS using fiber or wireless links. Both options are considered feasible, constructible and reliable for this project. Benefits of each technology are presented above described as “advantages”.

One component that goes hand in hand with connecting these agencies is connecting the TPCG fiber plant to the DOTD fiber plant. This would allow those agencies responsible for transportation and emergency management in the Houma area to have an interconnected and secure communication network to augment their current communication systems. To achieve this would require a physical connection between DOTD and TPCG fiber plant. This can be achieved with a modest amount of physical equipment (patch panel, splice enclosure, cabinet, etc). The estimated cost is $5000. A review of the fiber plants for both TGCG and DOTD shows the most likely locations for interconnection are:

- Magnolia at LA 182 (Barrow);
- Crescent at LA 182 (Barrow);
- Belanger at (LA 182 (Barrow);
- LA 24 (Main) at Suthon;
- LA 24 (Main) at Historic; and
- LA 24 (Main) at Goode (TPCG Hub Site)

An exact location should be determined during the design phase of the project.

Table 6: Area Center Communication Connections

*(at door step) means TPCG/DOTD cable plant is within 100 feet of the building

Center	Address	Connected to	Connected to	Fiber Connection	Wireless	Connection	Connection Cost -	Distance to	Fiber Source
TPCG, Government Tower	8026 Main St. Gov't Bldg Tower	Yes	No	-	-	-	-	-	CITY
TPCG, Public Works, Operations and Maintenance, Drainage	1860 Grand Caillou Rd.	No	No	$600,000	$30,000	$30,000	$30,000	12,000 FT	PH 2
TPCG, Utilities	301 Plant Rd.	Yes	No	-	-	-	-	-	CITY
TPCG, Public Transit, Good Earth Transit	Number 1 McCord Rd.	No	No	$105,000	$30,000	$30,000	$107,000	2,100 FT	PH 2
Louisiana State Police, Troop C	4047 West Park Ave.	No	No	$10,000		$12,000	$12,000	200 FT	PH 1
Terrebonne Parish Communications District (E911)	112 Capitol Blvd.	No	No	$155,000	$30,000	$30,000	$157,000	3,100 FT	PH 1
Bayou Cane Volunteer Fire Department (W. Main)	6160 W Main St.	No (at door step)	No	$16,000	$30,000	$18,000	$18,000	320 FT	PH 1
Acadian Ambulance	400 Honduras St	No	No	$40,000	-	$42,000	$42,000	800 FT	PH 1
Terrebonne Parish Library (Main Branch)	151 Civic Center Blvd.	No (at door step)	No	$16,750	$30,000	$18,750	$18,750	335 FT	PH 1
Terrebonne General Hospital	8166 Main St.	No (at door step)	No	$14,500	$30,000	$16,500	$16,500	290 FT	CITY
School Board Central Office	201 Stadium Drive	No	No	$23,750	-	$25,750	$25,750	475 FT	PH 1
Louisiana Technical College	201 Saint Charles Street	No	No	$65,000	$30,000	$67,000	$67,000	1,300 FT	PH 1
TPCG Information Systems	7868 Main St.	No	No	$15,000	-	$17,000	$17,000	300 FT	PH 1
Consolidated Waterworks	8814 Main St.	No	No	$10,000	-	$12,000	$12,000	200 FT	PH 2
Houma Terrebonne Airport	10264 East Main St.	No	No	$528,000	$30,000	$30,000	$530,000	10,560 FT	PH 2
TPCG Pollution Control Department	2000 Saint Louis Road	No	No	$528,000	$30,000	$30,000	$530,000	10,560 FT	PH 1
Houma Fire Department Station (Legion)	600 Legion Ave	No	No	$16,250	-	$18,250	$18,250	325 FT	PH 1
Houma Fire Department Station (St. Charles)	1430 St. Charles Ave	No	No	$175,000	-	$177,000	$177,000	3,500 FT	PH 1
Houma Fire Department Station (Airport)	120 James Rd.	No	No	$81,000	-	$30,000	$83,000	1,620 FT	PH 2
Bayou Cane Volunteer Fire Department Station (W. Park)	4617 West Park Ave	No	No	$13,500	-	$15,500	$15,500	270 FT	PH 1
Bayou Cane Volunteer Fire Department Station (Savanne)	1214 Savanne Rd	No	No	$650,000	$30,000	$30,000	$30,000	13,000 FT	PH 1
Bayou Cane Volunteer Fire Department Station (Hollywood)	123 North Hollywood Rd	No	No	$5,000	-	$7,000	$7,000	100 FT	PH 1
Leonard J Chabert Medical Center	1978 Industrial Blvd	No	No	$105,000	$30,000	$30,000	$107,000	2,100 FT	PH 2
Electrical Substation (Cummins)	2551 Cummins Rd	No	No	$86,250	$30,000	$30,000	$88,250	1,725 FT	PH 2
Electrical Substation (Gibb)	1305 Gibb Rd	No	No	$41,500	$30,000	$43,500	$43,500	830 FT	PH 2
Electrical Substation (Plant)	221 Plant Rd	No	No	$28,750	$30,000	$30,750	$30,750	575 FT	CITY
Electrical Substation (Belanger)	877 Belanger St	No	No	$2,250	$30,000	$4,250	$4,250	45 FT	CITY
Electrical Substation (Sixth)	528 Sixth St.	No	No	$37,750	$30,000	$39,750	$39,750	755 FT	PH 1
Electrical Substation (Mckinley)	438 Mckinley St	No	No	$149,000	$30,000	$151,000	$151,000	2,980 FT	PH 1
Electrical Substation (Valhi)	437 Valhi Blvd	No	No	$102,500	$30,000	$30,000	$104,500	2,050 FT	PH 1
				$3,620,750		**$1,016,000**	**$2,482,750**		

7.3 Connection for Draw Bridge Status Signs (DBSS)

Different communications alternatives have to be considered to accommodate communications for the two draw bridge status signs identified for this analysis. One proposed draw bridge status sign installation is located close to the intersection of Industrial Blvd and S. Van Ave. The nearest fiber backbone ends at the intersection of Grand Caillou Rd. and S. Van Ave. The estimated distance between the fiber backbone and the proposed draw bridge status sign is approximately 1 mile. The approximate Line-of-Site distance to an existing DMS sign is also approximately 1 mile. The second proposed draw bridge status sign installation is located on LA 182, approximately 2000 feet south of the LA 183 and LA 311 intersection. This draw bridge status sign is located adjacent to and can be directly connected to DOTD fiber plant. Estimated cost is $5,000.

Driven by existing communication infrastructure, choices for connecting the draw bridge status sign location (located on South Van) with DOTD's communication plant are to either continue the fiber backbone down to the location of the proposed draw bridge status sign or to install a wireless communications shot from either the end of the fiber run, or from the proposed draw bridge status sign which is to be located near Hwy 182. Other alternatives also include telephone leased lines. **Table 7** presents the associated costs for each alternative. These options are considered feasible, constructible and reliable for this project. Benefits of each technology are presented above described as “advantages”.

Draw bridge status will need to be communicated to the draw bridge status sign from their respective draw bridge control centers (Dularge Bridge and the Nav Bridge). The draw bridge control centers are approximately three-quarter's of a mile from their respective draw bridge status sign. The most cost effective method for communicating with the draw bridge status signs from their respective draw bridge control centers is wireless Ethernet Bridge at an estimated cost of $5,000 for each location.

Table 7: Draw bridge status sign

Item	QTY	Capital and Installation Costs	Monthly Costs (60 Months)	Total Cost
Trench conduit / fiber installed	5300LF	$30		$159K
Wireless Ethernet Bridge message to TMC	2 EA	$5,000		$10K
Wireless Ethernet Bridge - Bridge Control to sign	2 EA	$5,000		$10K
Leased Line from Telco (monthly)	2 EA		$700	$42K

7.4 Connecting Traffic Signals to Communication Plant

There are 44 traffic signal locations identified in the Houma ITS Deployment Phase 3 Technical Memorandum to be connected to the Houma ITS communication network. There are three feasible alternative connections to the ITS communications plant. Alternative 1- in those locations where the traffic signal is located adjacent to the fiber plant, a direct connection can be made using a splice kit, a small length of fiber placed in conduit and pull-box. Alternative 2 -, in those locations where the traffic signal is located a small distance for the fiber plant (300 to 600 feet) a connection can be made using all the elements cited in Alternative 1 plus the additional 300 to 600 feet of connective fiber and conduit. The cost of the 300 to 600 feet of fiber and conduit is estimated at $50 per foot. Alternative 3 – in those locations where the traffic signal is located a small distance from the fiber plant a connection can be made by wireless communication technology using radio transceivers to connect the traffic signal with the nearest access port to communication plant. It should be noted that cost of wireless ($2K per location) is predicated upon using the access provided by the nearest and/or adjacent traffic signals that are directly connected to the communication fiber plant. Without this access each wireless installation would be $7K to account for the access cost to the fiber communication plant. **Table 8** presents the cost associated with the communication connection at each traffic signal location. These options are considered feasible, constructible and reliable for this project. Benefits of each technology are presented in section 7.1 as “advantages”.

Table 8: Traffic Signal Connection to Fiber Communication Options

	Location	Costs Direct Connection to Fiber	Costs Wireless	Distance to Connection	Total Connection Cost
1	LA 24 (Main St.) at LA 3052 (WB Ramp)	$29,250	$2,000	585 FT	$29,250
2	LA 24 (Main St.) at LA 3052 (EB Ramp)	$3,750		75 FT	$3,750
3	LA 24 (Main St.) at LA 660 (Coteau)	$1,250		25 FT	$1,250
4	LA 24 (Main St.) at LA 3040 (MLK Blvd)	SAME CONTROLLER AS PARK AVE.			
5	LA 24 (Main St.) at Southland Mall Bridge	$500		10 FT	$500
6	LA 24 (Main St.) at Funderburk Ave.	$3,500		70 FT	$3,500
7	LA 24 (Main St.) at Westside Blvd.	$3,500		70 FT	$3,500
8	LA 24 (Main St.) at Buquet St.	$2,250		45 FT	$2,250
9	LA 24 (Main St.) at Duet St.	$3,500		70 FT	$3,500
10	LA 24 (Main St.) at Roy St.	$2,500		50 FT	$2,500
11	LA 24 (Main St.) at LA 3040 (Hollywood Rd.)	$1,000		20 FT	$1,000
12	LA 24 (Main St.) at LA 664 (St. Charles)	$3,000		60 FT	$3,000
13	LA 24 (Main St.) at Morgan St.	$3,000		60 FT	$3,000
14	LA 24 (Main St.) at Lafayette St.	$4,750		95 FT	$4,750
15	LA 24 (Main St.) at Church	$3,500		70 FT	$3,500
16	LA 24 (Main St.) at Roussell	$4,250		85 FT	$4,250
17	LA 24 (Main St.) at LA 182 (Barrow St.)	$1,500		30 FT	$1,500
18	LA 24 (Main St.) at Gabasse	$3,250		65 FT	$3,250
19	LA 24 (Main St.) to LA 182 (N.O. Blvd.)	$7,750		155 FT	$7,750
20	LA 24 (Main St.) at Grand Caillou	$2,250		45 FT	$2,250
21	LA 24 (Main St.) at Howard Ave. (LA 661)	$5,500		110 FT	$5,500
22	LA 24 (Main St.) at East St.	$115,000	$5,000	2,300 FT	$115,000
23	LA 24 (Main St.) at LA 3087 (Prospect St.)	$500		10 FT	$500
24	LA 24 (Park Ave.) at LA 3087 (Prospect St.)	$3,750		75 FT	$3,750
25	LA 24 (Park Ave.) at LA 661 (Howard)	$1,500		30 FT	$1,500
26	LA 24 (Park Ave.) at LA 57 (Grand Caillou)	$2,000		40 FT	$2,000
27	LA 24 / LA 659 (Park Ave.) at LA 182 (N.O. Blvd.)	$1,500		30 FT	$1,500
28	LA 24 (Park Ave.) at LA 182 (Barrow St.)	$2,750	$2,000	55 FT	$2,750
29	LA 24 (Park Ave.) at Suthon St.	$1,250	$2,000	25 FT	$1,250
30	LA 24 (Park Ave.) at Lafayette St.	$22,500	$2,000	450 FT	$22,500
31	LA 24 (Park Ave.) at Morgan St.	$15,750	$2,000	315 FT	$15,750
32	LA 24 (Park Ave.) at LA 664 (St. Charles St.)	$18,250	$2,000	365 FT	$18,250
33	LA 24 (Park Ave.) at LA 3040 (Hollywood Road)	$1,000		20 FT	$1,000
34	LA 24 (Park Ave.) at Holiday Dr.	$21,000	$2,000	420 FT	$21,000
35	LA 24 (Park Ave.) at Everett St./Duet St. Bridge	$13,250	$2,000	265 FT	$13,250
36	LA 24 (Park Ave.) at Westside Blvd.	$16,000	$2,000	320 FT	$16,000
37	LA 24 (Park Ave.) at Funderburk Ave.	$19,500	$2,000	390 FT	$19,500
38	LA 24 (Park Ave.) at Southland Mall	$21,000	$2,000	420 FT	$21,000
39	LA 24 (Park Ave.) at LA 3040 (Bayou Gardens)	$1,000		20 FT	$1,000
40	LA 24 (Park Ave.) at Idlewild Dr.	$19,250	$7,000	385 FT	$19,250
41	LA 24 (Park Ave.) at Oakshire	$16,250	$7,000	325 FT	$16,250
42	LA 24 (Park Ave.) at LA 660 (Coteau)	$20,250	$2,000	405 FT	$20,250
43	LA 24 (Park Ave.) at LA 3052 (EB Ramp)	$3,500		70 FT	$3,500
44	LA 24 (Park Ave.) at LA 3052 (WB Ramp)	$31,250	$2,000	625 FT	$31,250
					$457,750

From the information presented in **Table 8** the most cost effective method of connecting traffic signals is directly connecting to the fiber plant from the traffic signal cabinet. For those traffic signals not adjacent to the fiber plant, the most cost effective way of connecting to the fiber plant is by using a wireless connection to the nearest traffic signal cabinet. However, it is DOTD standard practice that any ITS equipment within 100 ft of fiber should be connected to the fiber.

7.5 Communication Recommendations

The evaluation of the communications options for the DOTD Houma ITS network SE analysis offers three viable communications technologies for consideration. They are: fiber optics, wireless, and leased-lines. Each one can provide the data transmission capacity, reliability and scalability to address the communications needs per the different applications identified for the Houma project. The primary element of differentiation for these technologies is the cost associated with their implementation.

This evaluation focused on four different communication applications. It is recommended that following communication technologies be consider each application.

1. Area Centers Connection to TPCG Fiber or DOTD fiber – For those agencies where TPCG fiber or DOTD fiber is located adjacent to their physical location a direct fiber connection should be used. For all other locations a wireless connection should be used. However, if local funding can be provided to facilitate the cost of installing fiber, the area centers within 1 mile distance to a fiber backbone should be connected with fiber, followed secondly by the centers within 2 miles.
2. Connection of draw bridge status signs – Where the draw bridge status sign is located adjacent to fiber plant, a direct fiber connection should be used. Where a direct connection is not available, wireless Ethernet bridge technology should be used to connect to the communication backbone. Communication between the draw bridge status sign and the draw bridge control centers should be made using wireless Ethernet technology.
3. Connecting LA 24 traffic signals system to LaTIS – All traffic signals should be connected to the fiber optic backbone.

7.6 Funding Consideration

DOTD ITS Division has indicated that the construction of the Phase 3 project would be completed under a 2004 ITS Earmark. The Federal Earmark is constrained to integration based projects, but one of the matches to use the earmark does allow for equipment classified as infrastructure. Being that Phase 3 is primarily integration based, this project will not have a problem meeting the Federal requirements. However, the earmark allocated amount is $1,076,977 (i.e., the allocated amount is 50%, the other is 20% local cash match for integration and 30% is a local match which can be infrastructure). Therefore, four donut charts have been provided in **Appendix B** to show additional funds needed based on the configuration of the communication to be implemented.

8 Software Alternative Configuration

An important component of the SE analysis for the Houma ITS Phases 3 and 4 projects is the software alternative analysis. This analysis evaluates different types of software that are available for the implementation into the LA 24 traffic signal system. Note the draw bridge status sign will operate without the use of software. Satisfaction of project software needs requires the identification of software components that both accommodate the current information demand and provide capacity to meet future system demand.

8.1 ITS Congestion Mitigation to be Tested

This project will use traffic signal central control software to improve the efficiency of the LA 24 traffic signal system in Houma, LA. The purpose of the central control software is to monitor traffic demand along a corridor and update the signal timing and offsets of each interconnected signal system in respond to the needs of the corridor. As previously indicated, the legacy Streetwise control software will be used for this project.

9 Procurement Options

The implementation of Houma ITS Phase 3 and 4 will include the deployment of numerous ITS technologies. These technologies will be used by DOTD to monitor traffic operations within the project limits (**Figure 1**), detect and evaluate incidents to determine the need for traffic diversion, and communicate roadway conditions to the motoring public. Once the traffic incident is resolved, the roadway facility can return to its normal operating conditions.

This section identifies the procurement options for the ITS hardware, software, and communication technologies that may be deployed by DOTD to satisfy previously identified requirements.

9.1 Procurement Options of ITS Technologies

Based on review of the Louisiana DOTD procurement regulations, ITS technologies are procured under the Louisiana Administrative Code Title 70: XXIII Chapter 3. Commodities purchased by the DOTD Procurement Section fall into two categories, either non-exempt commodities or exempt commodities.

9.1.1 Non-Exempt Commodities

Non-exempt commodities are defined as materials and supplies that will **not** become a component part of any road, highway, bridge, or appurtenance thereto. These commodities are subject to the requirements of the Louisiana Procurement Code and such regulations promulgated by the Commissioner of Administration and are governed by the rules and regulations adopted by the Director of State Purchasing.

Purchases of less than $500.00 (or the amount set in the latest Governor's Executive Order, whichever is higher) **do not** require competitive bids.

All Request for Quotations covering non-exempt commodities that exceed the non-competitive dollar limit but do not exceed $5,000.00 (or the dollar limits listed in the latest Governor's Executive Order, whichever is higher) are awarded on the basis of the lowest responsive price quotation solicited from at least three bona fide, qualified bidders. All Request for Quotations covering non-exempt commodities having an estimated cost which exceeds $5,000.00 but which do not exceed $20,000.00, (or the dollar limits listed in the latest Governor's Executive Order, whichever is higher) are awarded on the basis of the lowest responsive price quotation solicited from at least five bona fide, qualified bidders.

Purchases of non-exempt commodities having an estimated cost which exceeds $20,000.00 (or the latest delegated purchasing authority, whichever is higher) are prepared and forwarded to the Office of State Purchasing for bid solicitation.

9.1.2 Exempt Commodities

Exempt commodities are defined in R.S.39:1572 as materials and supplies that will become a component part of any road, highway, bridge, or appurtenance as defined in R.S. 39:1572.

Purchases of exempt commodities having an estimated cost which exceeds the non-competitive dollar limit of $500 (or the amount set in the latest Governor's Executive Order, whichever is higher) but which do not exceed $25,000.00 (or the latest revision to R.S. 48:205, whichever is higher) are also referred to as Request for Quotations.

All Request for Quotations covering exempt commodities which exceed the non-competitive dollar limit but which do not exceed $5,000.00 (or the dollar limits listed in the latest Governor's Executive Order, whichever is higher) are awarded on the basis of the lowest responsive price quotation from at least three bona fide, qualified bidders.

All Request for Quotations covering exempt commodities having an estimated cost which exceeds $5,000.00 (or the dollar limit listed in the latest Governor's Executive Order, whichever is higher) but which do not exceed $25,000.00 (or the latest revision to R.S. 48:205, whichever is higher) are awarded on the basis of the lowest responsive price quotation solicited from at least five bona fide, qualified bidders. .

Purchase of exempt commodities having an estimated cost which exceeds $25,000.00 (or the latest revision to R.S. 48:205, whichever is higher) will be processed as Sealed Bids and shall be advertised in accordance with R.S. 48:205.

9.2 ITS Hardware Technologies

ITS hardware technologies can be segmented into three categories: traffic monitoring, incident evaluation, and communications with the traveling public.

ITS technologies used by transportation agencies for monitoring traffic operations are primarily achieved with remote sensory devices. These devices employ radar, video imaging, and magnetic inductance to “sense” the presence and movement of vehicles traveling along the roadway facility. These devices are located at strategic points and at specific distances along the roadway. They can be non-intrusively mounted on existing light and sign structures (radar and video) or placed inside the roadway service (wire loops).

CCTV technologies are primarily used for incident evaluation and traffic monitoring. This technology allows traffic management personnel to visually observe traffic operations on a roadway facility and determine how traffic is moving. There are many more product options with CCTV, as there are many other applications than highway transportation.

Dynamic message signs (DMS) are an effective way of disseminating real-time traffic conditions to the traveling public. A DMS is an electronically controlled message board located at a strategic location near or over the travel lanes of the roadway.

Draw bridge status signs (DBSS) use technologies that give information to the public regarding the status of a draw bridge in a very efficient way. A DBSS is a static sign with flashing beacons located at decisions points. Placing the DBSS signs at decisions points, allow travelers to make educated decisions about taking an alternate route in the occurrence of the draw bridge being closed to traffic.

Traffic Signal System components consists of traffic signal controllers, signal heads, mast arm poles, strain poles, wiring and connection. Traffic signals are used for the controlled movement of vehicles through an intersection.

9.3 Software

All of these ITS technology system components typically come with software as part of the hardware purchase (vendor software). This software allows operators to control, manage and diagnose the hardware components located along the roadway. Typically these component systems can be integrated with existing traffic management system operating software. Currently the Houma area is operating 360 Surveillance's Cameleon ITS v4. The deployment of this project will require the integration of the equipment with the existing software. However, the traffic signals to be deployed as part of this project require the procurement of adaptive traffic signal control software.

Since the component software is considered a component of the hardware system, it would be typically purchased as an exempt commodity. However, the system integration software could be considered a non-exempt commodity since it is not part of the roadway.

9.4 Communications

The communications network (or plant) used to integrate the ITS technology hardware, manage data flows and receive video images is comprised of land-lines (fiber optic, cable, and twisted wire pairs), spread spectrum radio, and microwave or wireless technology. The communications plant connects the TOC to the various ITS components located along the roadway facility. This allows operators to receive information from the field and display it numerically, graphically, and visually. The information can be used by operators to determine roadway congestion, vehicle travel speeds, lane capacity, and to evaluate incidents. Additionally, operators can use the communication network to send information and communicate with motorists about driving conditions, lane closures and roadway detours.

The communication network, built as a component of the ITS network for traffic management is typically purchased as an exempt commodity. The physical communication plant is placed in conduits and equipment cabinets in the roadway right-of-way. However this may not be the case for microwave towers and equipment that are constructed outside of roadway right-of-way, but on other DOTD properties.

Another method used by DOTD to procure communications is that of leasing communications services from private communications companies. The procurement of communication services would be done in the same manner as the purchase of telephone services for DOTD. Prices for these services are typically negotiated on a per connection per month basis.

9.5 Project Procurement Methods Available for Use by DOTD

The procurement of ITS technologies and services associated with this project can be acquired by DOTD using one of or a combination of four different procurement methods. They are:

- Sealed Bid (or Design-Bid-Build) – DOTD prepares a detailed project design and advertises for interested parties to submit a sealed bid to build the project. The lowest bidder offering a fixed price (all else being equal) is awarded the project. Any changes to the project made by DOTD that result in additional work is subject to a negotiated change order.

- Design–Build – DOTD advertises a Notice of Intent and short list teams (maximum of 5) based on their interest and qualifications. DOTD prepares a Scope of Services Package which includes a functional specification for the short listed teams to submit proposals for the detail design and implementation of the project. The team with the lowest calculated adjusted score based on their bid price plus time value divided by the technical score is awarded the project.

Time value may are may not be considered in the project. Any changes to the project made by DOTD that result in additional work is subject to a negotiated change order.

- Request for Quotation – This is used primarily in the procurement of different types of ITS hardware. The DOTD prepares a specification and solicits bids form three or five bona fide bidders (depending on the purchase amount). The bidder with the lowest price (all else being equal) is the successful bidder.

- Lease – Leasing is used by DOTD for ITS projects primarily to secure communication services such as a dedicated telephone line to monitor and control a traffic signal. Where there is only one provider, sole sourcing is used.

The selection of a contracting method(s) for use in this project is influenced by a number of factors including: legal and administrative constraints, quality control, liability and responsibility of the contractor, procurement schedule, familiarity of the DOTD project manager, and past experience. An evaluation of the positive and negative attributes for each method previously identified provides a basis for determining which method(s) should be used for this project.

9.6 Procurement Method for Project

For this project DOTD should consider two procurement methods. The first is Sealed Bid which has been commonly used for ITS in Louisiana. DOTD is anticipated to develop detailed design plans and a proposal document for the project and let for construction. The contractor that offers the most economical price, complying with the all contractual requirements, will be awarded the project. The second procurement recommended would be for DOTD to procure the software package prior to the letting and procure the rest of the project through Sealed Bids.

10 ITS Standards

Standards are specifications that define how the different ITS sub-components interconnect and interact within the established parameters of the National ITS Architecture. Specifically, they stipulate how the different technologies interoperate to automatically share information. DOTD benefits from ITS standards for this project in several ways including:

- Reducing the risk of equipment obsolescence;
- Reducing the risk of a single point of supply and proprietary products;
- Lowering prices for equipment;
- Minimizing design and implementation confusion; and
- Assuring quality.

Additionally, federal regulations require that ITS projects must conform to the National ITS Architecture and the standards if they are financed using funds from the Highway Trust Fund. The architecture currently identifies 13 key standards areas that can be found in the ITS Standards Requirements Document (SRD).

ITS projects that are currently deployed by DOTD incorporate standards developed by a number of standards developing bodies. The American Association of State Highway and Transportation Officials (AASHTO), Institute of Transportation Engineers (ITE), and National Electrical Manufactures Association (NEMA) have taken the lead in developing standards for traffic management devices and their interoperability. These devices include message, traffic signals, traffic sensors, etc. The Institute of Electrical and Electronic Engineers (IEEE) and the International Standards Organization (ISO) primarily provide the standards for communication infrastructure. This includes communication cables, switches, nodes, etc. Finally, the National Electric Code (NEC) provides standards to all related electrical and power requirements associated with ITS projects. It should be noted that the development of standards is an ongoing and evolving process. Therefore standards will need to be continually reviewed as DOTD implements future projects.

The purpose of this chapter is to identify the standards that will be used in developing design concepts, detail design, and operational procedures associated with this project.

10.1 Project Standards

The most significant set of standards for ITS projects is the National Transportation Communications for ITS Protocol (NTCIP). This family of standards will establish the parameters for the development, design, and implementation of the ITS component of the Houma ITS Phase 3 project. AASHTO, ITE and NEMA have taken the lead in developing NTCIP standards.

NTCIP is a family of communication protocols (protocol is a system of rules and procedures governing communications between two devices) and data definition standards that serve and address the diverse needs of the various subsystems and user services presented in the national, state, and regional ITS architectures. NTCIP consists of a whole family of protocols covering the spectrum from point-to-point command/response to sophisticated object oriented techniques.

NTCIP provides standards for two different ITS applications: center-to-field (C2F) and center-to-center (C2C), both of which are applicable to this project.

10.1.1 Center-to-Field Standards

There are two existing application protocols (and one protocol under development) for C2F communications: the Internet's Simple Network Management Protocol (SNMP) and the Simple

Transportation Management Protocol (STMP). These protocols use the get/set-messaging model. Each protocol has its advantages. SNMP is the simplest to implement. The STMP is the most flexible and band width efficient. **Table 9** presents the comparison of the two protocols.

Table 9: SNMP and STMP Comparisons

Characteristic	SNMP	STMP
Can send any base date element	Yes	Yes
Bandwidth Efficiency	Worse	Better (uses dynamic objects)
Supports routing and dial-up	Options	Options
Message Set	Supported	Limited to 13
Ease of Implementation	Easy	Hard

Devices with either of the two protocols can use the same communications line with other devices using the same protocols. The manufacturer or type of device (traffic signals, message, etc.) is not important. Each device is assigned an address that is unique on that line or channel which allows the management system to communicate with that device.

The communication link for C2F can be any type of medium; fiber optics, cable, spread spectrum, radio, etc. It does not matter whether the communications medium is owned or leased by DOTD. The only requirement assumes that communication is a half-duplex poll and response, and the time for transmission and the response time for the end device are within the tolerances the devices need to communicate.

Although STMP is designed to use communication channels with slow transmission rates, it is not as bandwidth efficient as proprietary protocols used in the past.

10.2 Standards Applicable to the Project

A number of technical standards must be considered in the development of this project. There are over 80 ITS standards now being developed by different standards development organizations (SDOs). ITS designers are encouraged by United States Department of Transportation (U.S. DOT) to use SDO approved standards when developing ITS projects.

Mapping the applicable ITS standards to the project architecture provides a clearer understanding as to how each standard should be considered in design of the project. There are three architectural components to which the standards must be applied for this project: Center to Field, Center-to-Center and Center-to-Vehicle/Traveler. Adhering to these standards will assure interoperability and interchangeability of the project's components and its overall integration with current ITS operations. **Table 10** presents the relevant standards for each architectural component that may be used in the implementation of this project.

Table 10: ITS Standards Applicable to Project

Standard Number	Standard Name	C2F	C2C	Center to Veh/Traveler
NTCIP 1101	Simple Transportation Management Framework (STMF)	●		
NTCIP 1102	Octet Encoding Rules (OER)	●	●	
NTCIP 1103	Transportation Management Protocols (TMP)	●	●	
NTCIP 1104	Center-to-Center Having Convention Specification		●	
NTCIP 1201	Global Object Definitions	●		
NTCIP 1202	Object Definitions for Actuated Traffic Signal Controller	●		
NTCIP 1203	Object Definitions for Dynamic Message Signs	●		
NTCIP 1205	Object Definitions for CCTV Camera Control	●		
NTCIP 1206	Object Definitions for Data Collection and Monitoring (DCM) Devices	●		
NTCIP 1208	Object Definitions for CCTV Switching	●		
NTCIP 1209	Object Definitions for Transportation Sensor Systems (TSS)	●		
NTCIP 1210	Field Management Stations - Part 1: Object Definitions for Signal System Masters	●		
NTCIP 1211	Object Definitions for Signal Control and Prioritization (SCP)	●		
NTCIP 1400	TCIP Framework Standard	●	●	
NTCIP 1402	TCIP Incident Management Objects	●	●	
NTCIP 2101	Point to Point Using RS-232 Sub-network Profile		●	
NTCIP 2102	Point to Multi-Point Protocol Using FSK Modem Sub-network Profile		●	
NTCIP 2103	Subnet Profile for Point-to-Point Over RS-232		●	
NTCIP 2104	Ethernet Sub-network Profile		●	
NTCIP 2202	Internet (TCP/IP and UDP/IP) Transport Profile	●	●	
NTCIP 2301	Application Profile for Simple Transportation Management Framework (STMF)	●		
NTCIP 2302	Application Profile for Trivial File Transfer Protocol	●		
NTCIP 2303	Application Profile for File Transfer Protocol	●	●	
NTCIP 2304	Application Profile for Data Exchange ASN.1 (DATEX-ASN)	●		
NTCIP 8003	Profile Frame Work	●	●	

Standard Number	Standard Name	C2F	C2C	Center to Veh/Traveler
NTCIP 9001	NTCIP Guide	●	●	●
EIA-794	Data Radio Channel (DARC) System			●
EIA-795	Sub carrier Traffic Information Channel (STIC) System			●
IEEE Std 1404		●	●	
IEEE Std 1488, 2000	Trail-Use Standard for Message Set Template for ITS	●	●	●
IEEE Std 1489, 1999	Data Dictionaries for ITS	●	●	●
IEEE Std 1512, 2000	Common Incident Management Sets for Use by Emergency Management Centers	●		●
IEEE SH 94633-94638	Analysis of Existing Standards and Those Under Development Applicable to the needs of ITS Short Range and Wide Area Wireless Communications	●	●	●
ITE-AASHTO TM 1.03	Traffic Management Data Dictionary	●	●	
ITE-AASHTO TM 2.01	Message Sets for External Traffic Management Center Communications	●	●	
ITE 9603-2	Advanced Transportation Controller (ATC) Cabinet	●		
ITE ATC Type 270	Advanced Transportation Controller Standard Specification Type 270	●		
SAE J1763	General Reference Model	●	●	●
SAE J2353	Advance Traveler Information Systems (ATIS) Data Dictionary	●		●
SAE J2354	Advanced Traveler Information Systems (ATIS) Message Sets	●		●
SAE J2369	ATIS Message Sets Delivered Over Bandwidth Restricted Media			●

11 Testing

Testing fulfills the system engineering requirements of verification and validation. Verification can be simple described as “was the system built correctly?” While validation may be described as “was the correct system built?” Testing through the project development until the completion of the project provides for a successful project. The use of traceability matrices allows for the stakeholders to ensure the envision system described in the ConOps is the actual functional system deployed. During the construction of the project, equipment must be tested at various stages to ensure its operability, function and performance. These tests are detailed in the Technical Specification document developed to accompany the detail design plans. Also, once the system is constructed, tests on integrating the equipment into the existing system shall be required. These tests are also as defined and required by the specifications.

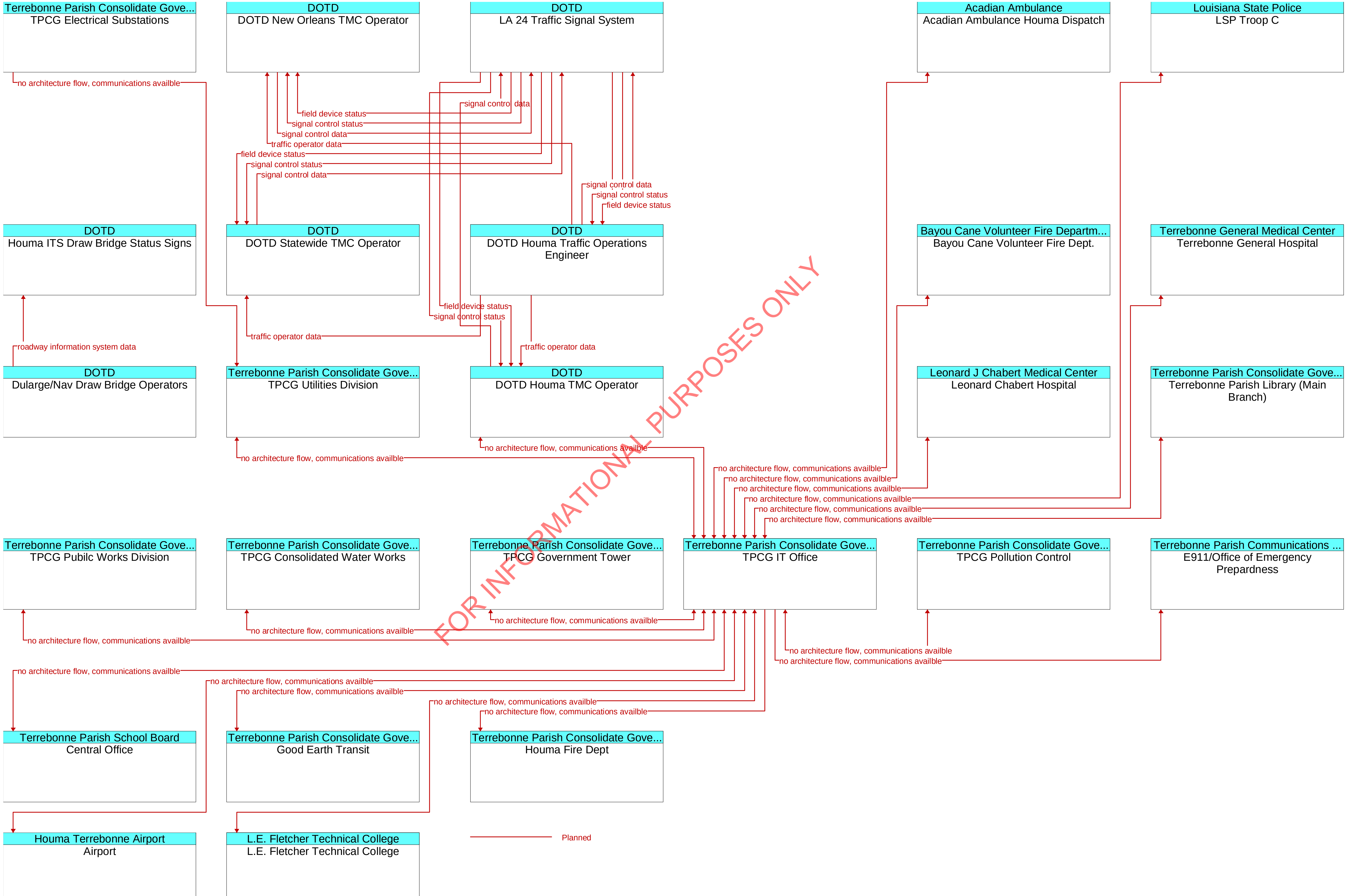
It is envisioned that during the detail design of the Houma Phase 3 and 4 projects an advanced traceability matrix will be provided to trace the conception of the project through the testing phase. This matrix will allow for DOTD personnel to check off the project deployment requirement and ensure ultimately, a successful final system.

12 Maintenance

DOTD shall be the agency responsible for maintain the equipment deployed as part of this project. Currently, DOTD uses contract and agency personnel to provide maintenance on ITS equipment through DOTD's ITS Division. The DOTD Maintenance Supervisor has been tasked with approximately 30 staff members to ensure the continued function of the various ITS systems statewide. DOTD currently has an anticipated annual budget of $2.5 million dollars for maintenance for the state. It is expected that the maintenance budget will be divided to facilitate each region. If any region doesn't use its total amount allocated, the money may be shifted to another region for maintenance.

Also, for each project deployment, an extended maintenance agreement accompanies the construction contract documents. This extended maintenance agreement (contract) requires 1 year of warranty and maintenance service on the system. Thereafter that required 1 year, DOTD has the option to extend the warranty through the contractor for an additional 3 years. This project is anticipated to include the extended maintenance requirement agreement.

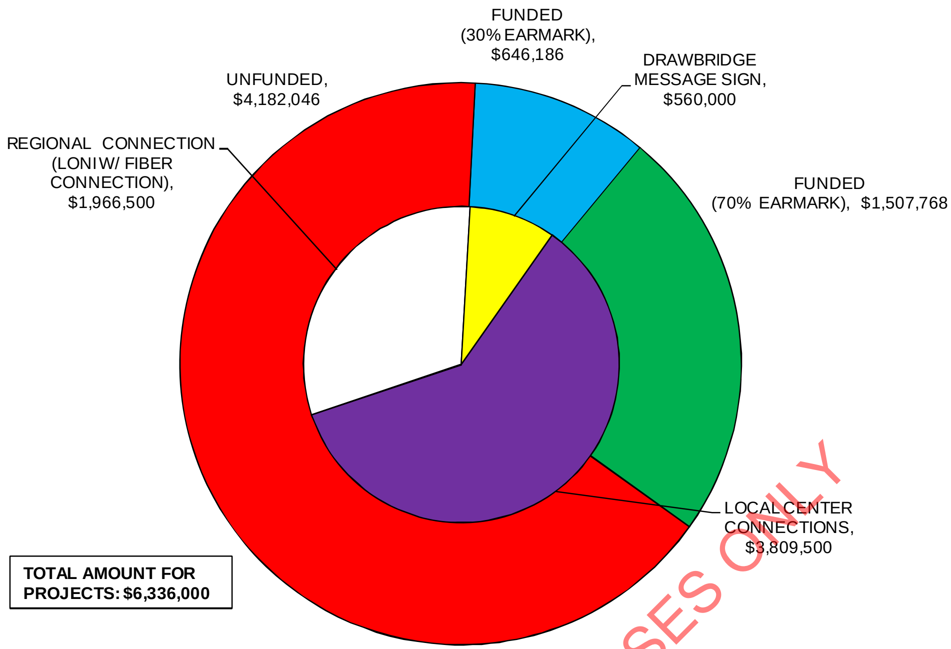
APPENDIX A



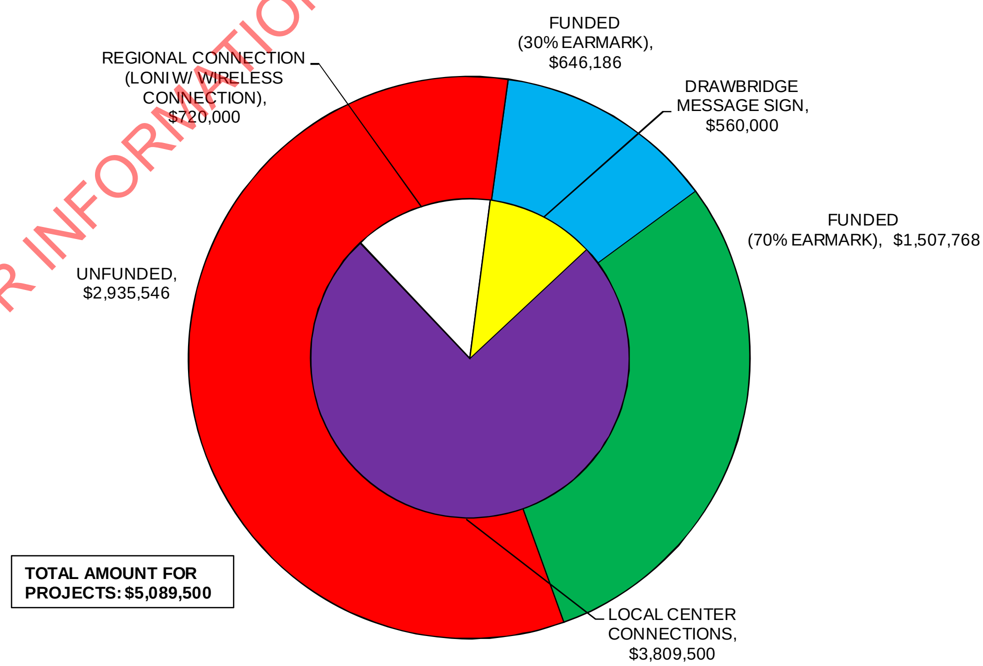
Terrebonne Parish Consolidate Gove...
TPCG Electrical Substations
DOTD
DOTD New Orleans TMC Operator
DOTD
LA 24 Traffic Signal System
Acadian Ambulance
Acadian Ambulance Houma Dispatch
Louisiana State Police
LSP Troop C
DOTD
Houma ITS Draw Bridge Status Signs
DOTD
DOTD Statewide TMC Operator
DOTD
DOTD Houma Traffic Operations Engineer
Bayou Cane Volunteer Fire Departm...
Bayou Cane Volunteer Fire Dept.
Terrebonne General Medical Center
Terrebonne General Hospital
DOTD
Dularge/Nav Draw Bridge Operators
Terrebonne Parish Consolidate Gove...
TPCG Utilities Division
DOTD
DOTD Houma TMC Operator
Leonard J Chabert Medical Center
Leonard Chabert Hospital
Terrebonne Parish Consolidate Gove...
Terrebonne Parish Library (Main Branch)
Terrebonne Parish Consolidate Gove...
TPCG Pubilc Works Division
Terrebonne Parish Consolidate Gove...
TPCG Consolidated Water Works
Terrebonne Parish Consolidate Gove...
TPCG Government Tower
Terrebonne Parish Consolidate Gove...
TPCG IT Office
Terrebonne Parish Consolidate Gove...
TPCG Pollution Control
Terrebonne Parish Communications ...
E911/Office of Emergency Prepardness
Terrebonne Parish School Board
Central Office
Terrebonne Parish Consolidate Gove...
Good Earth Transit
Terrebonne Parish Consolidate Gove...
Houma Fire Dept
Houma Terrebonne Airport
Airport
L.E. Fletcher Technical College
L.E. Fletcher Technical College
no architecture flow, communications availble
field device status
signal control status
signal control data
traffic operator data
roadway information system data
Planned
FOR INFORMATIONAL PURPOSES ONLY

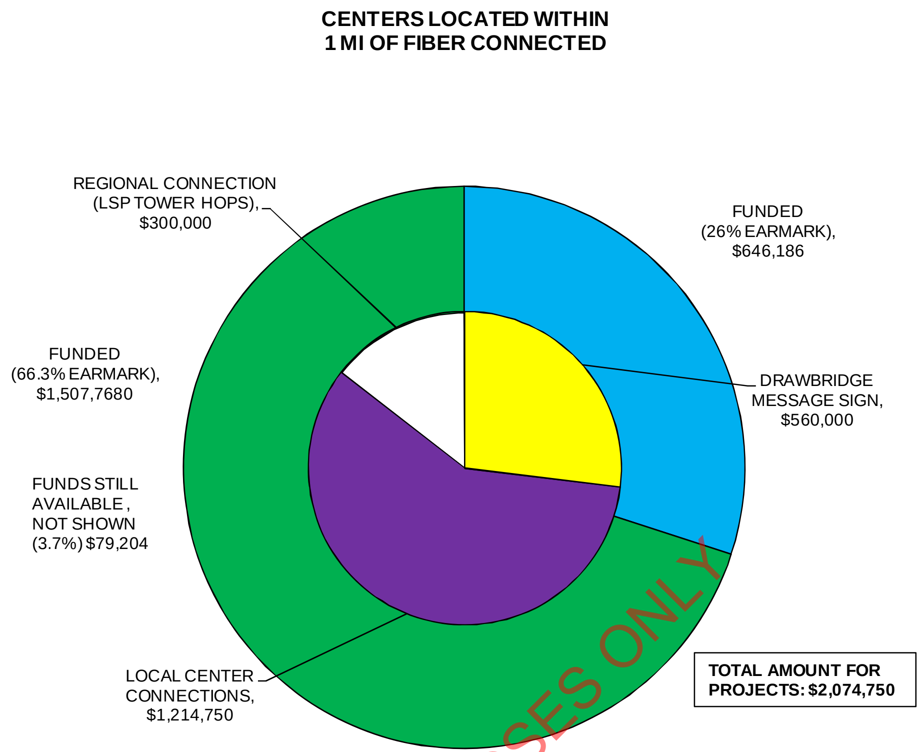
APPENDIX B

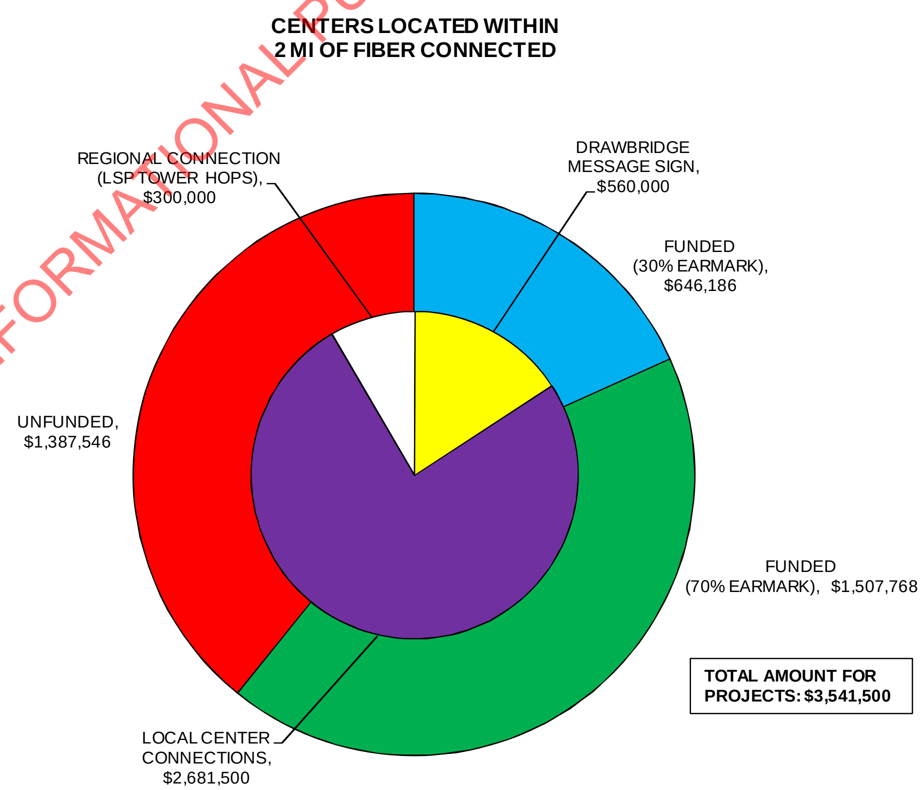
UNCONSTRAINED COST
(LONI W/ FIBER CONNECTION)



UNCONSTRAINED COST
(LONI W/ WIRELESS CONNECTION)




CENTERS LOCATED WITHIN
1 MI OF FIBER CONNECTED
REGIONAL CONNECTION
(LSP TOWER HOPS),
$300,000
FUNDED
(26% EARMARK),
$646,186
FUNDED
(66.3% EARMARK),
$1,507,7680
DRAWBRIDGE
MESSAGE SIGN,
$560,000
FUNDS STILL
AVAILABLE,
NOT SHOWN
(3.7%) $79,204
LOCAL CENTER
CONNECTIONS,
$1,214,750
TOTAL AMOUNT FOR
PROJECTS: $2,074,750


CENTERS LOCATED WITHIN
2 MI OF FIBER CONNECTED
REGIONAL CONNECTION
(LSP TOWER HOPS),
$300,000
DRAWBRIDGE
MESSAGE SIGN,
$560,000
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(30% EARMARK),
$646,186
UNFUNDED,
$1,387,546
FUNDED
(70% EARMARK), $1,507,768
TOTAL AMOUNT FOR
PROJECTS: $3,541,500
LOCAL CENTER
CONNECTIONS,
$2,681,500