State of Texas
Regional ITS Architectures and Deployment Plans

Corpus Christi Region

Regional ITS Architecture Report

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ADART	Autonomous Dial-a-Ride Transit
ASTM	American Society for Testing and Materials
ATMS	Advanced Traffic Management System
AVL	Automatic Vehicle Location
BRINSAP	Bridge Inventory Inspection System
CBCOG	Coastal Bend Council of Governments
CCTV	Closed-Circuit Television
CVO	Commercial Vehicle Operations
DMS	Dynamic Message Sign
DPS	Department of Public Safety
EIA	Electronic Industries Association
EOC	Emergency Operations Center
ETIS	Emergency Transportation Information System
EV	Emergency Vehicle
FHWA	Federal Highway Administration
HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
HCRS	Highway Condition Reporting System
HOV	High Occupancy Vehicle
HRI	Highway-Rail Intersections
I/F	Interface
ISP	Information Service Provider
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
MCM	Maintenance and Construction Management

LIST OF ACRONYMS

MCV	Maintenance and Construction Vehicle
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
NEMA	National Electrical Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NTCIP	National Transportation Communications for ITS Protocol
POCCA	Port of Corpus Christi Authority
RTA	Regional Transportation Authority
RWIS	Road Weather Information System
SAE	Society of Automotive Engineers
SDO	Standards Development Organization
SPID	South Padre Island Drive
STARS	Statewide Traffic and Recording System
TCEQ	Texas Commission on Environmental Quality
TCOON	Texas Coastal Ocean Observation Network
TCIP	Transit Communication Interface Protocol
TEA-21	Transportation Equity Act for the 21st Century
TM	Traffic Management
TMC	Traffic Management Center
TOC	Traffic Operations Center
TxDOT	Texas Department of Transportation
TxDPS	Texas Department of Public Safety
USDOT	United States Department of Transportation
USGS	United States Geological Survey
VIVDS	Video Image Vehicle Detection System

SUMMARY

In January 2001, the Federal Highway Administration (FHWA) issued a final rule to implement Section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21) requiring that Intelligent Transportation System (ITS) projects funded through the Highway Trust Fund conform to the National ITS Architecture and applicable standards.

To meet these requirements, in 2001 the Texas Department of Transportation (TxDOT) initiated the development of regional ITS architectures and deployment plans throughout the State of Texas. The Corpus Christi Region was the second in the series of regional ITS architectures to be prepared as part of this initiative.

The Corpus Christi Region is bordered by the Gulf of Mexico to the east, TxDOT Yoakum and San Antonio Districts to the north, TxDOT Laredo District to the west, and the TxDOT Pharr District to the south. Interstate 37 connects the City of Corpus Christi to the City of San Antonio to the northwest. For the Corpus Christi Regional ITS Architecture and Deployment Plan, the study area included all ten counties that are a part of the TxDOT Corpus Christi District. In addition, the twelve county Coastal Bend Council of Governments (CBCOG) was also included in the study area. CBCOG includes eight counties that lie in the TxDOT Corpus Christi District and four counties that lie in other TxDOT Districts.

The Architecture for the Corpus Christi Region followed a comprehensive process focused on stakeholder outreach and education, identifying market packages and interfaces tailored to the needs of the Corpus Christi Region, and developing a consensus-based architecture for the Region. This architecture provides a framework for ITS infrastructure to be deployed and integrated in the Corpus Christi Region over the next 20 years.

Stakeholders from throughout the Region participated in the development of the Regional ITS Architecture, including representatives from TxDOT, FHWA, Texas Department of Public Safety (TxDPS), cities, counties, transit agencies, police, fire, Port of Corpus Christi, and the U.S. Coast Guard. Stakeholders also included representatives from neighboring states and surrounding TxDOT Districts. These stakeholders provided input and review at key steps in the architecture development process, including a project kick-off meeting, architecture development and review workshops, and final review of the architecture documentation.

An inventory of existing and planned ITS infrastructure in the Region provided the basis for the architecture development. Stakeholder needs that could be addressed by ITS technologies guided the selection of market packages, data flows, and integration requirements. A diverse range of needs were identified by stakeholders in the Region. The highest priority needs focused on improving freeway and arterial control, incident management, local agency coordination and resource sharing, and preparedness for hurricane evacuations. In addition to traffic management and hurricane evacuations challenges, the Corpus Christi Region also experiences a large population increase during the winter months as people from northern areas temporarily relocate to the mild climate in the Corpus Christi Region.

Market packages were selected that corresponded to the desired services and functions identified for the Region, and were customized for Corpus Christi Region agencies and equipment. These market packages included high priority 'foundation' services and functions, such as network surveillance, surface street control, freeway control, road weather data collection, and transit vehicle tracking, as well as market packages to address coordination needs, including incident management system and regional traffic control and coordination. A customized market package was developed for the Corpus Christi Region to address emergency response for hurricane coordination. Stakeholders then prioritized these

market packages as high, medium, and low. These priorities were used in the second phase of the project to develop the ITS Deployment Plan for the Corpus Christi Region.

An interconnect, or "Sausage Diagram" was developed for the Corpus Christi Region which provided a top-level overview of system functions and primary interconnects. More detailed interfaces were then developed which identified the connectivity between the systems and elements. Each element identified in the ITS architecture for the Corpus Christi Region was mapped to the other elements that it must interface with. These interfaces were further defined by architecture data flows between individual elements that specify the information to be exchanged. These data flows could include requests for information, alerts and messages, status requests, confirmations, and other information requirements.

Functional requirements for the Corpus Christi Region were identified through customized market packages and data flows, and the equipment packages that deliver specific capabilities. The equipment packages that were identified provide more detailed descriptions of functionality and can be deployed incrementally. Standards that could apply to the Corpus Christi Region also were identified as part of the architecture development process.

An Operational Concept for the Corpus Christi Region was developed to illustrate how systems, components, and agencies will be integrated and function as a result of the framework provided by the Regional ITS Architecture. The purpose of the Operational Concept is to demonstrate the roles and responsibilities of the various stakeholders in the Corpus Christi Region. This is illustrated using two operational scenarios: an evacuation due to a hurricane and a freeway closure caused by a major incident.

The Regional ITS Architecture for the Corpus Christi Region is documented in the final report. In addition, a companion web site was developed that contains all of the architecture information, stakeholders, regional inventory, customized market packages, interfaces, and standards.

1. INTRODUCTION

1.1 Project Overview

In January 2001, FHWA issued a final rule to implement Section 5206(e) of the TEA-21. This rule required that ITS projects funded through the Highway Trust Fund conform to the National ITS Architecture and applicable standards. The rule requests that the National ITS Architecture be used to develop a local implementation of the National ITS Architecture, which is referred to as a "Regional ITS Architecture."

In order to meet these requirements, TxDOT initiated the development of regional ITS architectures and deployment plans throughout the State of Texas. In addition to meeting the federal requirements for funding, the development of regional ITS architectures provides a framework for implementing ITS on a regional level, encourages interoperability and resource sharing, identifies applicable standards, and allows for cohesive long range planning among stakeholders in the Region. Although not required by the FHWA final rule, TxDOT also sought to have an ITS deployment plan developed for each Region. An ITS deployment plan identifies and prioritizes projects that are needed to implement the ITS architecture on a short, medium, and long-term basis.

A key goal in the development of the regional ITS architectures was to develop a consensus-based architecture with as many stakeholders as possible involved. Each stakeholder had an equal voice in determining the direction of the architecture for the region. Stakeholders included representatives from TxDOT, FHWA, TxDPS, cities, counties, transit agencies, police, fire, Port of Corpus Christi, and the U.S. Coast Guard. A series of five meetings were held with the ITS stakeholders to discuss the development and gather input into the Corpus Christi Regional ITS Architecture and Deployment Plan. In addition, a project web site was developed which contains all of the information on the Corpus Christi Regional ITS Architecture and provides stakeholders with an opportunity to review and comment on the architecture directly from the web.

The result is an ITS architecture that establishes a vision and direction for the Region. ITS needs of the Corpus Christi Region were established early in the project. Existing and planned elements of the architecture have been identified and the key agencies required to develop the ITS services, or market packages as they are referred to in the National ITS Architecture, for the Corpus Christi Region have been identified. An operational concept also has been developed that focuses on the roles and responsibilities of the various agencies involved in the Corpus Christi Region. A separate ITS Deployment Plan was developed that identifies projects in the Corpus Christi Region that are required to implement the architecture.

1.2 Document Overview

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

Section 1 – Introduction

This section provides an overview of the State of Texas ITS Architectures and Deployment Plan Program, the ITS Architecture for the Corpus Christi Region, as well as an overview of some of the key features and stakeholders in the Corpus Christi Region.

Section 2 – Integration Strategy

This section discusses Corpus Christi Region stakeholder needs and issues, regional ITS initiatives and potential regional ITS programs, and opportunities for integration to achieve regional goals and contribute to regional and national ITS interoperability.

Section 3 – Regional ITS Architecture Development Process

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

Section 4 – Conceptual Design

The Conceptual Design contains the key sections of the Corpus Christi Regional ITS Architecture. The inventory of existing and planned systems is presented in Section 4, and is sorted by both stakeholder as well as by entity for easy reference. The market packages that were selected for the Corpus Christi Region also are included in this section, as are the system functional requirements. The Corpus Christi Region interconnects are presented, including the "Sausage Diagram" showing the relationships of the key subsystems and elements in the Region, system interfaces, and the physical subsystem architecture flows. Standards that apply to the Corpus Christi Regional ITS Architecture also are listed.

Section 5 – Operational Concept

An Operational Concept has been prepared that discusses the key functions and services of the envisioned ITS for the Corpus Christi Region. As part of this concept, several operational scenarios are described and roles and responsibilities of stakeholders are discussed. Potential agreements that could be required to support integration and information sharing are described.

The Corpus Christi Regional ITS Architecture also contains two appendices:

- Appendix A – Customized Market Packages; and
- Appendix B – Interface Diagrams.

A project web site has been established that contains the architecture documentation, inventories, interconnects, market packages, interfaces, and functional requirements. The web site provides hyperlinks to more detailed information about the Corpus Christi Regional ITS Architecture than what could feasibly be included in the printed document. In certain sections of the document, readers are referred to the project web site for additional information and details. (At the time this report was published, the Corpus Christi Regional ITS Architecture web site was being hosted at www.consystec.com. The site can be accessed by selecting the link to Texas, and then the link to Corpus Christi. TxDOT plans to permanently host the site in the future at www.dot.state.tx.us/trf/its.)

1.3 The Corpus Christi Region

1.3.1 Geographic Overview

The Corpus Christi Region is bordered by the Gulf of Mexico to the east, TxDOT Yoakum and San Antonio Districts to the north, the TxDOT Laredo District to the west, and the TxDOT Pharr District to the south. For the Corpus Christi Regional ITS Architecture and Deployment Plan, the study area included all ten counties that are a part of the TxDOT Corpus Christi District. In addition, the twelve county CBCOG was also included in the study area. CBCOG includes eight counties that lie in the TxDOT Corpus Christi District and four counties that lie in other TxDOT Districts. The geographic boundaries of the Corpus Christi Region are highlighted in **Figure 1**.

Counties included in the Corpus Christi Region are:

- Aransas;
- Bee;
- Brooks;
- Duval;
- Goliad;
- Jim Wells;
- Karnes;

- Kenedy;
- Kleberg;
- Live Oak;
- McMullen;
- Nueces;
- Refugio; and
- San Patricio.

TxDOT partners with local governments for roadway construction, maintenance, and traffic operations support. For cities with a population of less than 50,000, TxDOT is the responsible agency for on-system roadways. The City of Corpus Christi, with a population of 277,454, is the only city in the Region with a population that exceeds the TxDOT 50,000 threshold.

1.3.2 Roadway Infrastructure

As illustrated in **Figure 1**, the Corpus Christi Region has an extensive transportation infrastructure. The primary facilities include I-37, US 281, US 77, US 183, US 181, and US 59.

One of the most heavily traveled truck routes in southern Texas is the I-37 corridor. I-37 is a north/south, four-lane divided interstate highway, and within the City of Corpus Christi this roadway expands to six lanes. The effective operation of this highway is critical to the movement of goods and people to the port City of Corpus Christi from San Antonio. I-37 extends only from San Antonio to Corpus Christi. Given the rural setting for most of I-37 outside these two cities and the relatively short distance (143 miles), overnight facilities are very limited. Knowing the road and travel conditions within this transportation corridor and having the ability to get this information to the motorist is an important element for this project. For example, if I-37 has been closed down due to a major incident or weather, and motorists are informed of the closure in advance, they can alter their travel plans with an alternate route.
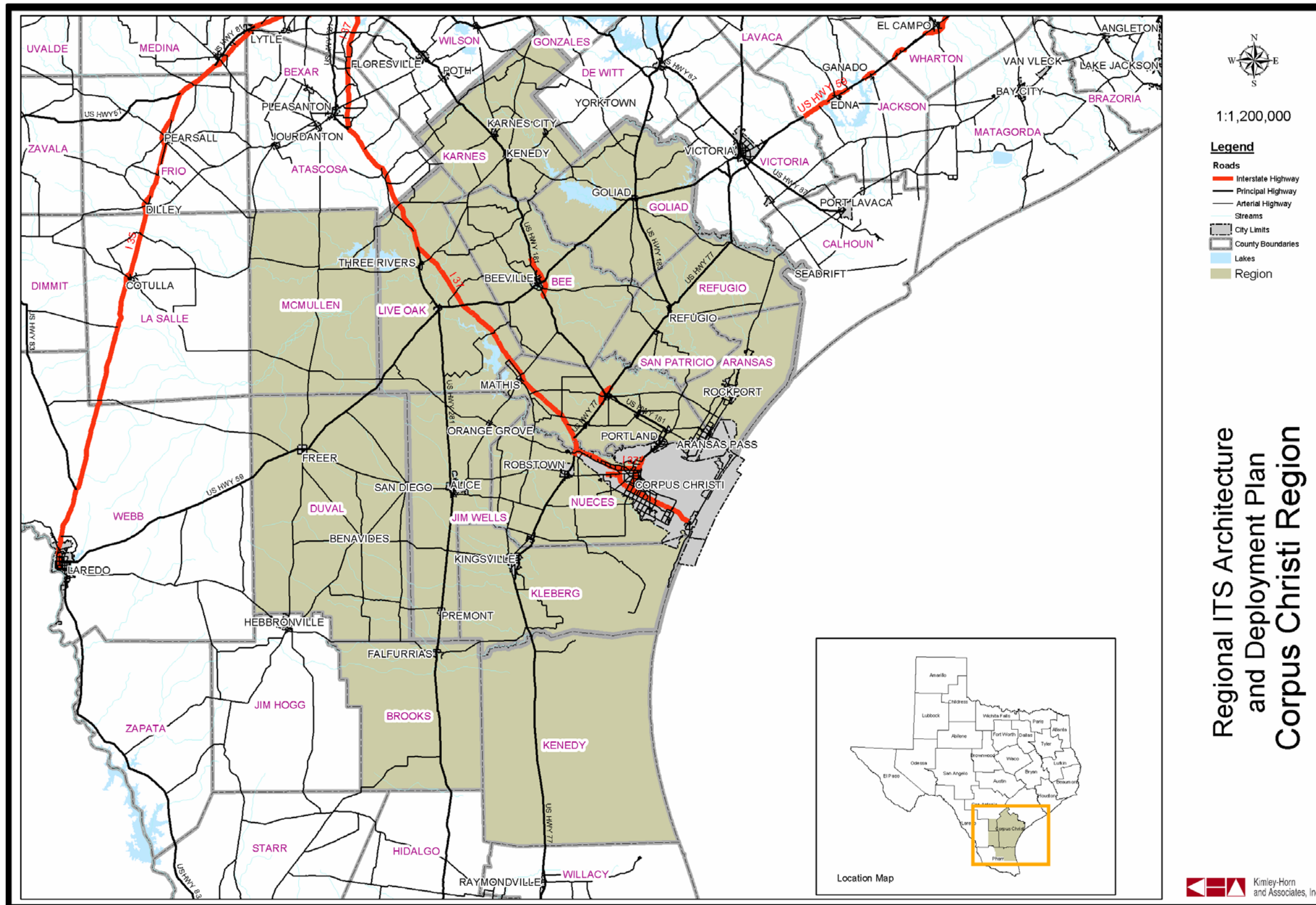
Figure 1 – Corpus Christi Region Map

1.3.3 Corpus Christi Region ITS Plans

Agencies in the Corpus Christi Region have been deploying ITS since early 2001. It is important to recognize the initial deployment of ITS infrastructure in a region because federal requirements mandate that a region, in order to secure future funding for ITS projects, must have an ITS Architecture Plan in place within four years of the initial deployment of ITS strategies and components. As the Corpus Christi Region pursues funding opportunities for proposed projects, it will be necessary to show that the proposed project fits within the architecture developed for the Region as part of this project.

Currently, the Corpus Christi Region has several ITS components deployed in the field including dynamic message signs (DMS), video surveillance and detection, weather sensors, and automatic vehicle location (AVL). The following sections discuss these deployments.

Dynamic Message Signs

The TxDOT Corpus Christi District is currently the only agency in the Corpus Christi Region that has deployed DMS, both permanent and portable. The locations of the District's permanent DMS are indicated below:

- JFK Causeway; and
- Along US 181 between the JFK Causeway and Portland.

The District uses these signs primarily to alert motorists of severe weather and/or roadway conditions. In addition to conditions within the District boundaries, roadway conditions in neighboring states could be disseminated to the motorist via the DMS during times of necessary evacuations.

Video Surveillance and Detection

The second element of the Region's initial ITS is the deployment of video surveillance cameras. These cameras are strategically located at high accident and/or high traffic volume interchanges. The City of Corpus Christi currently has only one surveillance camera deployed and plans to deploy more in the future. The following cameras are owned and operated by the TxDOT Corpus Christi District. The location of each camera and its status (existing or planned) are listed below:

- Interchanges along the Crosstown Expressway including I-37 (planned);
- Interchange of I-37 and US 77 (existing);
- Port Aransas for queuing (existing);
- Interchange of US 77 and Robstown (planned); and
- Rest Areas in Live Oak (existing).

During times of mandatory evacuations due to the impending landfall of a hurricane in the Corpus Christi Region, it is imperative that accurate traveler information available be provided to motorists as they depart the Region. Cameras help ascertain traffic conditions, as well as identify low-lying roadways that may have been flooded from remote locations. Then this information, along with possible alternate routes, can be provided to motorists.

In addition to the use of video for surveillance, the City of Corpus Christi and TxDOT are using video image vehicle detection systems (VIVDS) at many intersections within the Region during construction activities. Unlike loop detection, VIVDS will not be affected by paving operations and the detection zone of a VIVDS can be quickly changed to accommodate lane shifts during construction. VIVDS can detect vehicles approaching or stopping at a signalized intersection, and, under actuated conditions, place a call for the service of the appropriate phase for that vehicle. Both the City of Corpus Christi and the TxDOT Corpus Christi District are planning to bring the video feed from the VIVDS at the local intersections to operation centers for monitoring.

Weather Sensors

Areas of the Corpus Christi Region often experience the need for evacuations due to hazardous materials spills or hurricanes. For both of these instances, it is important to understand weather conditions to appropriately direct motorists correctly. In order to provide the appropriate guidance, the coordinating agencies (Emergency Operations Center (EOC) or Metrocomm) must have data on wind direction, possible flooded area, pavement conditions, etc. Weather sensors deployed in the field by the Blucher Institute and other agencies provide these necessary data.

Automatic Vehicle Location

The City of Corpus Christi Public Safety and the Regional Transportation Authority (RTA) have deployed AVL on all police cars, fire trucks, ambulances and public transportation vehicles. The AVL tags, along with GIS software at the respective dispatch points, allows for the instantaneous location of vehicles. The use of the AVL technology can quicken response times to incidents for emergency management personnel. Additionally, the use of AVL by the RTA has enabled the agency to implement Autonomous Dial-a-Ride Transit (ADART) for its para-transit and on-demand transit services. The ADART system is currently in Phase 3 of testing and is deployed on two buses. The system works when a patron dials in to request transportation between two points. The system is able to determine which para-transit vehicle is closest to the call and would be the most efficient to be used. The vehicle is then dispatched autonomously to pick up the patron.

1.3.4   Stakeholders

Stakeholder coordination and involvement is one of the key elements to the development of a regional ITS architecture and deployment plan. Because ITS often transcends traditional transportation infrastructure, it is important to involve non-traditional stakeholders in the architecture development and visioning process. Input from these stakeholders, both public and private, is a critical part of defining the interfaces, integration needs, and overall vision for ITS in the Corpus Christi Region.

The following is a list of stakeholders in the Corpus Christi Region who have participated in the project workshops or provided input to the study team as to the needs and issues that should be considered as part of the Corpus Christi Regional ITS Architecture:

- City of Corpus Christi Fire Department;
- City of Corpus Christi Management Information Systems;
- City of Corpus Christi Office of Emergency Management;
- City of Corpus Christi Police Department;
- City of Corpus Christi Street Department;

- Coastal Bend Council of Governments;
- Corpus Christi Chamber of Commerce;
- Corpus Christi MPO;
- FHWA Texas Division;
- FHWA Southern Resource Center;
- Local Emergency Planning Committee;
- Nueces County Emergency Management;
- Nueces County Public Works;
- Port of Corpus Christi;
- Regional Transportation Authority;
- Texas Department of Public Safety;
- TxDOT Corpus Christi District;
- TxDOT Traffic Operations Division (Austin); and
- U.S. Coast Guard.

2. INTEGRATION STRATEGY

2.1 Integration Purpose

The purpose of the integration strategy is to identify the needs, stakeholders, and strategy for regional integration in the Corpus Christi Region.

For each operating agency or stakeholder entity identified through the development of the Regional ITS Architecture, there are operations that currently exist as normal practice in order to accomplish the primary business goals and objectives for each stakeholder. As an example, a primary operation of Metrocomm is to dispatch emergency personnel to the appropriate locations when a call for help is placed. The integration of Metrocomm with any of the other stakeholders will not change this primary function of Metrocomm or disrupt its typical business practices. The integration of Metrocomm with another agency, such as the TxDOT Corpus Christi District, will require that the data that will be exchanged between the two entities (such as the blockage of a lane of traffic due to a crash) meet certain requirements for that particular data type. Identifying the need for this connection between agencies and the opportunities for integration and interoperability in the Region are key purposes of this Section.

While there are many examples of data exchanges that will take place under the Corpus Christi Regional ITS Architecture, they will not be discussed individually nor in totality in this section. This section will provide an overview of the major issues and stakeholders' needs within the Corpus Christi Region and the primary areas of concern that were uncovered in the preparation of the Corpus Christi Regional ITS Architecture. Additionally, this section will discuss the need for interregional integration with agencies external to the Corpus Christi Region, such as the need for integration with inland agencies during hurricane evacuations.

A key step in developing any regional ITS architecture is the identification of major stakeholders in the Region. Key stakeholders that participated in the development of the Corpus Christi Regional ITS Architecture are listed in **Table 1**. A number of other stakeholders were identified and invited to participate. In many cases, these stakeholders were not able to attend due to time constraints. Minutes of meetings, copies of reports, and access to the project web site was provided to these stakeholders to encourage their participation as much as possible.

2.2 Regional Needs

Needs from the Region were identified in the project kick-off meeting held on March 7, 2002. Stakeholders participating in that meeting identified the needs in the Region. The needs identified are categorized into functional areas and documented in **Table 2**.

Table 1 – Corpus Christi Stakeholder Agencies and Contacts

Stakeholder Agency	Key Contact	Address	Phone Number	E-mail
City of Corpus Christi	Andy Leal	P.O. Box 9277 Corpus Christi, Texas 78469	(361) 857-1940	andyl@ci.corpus-christi.tx.us
City of Corpus Christi Fire Department	Tod Gates	201 North Chaparral, Suite 300 Corpus Christi, Texas 78401	(361) 880-3932	gates22@juno.com
City of Corpus Christi MIS	Jim Russell	P.O. Box 9277 Corpus Christi, Texas 78469	(361) 880-3740	jim_r@ci.corpus-christi.tx.us
City of Corpus Christi Office of Emergency Management	Juan Ortiz	1201 Leopard Street Corpus Christi, Texas 78469	(361) 880-3700	juano@ci.corpus-christi.tx.us
City of Corpus Christi Police Department	Robert MacDonald	P.O. Box 9016 Corpus Christi, Texas 78469	(361) 886-2686	rfmacd@hotmail.com
City of Corpus Christi Police Department	Michael McKinney	P.O. Box 9016 Corpus Christi, Texas 78469	(361) 886-2802	mlm0380@hotmail.com
City of Corpus Christi Police Department	Don Nattinger	321 John Sartain Corpus Christi, Texas 78401	(361) 886-2686	d-natt@worldnet.att.net
City of Corpus Christi Police Department	Leonard Scott	P.O. Box 9016 Corpus Christi, Texas 78469	(361) 886-2746	leonard@ci.corpus-christi.tx.us
City of Corpus Christi Traffic Signals	Tony Salinas	P.O. Box 9277 Corpus Christi, Texas 78469	(361) 857-1610	tons@ci.corpus-christi.tx.us
Coastal Bend Council of Governments	Richard Bullock	2910 Leopard Street Corpus Christi, Texas 78469	(361) 883-5743	richard@cbcog98.org
Coastal Bend Council of Governments	Sonia Vasquez	2910 Leopard Street Corpus Christi, Texas 78469	(361) 883-5743	sonia@chcog98.org
Corpus Christi MPO	Mohammad Farhan	1305 North Shoreline, Suite 310 Corpus Christi, Texas 78401	(361) 884-0687	mfarhan@swbell.net
Corpus Christi MPO	Muhammad Amin Ulkarim	1305 North Shoreline, Suite 310 Corpus Christi, Texas 78401	(361) 884-0687	amin_mpo@swbell.net
Federal Motor Carrier Administration	Rodney Baumgartner	826 Federal Building #865 300 East 8th Street Austin, Texas 78701	(512) 536-5980	rodney.baumgartner@fmcsa.dot.gov
FHWA Southern Resource Center	Daniel Grate, Jr.	61 Forsyth St., Suite 17T26 Atlanta, GA 30303-3104	(404) 562-3912	daniel.grate@fhwa.dot.gov
Local Emergency Planning Committee	Henry Gonzales	201 North Chaparral, Suite 300 Corpus Christi, Texas 78401	(361) 880-3960	henrygo@cctexas.com
Nueces County Public Works	Bill Roberts	901 Leopard, Suite 103 Corpus Christi, Texas 78401	(361) 888-0513	brobert@nueces.esc2.net
Port of Corpus Christi	Tony Alejandro	222 Power Street Corpus Christi, Texas 78401	(361) 885-6188	tony@pocca.com
Regional Transportation Authority	Eduardo Carrion	5658 Bear Lane Corpus Christi, Texas 78405	(361) 289-2712	ecarrion@ccrta.org
Regional Transportation Authority	Fred Haley	5658 Bear Lane Corpus Christi, Texas 78405	(361) 289-2712	fhaley@ccrta.org
Texas Department of Public Safety	Robert Haiyasoso	1922 South Padre Island Drive Corpus Christi, Texas 78416	(361) 698-5618	robert.haiyasoso@txdps.state.tx.us
TxDOT Corpus Christi District	Charlie Cardenas	1701 South Padre Island Drive Corpus Christi, Texas 78416	(361) 808-2381	jcarde1@dot.state.tx.us

Table 1 – Corpus Christi Stakeholder Agencies and Contacts (continued)

Stakeholder Agency	Key Contact	Address	Phone Number	E-mail
TxDOT Corpus Christi District	Tony Parlamas	1701 South Padre Island Drive Corpus Christi, Texas 78416	(361) 808-2312	aparlama@dot.state.tx.us
TxDOT Corpus Christi District	Bill Randall	1701 South Padre Island Drive Corpus Christi, Texas 78416	(361) 808-2213	wrandall@dot.state.tx.us
TxDOT Corpus Christi District	Ismael Soto	1701 South Padre Island Drive Corpus Christi, Texas 78416	(361) 808-2225	isoto@dot.state.tx.us
TxDOT Public Transportation Division (Austin)	Ben Herr	125 East 11th Street Austin, Texas 78701-2483	(512) 416-2812	lherr@dot.state.tx.us
TxDOT Traffic Operations Division (Austin)	Clint Jumper	Attn: TRF-TM 125 East 11th Street Austin, Texas 78701-2483	(512) 416-2215	cjumper@dot.state.tx.us
TxDOT Traffic Operations Division (Austin)	Janie Light	Attn: TRF-TM 125 East 11th Street Austin, Texas 78701-2483	(512) 416-3258	jlight@dot.state.tx.us
U.S. Coast Guard	Thomas Hopkins	MSO Corpus Christi 555 North Carancahua Street, Suite 500 Corpus Christi, Texas 78478	(361) 888-3162	thopkins@msocorpuschristi.uscg.mill

Table 2 – Corpus Christi Region: Summary of ITS Needs

Corpus Christi Region

Summary of ITS Needs
Corpus Christi Regional ITS Architecture and Deployment Plan Kick-Off Meeting
March 7, 2002

Institutional Issues/Needs

- Need to improve coordination with inland cities during evacuations
- Need to develop agreements for sharing data
- Need to develop agreements on control of equipment
- Need to develop agreements on protocol

Traffic Management Needs

- Need emergency vehicle pre-emption along arterials and at isolated intersections with limited sight distance
- Need speed and volume counters
- Need pan/tilt/zoom camera control on interchange CCTV camera feeds to the City of Corpus Christi

Traveler Information Needs

- Need to collect and disseminate information on traffic flow
- Need more DMS
- Need to provide more information to motorists (emergency and tourist)
- Need to move toward utilizing 511 system for information for tourists and during evacuations
- Need highway advisory radio (HAR)
- Need to distribute weather alerts to public and major employers

Data Needs (Collecting, Sharing)

- Need real-time traffic data at Emergency Operations Center (EOC)
- Need to share video feed from emergency response back to Metrocom and EOC
- Need to share traffic flow data for routing of emergency vehicles
- Need to integrate data sources
- Need a system to allow agencies to share video
- Need to integrate data from Highway Conditions Reporting System (HCRS) and City of Corpus Christi and disseminate information
- Need weather conditions reports

Public Transportation Management Needs

- Need on-board transit security cameras (Note: This need was identified at a later meeting)
- Need real time bus information (Note: This need was identified at a later meeting)
- Need electronic fare payment systems (Note: This need was identified at a later meeting)

Electronic Payment Needs

None identified

Commercial Vehicle Operations Needs

- Need weigh-in-motion
  Need to integrate TxDOT TransGuide traffic management center (TMC) in San Antonio with the Port of Corpus Christi

Table 2 – Corpus Christi Region: Summary of ITS Needs (continued)

Emergency Management Needs

- Need to expand radio to Kleberg and San Patricio counties for law enforcement
- Need video conferencing between traffic operations/management centers and EOC during evacuations
- Need complete surveillance on highways
- Need Emergency Transportation Information System (ETIS)

Advanced Vehicle Safety Systems Needs

None Identified

Information Management Needs (Data Archiving)

None identified – data needs covered in other categories

Maintenance and Construction Operations Needs

- Need monitoring system for lighting on bridges and causeway
- Need to disseminate road closure information to major employers

Given the location of the Corpus Christi Region on the coast of the Gulf of Mexico and the use of the Port of Corpus Christi for the movements of many goods, it is reasonable to expect the need for evacuations from time to time due to hurricanes, hazardous material spills, and/or pipeline ruptures. One of the driving forces for integrating the various stakeholders in the Corpus Christi Region is the need to be able to provide motorists and residents real-time information as it relates to weather and roadway conditions during these times of mass exodus. For this reason, weather sensor data collected by the Blucher Institute and traffic data collected by the City of Corpus Christi or the TxDOT Corpus Christi District will be very useful to the EOC as it tries to efficiently move people away from danger and to a safe place during a time of crisis. Established standards will govern the exchange of these data.

Similarly, for non-major accidents such as traffic accidents along I-37, there is a need for the TxDOT Corpus Christi District to provide Metrocomm data related to the exact location of the accident as identified using TxDOT surveillance cameras. The primary function of the surveillance cameras will be to monitor traffic conditions on a daily basis and provide the video feed to a Traffic Operations Center where a determination can be made to post a message to a dynamic message sign given certain conditions; however, when there is an incident, the video can be extremely useful for Metrocomm as it dispatches emergency personnel and manages the accident scene. The integration of these two agencies will certainly not have to be physical, but rather virtual, wherein the two agencies are willing to share data, be they video feeds or site clearance information with each other. The sharing of these data is the integration of these two agencies.

The necessity for all of these stakeholders to communicate during times of emergency has resulted in the formation of committees to facilitate the exchange of information. The development of the Regional ITS Architecture for the Corpus Christi Region will provide a means to automate this exchange of information.

2.3 Regional Integration and Interoperability

The Corpus Christi Region is bordered by the TxDOT Yoakum District to the northeast, the San Antonio District to the north and west, the Laredo District to the west, and Pharr District to the south. Due east of the Corpus Christi Region is the Gulf of Mexico. During times of evacuation, it is imperative that the agency leading the evacuation is cognizant of road and weather conditions in the areas to which people are being directed. In the case of Corpus Christi, the closest major city inland from the Corpus Christi Region is San Antonio. As such, the EOC in Corpus Christi wants communications with the San Antonio area and the ability to share traffic data and weather conditions with TransGuide, TxDOT's traffic management center for the San Antonio area.

Data collected at the EOC from the City of Corpus Christi Traffic Operations Center (TOC) and future TxDOT Corpus Christi TxDOT District Traffic Management Center (TMC) should be supplied to TransGuide so that the center will know when to expect a high volume of vehicles entering the San Antonio area and prepare the San Antonio area such that officials can make decisions on the operations of roadways within their jurisdiction. As an example, signal timing could be adjusted to accommodate the influx of vehicles. Similarly, the interstate could be converted to one-way operations until such time as it appears the majority of exiting vehicles have arrived in the San Antonio Region.

Also during times of major crises, the Corpus Christi EOC will need to coordinate evacuations with the Texas State EOC. Data that should be shared includes estimated time for landfall of a hurricane and flooding information on roadways that are on the State's trunk highway system and have an effect outside the Corpus Christi Region. Evacuation routes and other hurricane preparedness and coordination activities could also be shared between the State and Corpus Christi Region EOCs. Finally, incidents that occur on major roadways either in the Corpus Christi Region or on roadways that could impact the movement of people and goods in the Corpus Christi Region should be shared. The integration of the State EOC and the local EOC can facilitate the clearing of such an incident more efficiently.

As an example, a fuel spill along I-37 north of the Corpus Christi Region would require a major clean-up in addition to other emergency personnel on site. Coordination between the two EOCs could identify the closest clean-up crew that could respond to the spill and dispatch them to the scene. Similarly, once on scene, the response team could provide the State EOC and the Corpus Christi Region EOC status reports on the clean-up and potential timing for return to normal operations.

The headquarters of TxDOT maintains a database of traffic counts and accident records for roadways throughout the State of Texas. On occasion, agencies within the Corpus Christi Region will need access to these databases either to retrieve data or supply data to the database. These data exchanges also will require integrating the agencies' data flows such that neither of the agencies' normal business operations is disturbed to share these data.

One of the primary purposes of the development of an ITS architecture is to ensure that while various agencies are deploying ITS components, there are some commonalties between them that will allow and facilitate the exchange of data fairly seamlessly and automatically. This is not to say that all technologies or media that are used by the various agencies will be the same, but that there is an acknowledgement that the data that is being collected and disseminated is valuable to many different agencies; therefore, the integration strategy has to be implemented to ensure the data exchange is possible.

3. REGIONAL ITS ARCHITECTURE DEVELOPMENT PROCESS

Development of the Regional ITS Architecture and Deployment Plan for the Corpus Christi Region relied heavily on stakeholder input to ensure that the architecture reflected local needs. A series of five meetings was held with stakeholders to gather input, and a web site with the components of the regional architecture as well as hard copies of documents were made available to stakeholders for review and comment.

3.1 Corpus Christi Process

The process followed for the Corpus Christi Region was designed to ensure that stakeholders could provide input and review to the development of the Region's ITS Architecture.

Prior to the first project kick-off meeting with the contractor and stakeholders, TxDOT identified relevant stakeholders in the Region to begin discussions on the development of a Regional ITS Architecture and Deployment Plan. Stakeholders signed a memorandum of understanding (MOU) stating that they would work together in the Region to develop the ITS architecture.

After selecting a contractor, the process shown in **Figure 2** was used to develop the Region's ITS Architecture. In addition to the architecture, an ITS Deployment Plan for the Region also was developed to identify projects needed to implement the architecture.
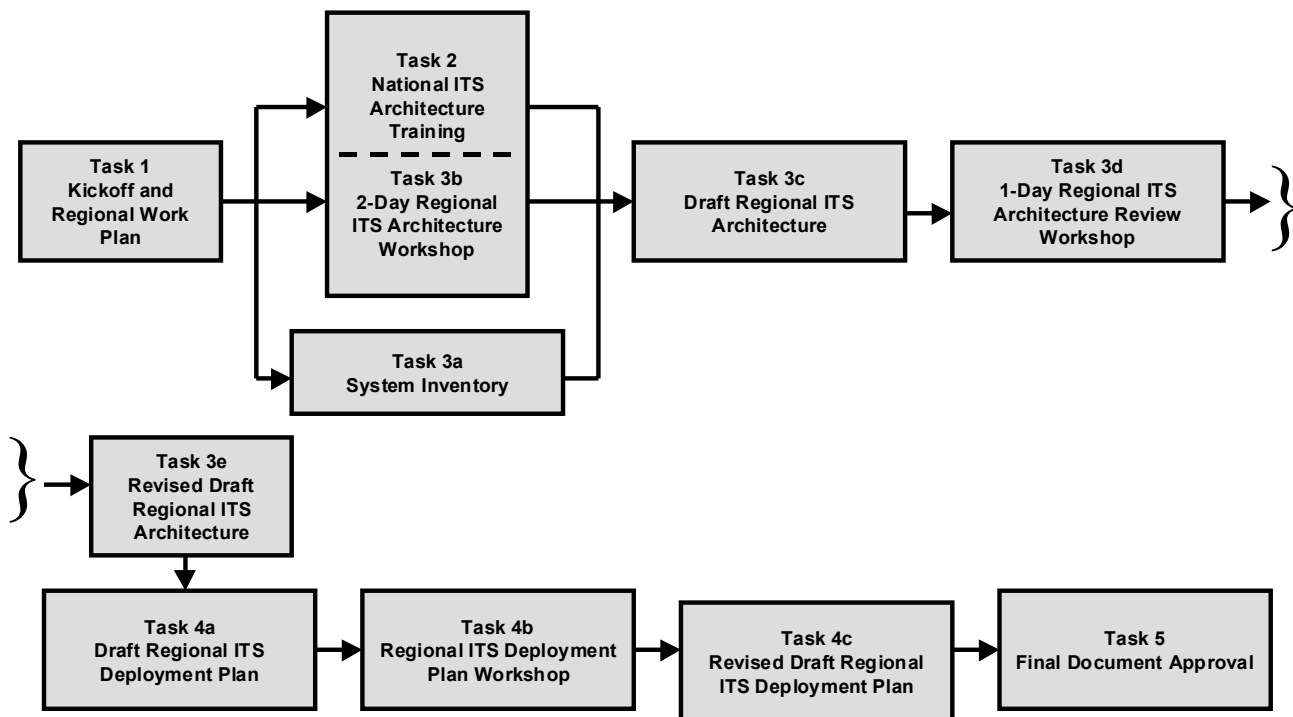
Figure 2 – Corpus Christi Regional ITS Architecture and Deployment Plan Development Process

A total of five meetings with stakeholders over a period of eleven months was used to develop the Corpus Christi Regional ITS Architecture and Deployment Plan. These meetings included:

- Kick-off and Regional Work Plan Meeting;
- 2-Day Regional ITS Architecture Workshop;
- 1-Day Regional ITS Architecture Review Workshop;
- ITS Deployment Plan Workshop; and
- Final Comment Resolution Meeting.

Key components of the process are described below:

Task 1 – Kick-Off and Regional Work Plan: Based on the initial stakeholder meeting and MOU that was signed, a number of key stakeholders were identified. Additional stakeholders that did not sign the initial MOU also were identified and invited to the first project kick-off meeting. At this meeting, the regional work plan was presented to stakeholders for review and comment. Subsequent meeting dates were identified and agreed upon by the stakeholders.

As part of this meeting, a workshop was held with the stakeholders to identify three additional areas of information:

- Additional stakeholders to invite to participate in the process;
- Needs of the stakeholders in the Region; and
- Existing and planned ITS elements in the Region.

Task 2 – National ITS Architecture Training: Task 2 was the development and presentation of training on the National ITS Architecture. The purpose of the training was to familiarize stakeholders with the architecture terminology to the extent needed to allow them to provide input and review on the Corpus Christi Region's ITS Architecture. The National ITS Architecture training was presented in conjunction with the 2-Day Regional ITS Architecture Workshop described in Task 3B.

Task 3A – System Inventory: Collecting information for the system inventory began at the kick-off meeting through the workshop with the stakeholders to determine existing and planned ITS elements in the Region. After the kick-off meeting, follow-up calls were conducted with a number of local stakeholders to gather additional input for the architecture. To complete the inventory, stakeholders were presented with the results of the inventory in the 2-Day Regional ITS Architecture Workshop described in Task 3B.

Task 3B – 2-Day Regional ITS Architecture Workshop: The purpose of the 2-Day Regional ITS Architecture Workshop was to review the inventory with stakeholders and begin the development of the Corpus Christi Regional ITS Architecture. Training on the National ITS Architecture also was integrated into the workshop so that key elements of the architecture, such as market packages, could be explained prior to selecting and customizing these elements. The result of the 2-Day Regional ITS Architecture Workshop was a Regional ITS Architecture for Corpus Christi, which included a system inventory, interconnect diagram, customized market packages, identification of functional requirements through process specifications, system interfaces, and relevant ITS standards.

Task 3C – Draft Regional ITS Architecture: After the 2-Day Regional ITS Architecture Workshop was completed, a web site was developed with a dedicated link to the Texas Regional ITS Architecture program. Stakeholders were asked to review the web site and provide comments through an email link set up on the site. A hard copy of the Draft Regional ITS Architecture for the Corpus Christi Region was sent to stakeholders prior to the 1-Day Regional ITS Architecture Review Workshop.

Task 3D – 1-Day Regional ITS Architecture Review Workshop: The 1-Day Regional ITS Architecture Review workshop was designed to allow stakeholders to review the draft architecture and provide comments. The primary focus of the workshop was to review the architecture flows between elements in the market packages. Training on architecture flows as well as ITS standards also was completed.

Task 3E – Revised Draft Regional ITS Architecture: Input from stakeholders in the 1-Day Regional ITS Architecture Review Workshop, as well as comments from stakeholders reviewing the web site and hard copy document, were used to revise the Draft Regional ITS Architecture. The revisions were incorporated into the web site as well as into the hard copy document. The Revised Draft Regional ITS Architecture was mailed to stakeholders for additional review.

Task 4A – Draft Regional ITS Deployment Plan: A Draft Regional ITS Deployment Plan was developed based on the prioritization of market packages and needs expressed by the stakeholders in the Region. The Draft Regional ITS Deployment Plan included a list of recommended projects in a 5-year, 10-year, and 20-year timeframe. Each project was linked to at least one or more market packages from the Corpus Christi Regional ITS Architecture.

Task 4B – Regional ITS Deployment Plan Workshop: The Draft Regional ITS Deployment Plan was presented to stakeholders at the Regional ITS Deployment Plan Workshop. Stakeholders were asked to provide input on the recommended projects, priority, and deployment timeframe.

Task 4C – Revised Draft Regional ITS Deployment Plan: Based on the review and input from stakeholders at the Regional ITS Deployment Plan Workshop, as well as review comments received from stakeholders outside of the workshop, a Revised Draft Regional ITS Deployment Plan was developed and sent to stakeholders.

Task 5 – Final Document Approval: A final comment resolution meeting was held with stakeholders to review the Revised Draft Regional ITS Architecture and the Revised Draft Regional ITS Deployment Plan. Next steps for the Region were also discussed. Comments were incorporated and a final Regional ITS Architecture and Regional ITS Deployment Plan were developed.

3.2   USDOT Regional ITS Architecture Guidance

On October 12, 2001, the U.S. Department of Transportation (USDOT) issued guidance on development of a regional ITS architecture through the document "Regional ITS Architecture Guidance: Developing, Using, and Maintaining an ITS Architecture for Your Region." **Figure 3** summarizes the guidance provided by the USDOT.

The process used to develop the Corpus Christi Regional ITS Architecture and Deployment Plan follows Steps 1 through 4 of the guidance. Steps 5 and 6 are designed to provide guidance upon the completion of the development of the Regional ITS Architecture.

Step 1, Get Started, of the guidance was completed in Task 1 – Kick-off and Regional Work Plan, as well as preliminary work completed by TxDOT to identify initial stakeholders and the need to complete the architecture for the Corpus Christi Region. Through these efforts, the need for an architecture, appropriate stakeholders, and the Region was defined.

Step 2, Gather Data, was completed through Task 1 – Kick-off and Regional Work Plan, Task 3A – System Inventory, and Task 3B – 2-Day Regional ITS Architecture Workshop. These efforts allowed the inventory for the Corpus Christi Region to be completed, identified ITS needs in the Region, and led to the development of an operational concept and definition of functional requirements.

Step 3, Define Interfaces, was completed in Task 3B – 2-Day Regional ITS Architecture Workshop and Task 3D – 1-Day Regional ITS Architecture Review Workshop. These workshops engaged stakeholders in customizing Market Packages for the Region, which included identifying interconnects among elements in the architecture and reviewing and selecting data flows between elements.

Step 4, Implementation, was completed in Task 3D – 1-Day Regional ITS Architecture Review Workshop through the prioritization of market packages. Sequencing of projects began in this process and was completed in the ITS Deployment Plan. Applicable ITS standards to match the identified data flows also were identified through the 1-Day ITS Architecture Review Workshop.
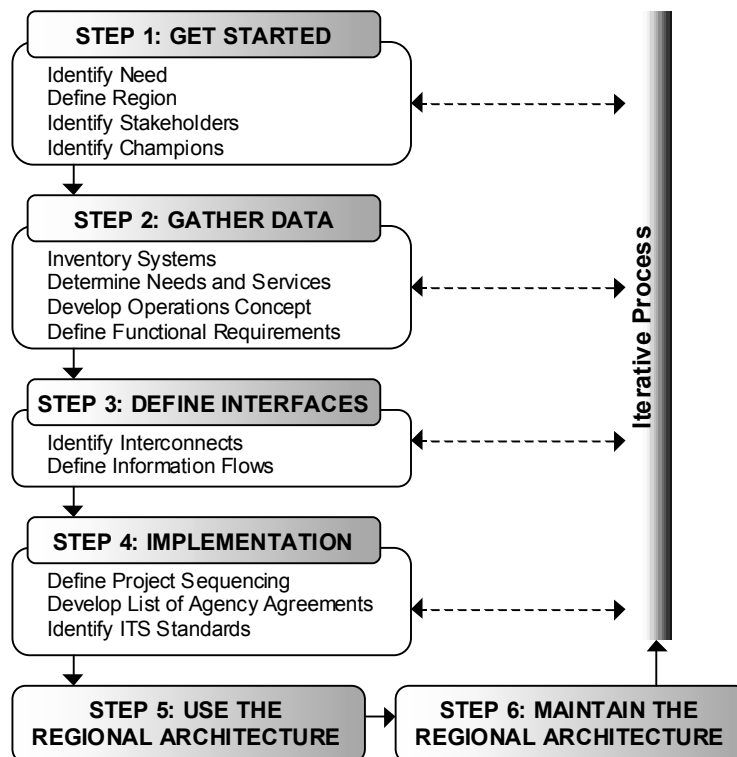
(Source: Regional ITS Architecture Guidance: Developing, Using, and Maintaining an ITS Architecture for Your Region, USDOT)

Figure 3 – USDOT Guidance on Regional ITS Architecture Development

4. CONCEPTUAL DESIGN

4.1 Systems Inventory

One of the key initial steps in the architecture development process is to establish an inventory of existing ITS elements. At the project kick-off meeting and through subsequent discussions with agency representatives throughout the Region, Corpus Christi stakeholders provided the team with a list of existing, planned, and future systems that would play a role in the Region's ITS architecture. "Planned" is defined as a system with funding identified, while "future" is defined as a system that does not yet have funding identified.

Existing, planned, and future systems in the Corpus Christi Region were identified in the following categories:

- *Travel and Traffic Management* – includes state and local traffic operations centers, traffic signal systems, detection systems, closed-circuit television (CCTV), VIVDS, fixed and portable dynamic message signs, signal preemption, and other related technologies.
- *Public Transportation Management* – includes transit AVL, dial-a-ride automated dispatch, and kiosk transit information systems.
- *Electronic Payment* – none identified.
- *Commercial Vehicle Operations* – includes surveillance cameras at the port of Corpus Christi.
- *Emergency Management* – includes dispatch for police, Metrocomm Emergency Alert System, emergency operations/management centers, and mobile data computers for emergency services (Metrocomm).
- *Information Management* – includes electronic data management and archiving systems.
- *Maintenance and Construction Operations* – includes maintenance vehicle tracking systems.

The System Inventory is a valuable task for several reasons. First, it provides a baseline of existing and planned ITS projects and systems in the Region. Second, it outlines which agencies are currently deploying and operating ITS, as well as those that are planning to implement ITS programs. Third, it provides a foundation for identifying needed elements or agency participation for the regional ITS, which will be important for subsequent tasks including the market package identification and prioritization, system interface and integration requirements in the Region, and ultimately the ITS Deployment Plan.

4.1.1 Subsystems and Terminators

Each identified system or component in the Corpus Christi Regional ITS inventory was mapped to a subsystem or terminator in the National ITS Architecture. Subsystems and terminators are the 'entities' that represent systems in ITS. Subsystems are the highest level building blocks of the physical architecture, and the National ITS Architecture groups them into four major classes: Centers, Roadside, Vehicles and Travelers. Each of these major classes includes various subsystems that represent a set of transportation functions (or processes) that are likely to be collected together under one agency, jurisdiction, or location, and correspond to physical elements, such as traffic operations centers, traffic signals, vehicles, and so on. **Figure 4** shows the National ITS Architecture subsystems. This figure, also known as the "sausage diagram" is a standard interconnect diagram, showing the

relationships of the various subsystems within the architecture; a customized interconnect diagram for the Corpus Christi Region is included in Section 4.3.1 of this report. Communication functions between the subsystems are represented in the ovals. It should be noted that "wireline" communication refers to fixed-point to fixed-point communications, which include not only twisted pair and fiber optic technologies, but also such wireless technologies as microwave and spread spectrum.

Terminators are the people, systems, other facilities, and environmental conditions outside of ITS that need to communicate or interface with ITS subsystems. They help to define the boundaries of the National ITS Architecture as well as a regional system. Examples of terminators include drivers, traffic operations personnel, information service providers, weather effects (snow, rain, fog), telecommunications systems, and government reporting systems, among others.
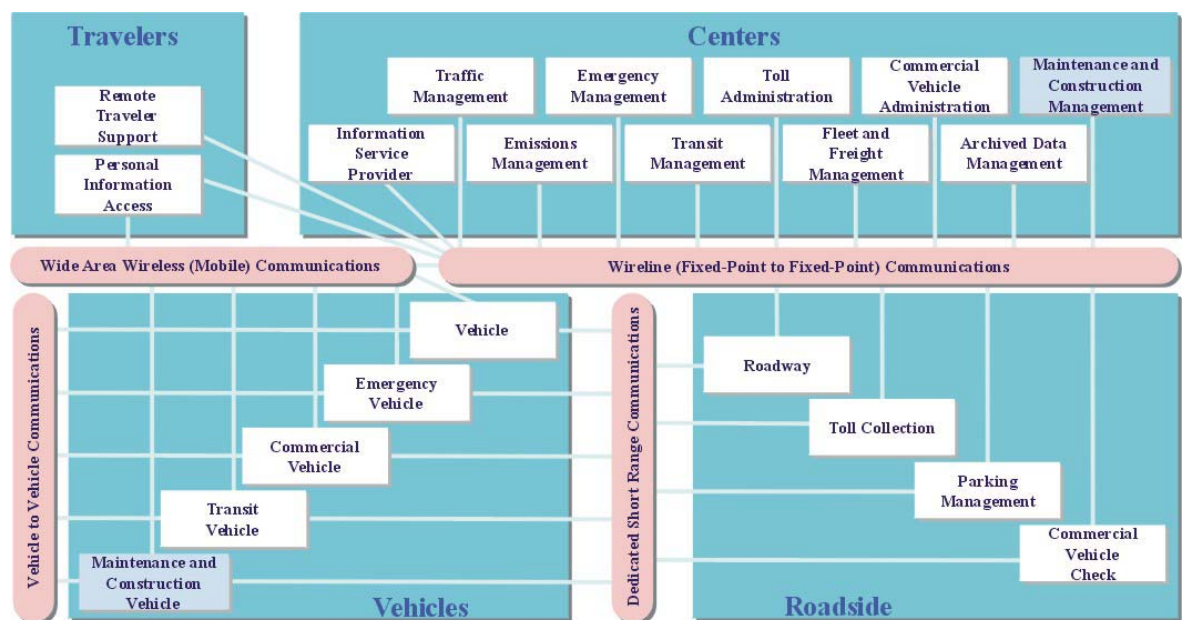
Figure 4 – Physical Subsystem Interconnect Diagram

4.1.2   Corpus Christi ITS Inventory by Stakeholder

Each stakeholder is associated with one or more systems or elements (subsystems and terminators) that make up the transportation system in the Corpus Christi Regional. **Table 3** sorts the inventory by stakeholder, so each stakeholder can easily identify and review all their relevant assets that are identified in the Corpus Christi Regional ITS Architecture.

The information in **Table 3** also is included on the Corpus Christi ITS Architecture web site, which is accessible by selecting the link to the Texas Regional ITS Architecture, the Corpus Christi Region, and then selecting the "Inventory by Stakeholder" button which will open the stakeholder list. Each element in the list contains a hyperlink to more detailed information, including status, description, stakeholder, and other elements within the inventory with which it interfaces. (At the time this report was published, the Corpus Christi Regional ITS Architecture web site was being hosted at www.consystec.com. TxDOT plans to permanently host the site in the future at www.dot.state.tx.us/trf/its.)

4.1.3 Corpus Christi ITS Inventory by Entity

The Corpus Christi Regional ITS Architecture inventory is made up of the transportation and communications centers, the field equipment, the vehicles, and other systems in the regional transportation system. These components have been assigned to an entity (subsystem or terminator) as defined by the National ITS Architecture. **Table 4** presents the Corpus Christi Region inventory using the associated National ITS Architecture subsystem or terminator. This sorts elements that perform similar functions together, so elements of a particular type can be easily identified. This inventory also can be accessed from the Corpus Christi Regional ITS Architecture web site by selecting the "Inventory by Stakeholder" button.

Table 3 – Corpus Christi ITS Inventory (Sorted by Stakeholder)

Stakeholder	Element	Entity	Status
Christus Spohn Health Systems	Christus Spohn Memorial Hospital	Care Facility	Existing
City of Corpus Christi	Bayfront Arena Parking System	Parking Management Subsystem	Future
	City of Corpus Christi Convention and Visitors Bureau Web Page	Event Promoters	Existing
	City of Corpus Christi Convention and Visitors Bureau Web Page	Information Service Provider Subsystem	Existing
	City of Corpus Christi Field Equipment	Roadway Subsystem	Existing
	City of Corpus Christi Field Sensors	Roadway Subsystem	Future
	Corpus Christi Emergency Operations Center	Emergency Management Subsystem	Existing
	Corpus Christi Emergency Operations Center	Maintenance and Construction Management Subsystem	Existing
	Corpus Christi Fire Vehicles	Emergency Vehicle Subsystem	Existing
	Corpus Christi Fleet Maintenance	Equipment Repair Facility	Existing
	Corpus Christi International Airport Public Safety	Emergency Management Subsystem	Existing
	Corpus Christi Mobile Communications Vehicles	Emergency Vehicle Subsystem	Existing
	Corpus Christi Police Department Metrocomm Dispatch	Emergency Management Subsystem	Existing
	Corpus Christi Police Vehicles	Emergency Vehicle Subsystem	Existing
	Corpus Christi Street Services Maintenance and Operations	Maintenance and Construction Management Subsystem	Existing
	Corpus Christi Street Services Traffic Operations Center	Archived Data User Systems	Existing
	Corpus Christi Street Services Traffic Operations Center	Maintenance and Construction Management Subsystem	Existing
	Corpus Christi Street Services Traffic Operations Center	Traffic Management Subsystem	Existing
	Corpus Christi Traffic Engineering	Archived Data User Systems	Existing

Table 3 – Corpus Christi ITS Inventory (Sorted by Stakeholder) (continued)

Stakeholder	Element	Entity	Status
City of Corpus Christi (continued)	Joint City/County/RTA Data Warehouse	Archived Data Management Subsystem	Future
	MetroComm Community Alerting Tools	Information Service Provider Subsystem	Existing
City/County Public Safety Agency	City/County EOC	Emergency Management Subsystem	Existing
	City/County Public Safety Dispatch	Emergency Management Subsystem	Existing
	City/County Public Safety Vehicles	Emergency Vehicle Subsystem	Existing
Commercial Vehicle Operators	Commercial Vehicle Operations	Fleet and Freight Management Subsystem	Existing
	Commercial Vehicles	Commercial Vehicle Subsystem	Existing
Conrad Blucher Institute	TCOON Coastal Weather Sensors	Roadway Subsystem	Existing
	TCOON Data Collection Center	Traffic Management Subsystem	Existing
Corpus Christi International Airport	Corpus Christi International Airport	Multimodal Transportation Service Provider	Existing
Corpus Christi MPO	Corpus Christi MPO Office	Archived Data User Systems	Existing
County Road and Bridge	County Road and Bridge	Maintenance and Construction Management Subsystem	Existing
DPS	DPS Communications Service	Emergency Management Subsystem	Existing
	Highway Patrol Vehicles	Emergency Vehicle Subsystem	Existing
DPS Division of Emergency Management	State EOC	Emergency Management Subsystem	Existing
Halo Flight	Halo Flight Helicopter	Emergency Vehicle Subsystem	Existing
Independent School Districts	Independent School District Transit Dispatch	Transit Management Subsystem	Existing
	School District Buses	Transit Vehicle Subsystem	Existing
Local Media	Print and Broadcast Media	Media	Existing
Naval Air Station	NAS Security Office	Emergency Management Subsystem	Existing
Naval Station Ingleside	Naval Station Ingleside Operations Center	Emergency Management Subsystem	Existing

Table 3 – Corpus Christi ITS Inventory (Sorted by Stakeholder) (continued)

Stakeholder	Element	Entity	Status
NOAA	National Weather Service	Weather Service	Existing
Other TxDOT Districts	Other TxDOT District TMCs	Traffic Management Subsystem	Existing
Port of Corpus Christi	POCCA Harbor Masters Office	Emergency Management Subsystem	Existing
	POCCA Harbor Masters Office	Port Facility	Existing
Private Ambulance Services	Private Ambulance Dispatch Center	Emergency Management Subsystem	Existing
	Private Ambulances	Emergency Vehicle Subsystem	Existing
Private ISPs	Private Sector Traveler Information Services	Information Service Provider Subsystem	Existing
Private Mayday Providers	Private Vehicle Emergency Systems	Emergency Management Subsystem	Existing
Private Meteorological Service Provider	Private Weather Service	Surface Transportation Weather Service	Future
Private Tow/Wrecker	Private Tow/Wrecker Dispatch	Emergency Management Subsystem	Existing
Private Travelers	Private Traveler Personal Computing Devices	Personal Information Access Subsystem	Existing
Private Vehicle Owners	Private Vehicles	Vehicle Subsystem	Existing
Railroad Operators	Rail Operations	Rail Operations	Existing
Refinery Terminal Fire Company	Refinery Terminal Fire Company Dispatch	Emergency Management Subsystem	Existing
Regional Hospitals	Regional Hospitals	Care Facility	Existing
Regional Transportation Authority	RTA ADART Server	Transit Management Subsystem	Existing
	RTA ADART Vehicles	Transit Vehicle Subsystem	Future
	RTA Kiosks	Remote Traveler Support Subsystem	Existing
	RTA Paratransit Operations	Transit Management Subsystem	Existing
	RTA Transit System Dispatch Center	Transit Management Subsystem	Existing
	RTA Transit Vehicles	Transit Vehicle Subsystem	Existing
Rural Transit Providers	Rural Transit Districts	Transit Management Subsystem	Existing

Table 3 – Corpus Christi ITS Inventory (Sorted by Stakeholder) (continued)

Stakeholder	Element	Entity	Status
Telcos	Telco 911 Call Routing	Emergency Telecommunications System	Existing
Texas Commission for Environmental Quality	TCEQ Air Quality Monitoring Center	Emissions Management Subsystem	Existing
	TCEQ Air Quality Monitoring Sensor Website	Information Service Provider Subsystem	Existing
	TCEQ Air Quality Monitoring Sensors	Roadway Subsystem	Existing
TxDOT	511 System	Traveler Info Phone System	Future
	BRINSAP - Bridge Inventory Inspection System	Asset Management	Existing
	Other TxDOT District Maintenance Sections	Maintenance and Construction Management Subsystem	Existing
	Rest Areas/Visitor Centers/Service Plaza Kiosks	Remote Traveler Support Subsystem	Existing
	Tule Lake Lift Bridge	Multimodal Crossings	Existing
	TxDOT Area Engineering	Maintenance and Construction Administrative Systems	Existing
	TxDOT Corpus Christi CCTV	Roadway Subsystem	Existing
	TxDOT Corpus Christi District Webpage	Information Service Provider Subsystem	Future
	TxDOT Corpus Christi DMS	Roadway Subsystem	Future
	TxDOT Corpus Christi Emergency Control Center	Emergency Management Subsystem	Future
	TxDOT Corpus Christi Field Sensors	Roadway Subsystem	Future
	TxDOT Corpus Christi HAR	Roadway Subsystem	Existing
	TxDOT Corpus Christi HOV Lane Control Equipment	Roadway Subsystem	Future
	TxDOT Corpus Christi Maintenance Section	Maintenance and Construction Management Subsystem	Existing
	TxDOT Corpus Christi Public Information Office	Information Service Provider Subsystem	Existing
	TxDOT Corpus Christi Public Information Office	Maintenance and Construction Management Subsystem	Existing

Table 3 – Corpus Christi ITS Inventory (Sorted by Stakeholder) (continued)

Stakeholder	Element	Entity	Status
TxDOT (continued)	TxDOT Corpus Christi Public Information Office	Traffic Management Subsystem	Existing
	TxDOT Corpus Christi TMC	Archived Data User Systems	Existing
	TxDOT Corpus Christi TMC	Maintenance and Construction Management Subsystem	Existing
	TxDOT Corpus Christi TMC	Traffic Management Subsystem	Existing
	TxDOT Corpus Christi Traffic Signals	Roadway Subsystem	Existing
	TxDOT Crash Record Information System	Archived Data Management Subsystem	Existing
	TxDOT District Shop	Equipment Repair Facility	Existing
	TxDOT Ferry System Field Equipment	Roadway Subsystem	Future
	TxDOT Ferry System Operations Center	Traffic Management Subsystem	Existing
	TxDOT Flood Warning Sensors	Flood Monitoring Sensor	Future
	TxDOT Highway Condition Reporting System	Information Service Provider Subsystem	Existing
	TxDOT Maintenance and Construction Vehicles	Maintenance and Construction Vehicle Subsystem	Existing
	TxDOT Planning STARS Systems	Archived Data Management Subsystem	Existing
	TxDOT Rural Maintenance Sections	Maintenance and Construction Management Subsystem	Existing
TxDOT Motor Carrier Division	TxDOT Motor Carrier Routing Information	Information Service Provider Subsystem	Existing
U.S. Coast Guard	Coast Guard Marine Safety Office	Emergency Management Subsystem	Existing
	Coast Guard Operations Center	Emergency Management Subsystem	Existing
USGS	USGS Flood Warning System	Roadway Subsystem	Existing

Table 4 – Corpus Christi ITS Inventory (Sorted by Entity)

Entity	Element	Stakeholder	Status
Archived Data Management Subsystem	Joint City/County/RTA Data Warehouse	City of Corpus Christi	Future
	TxDOT Crash Record Information System	TxDOT	Existing
	TxDOT Planning STARS Systems	TxDOT	Existing
Archived Data User Systems	Corpus Christi MPO Office	Corpus Christi MPO	Existing
	Corpus Christi Street Services Traffic Operations Center	City of Corpus Christi	Existing
	Corpus Christi Traffic Engineering	City of Corpus Christi	Existing
	TxDOT Corpus Christi TMC	TxDOT	Existing
Asset Management	BRINSAP - Bridge Inventory Inspection System	TxDOT	Existing
Care Facility	Christus Spohn Memorial Hospital	Christus Spohn Health Systems	Existing
	Regional Hospitals	Regional Hospitals	Existing
Commercial Vehicle Subsystem	Commercial Vehicles	Commercial Vehicle Operators	Existing
Emergency Management Subsystem	City/County EOC	City/County Public Safety Agency	Existing
	City/County Public Safety Dispatch	City/County Public Safety Agency	Existing
	Coast Guard Marine Safety Office	U.S. Coast Guard	Existing
	Coast Guard Operations Center	U.S. Coast Guard	Existing
	Corpus Christi Emergency Operations Center	City of Corpus Christi	Existing
	Corpus Christi International Airport Public Safety	City of Corpus Christi	Existing
	Corpus Christi Police Department Metrocomm Dispatch	City of Corpus Christi	Existing
	DPS Communications Service	DPS	Existing
	NAS Security Office	Naval Air Station	Existing
	Naval Station Ingleside Operations Center	Naval Station Ingleside	Existing

Table 4 – Corpus Christi ITS Inventory (Sorted by Entity) (continued)

Entity	Element	Stakeholder	Status
Emergency Management Subsystem (continued)	POCCA Harbor Masters Office	Port of Corpus Christi	Existing
	Private Ambulance Dispatch Center	Private Ambulance Services	Existing
	Private Tow/Wrecker Dispatch	Private Tow/Wrecker	Existing
	Private Vehicle Emergency Systems	Private Mayday Providers	Existing
	Refinery Terminal Fire Company Dispatch	Refinery Terminal Fire Company	Existing
	State EOC	DPS Division of Emergency Management	Existing
	TxDOT Corpus Christi Emergency Control Center	TxDOT	Future
Emergency Telecommunications System	Telco 911 Call Routing	Telcos	Existing
Emergency Vehicle Subsystem	City/County Public Safety Vehicles	City/County Public Safety Agency	Existing
	Corpus Christi Fire Vehicles	City of Corpus Christi	Existing
	Corpus Christi Mobile Communications Vehicles	City of Corpus Christi	Existing
	Corpus Christi Police Vehicles	City of Corpus Christi	Existing
	Halo Flight Helicopter	Halo Flight	Existing
	Highway Patrol Vehicles	DPS	Existing
	Private Ambulances	Private Ambulance Services	Existing
Emissions Management Subsystem	TCEQ Air Quality Monitoring Center	Texas Commission for Environmental Quality	Existing
Equipment Repair Facility	Corpus Christi Fleet Maintenance	City of Corpus Christi	Existing
	TxDOT District Shop	TxDOT	Existing
Event Promoters	City of Corpus Christi Convention and Visitors Bureau Web Page	City of Corpus Christi	Existing
Fleet and Freight Management Subsystem	Commercial Vehicle Operations	Commercial Vehicle Operators	Existing

Table 4 – Corpus Christi ITS Inventory (Sorted by Entity) (continued)

Entity	Element	Stakeholder	Status
Flood Monitoring Sensor	TxDOT Flood Warning Sensors	TxDOT	Future
Information Service Provider Subsystem	City of Corpus Christi Convention and Visitors Bureau Web Page	City of Corpus Christi	Existing
	MetroComm Community Alerting Tools	City of Corpus Christi	Existing
	Private Sector Traveler Information Services	Private ISPs	Existing
	TCEQ Air Quality Monitoring Sensor Website	Texas Commission for Environmental Quality	Existing
	TxDOT Corpus Christi District Webpage	TxDOT	Future
	TxDOT Corpus Christi Public Information Office	TxDOT	Existing
	TxDOT Highway Condition Reporting System	TxDOT	Existing
	TxDOT Motor Carrier Routing Information	TxDOT Motor Carrier Division	Existing
Maintenance and Construction Administrative Systems	TxDOT Area Engineering	TxDOT	Existing
Maintenance and Construction Management Subsystem	Corpus Christi Emergency Operations Center	City of Corpus Christi	Existing
	Corpus Christi Street Services Maintenance and Operations	City of Corpus Christi	Existing
	Corpus Christi Street Services Traffic Operations Center	City of Corpus Christi	Existing
	County Road and Bridge	County Road and Bridge	Existing
	Other TxDOT District Maintenance Sections	TxDOT	Existing
	TxDOT Corpus Christi Maintenance Section	TxDOT	Existing
	TxDOT Corpus Christi Public Information Office	TxDOT	Existing
	TxDOT Corpus Christi TMC	TxDOT	Existing
	TxDOT Rural Maintenance Sections	TxDOT	Existing

Table 4 – Corpus Christi ITS Inventory (Sorted by Entity) (continued)

Entity	Element	Stakeholder	Status
Maintenance and Construction Vehicle Subsystem	TxDOT Maintenance and Construction Vehicles	TxDOT	Existing
Media	Print and Broadcast Media	Local Media	Existing
Multimodal Crossings	Tule Lake Lift Bridge	TxDOT	Existing
Multimodal Transportation Service Provider	Corpus Christi International Airport	Corpus Christi International Airport	Existing
Parking Management Subsystem	Bayfront Arena Parking System	City of Corpus Christi	Future
Personal Information Access Subsystem	Private Traveler Personal Computing Devices	Private Travelers	Existing
Port Facility	POCCA Harbor Masters Office	Port of Corpus Christi	Existing
Rail Operations	Rail Operations	Railroad Operators	Existing
Remote Traveler Support Subsystem	Rest Areas/Visitor Centers/Service Plaza Kiosks	TxDOT	Existing
	RTA Kiosks	Regional Transportation Authority	Existing
Roadway Subsystem	City of Corpus Christi Field Equipment	City of Corpus Christi	Existing
	City of Corpus Christi Field Sensors	City of Corpus Christi	Future
	TCEQ Air Quality Monitoring Sensors	Texas Commission for Environmental Quality	Existing
	TCOON Coastal Weather Sensors	Conrad Blucher Institute	Existing
	TxDOT Corpus Christi CCTV	TxDOT	Existing
	TxDOT Corpus Christi DMS	TxDOT	Future
	TxDOT Corpus Christi Field Sensors	TxDOT	Future
	TxDOT Corpus Christi HAR	TxDOT	Existing
	TxDOT Corpus Christi HOV Lane Control Equipment	TxDOT	Future
	TxDOT Corpus Christi Traffic Signals	TxDOT	Existing

Table 4 – Corpus Christi ITS Inventory (Sorted by Entity) (continued)

Entity	Element	Stakeholder	Status
Roadway Subsystem (continued)	TxDOT Ferry System Field Equipment	TxDOT	Future
	USGS Flood Warning System	USGS	Existing
Surface Transportation Weather Service	Private Weather Service	Private Meteorological Service Provider	Future
Traffic Management Subsystem	Corpus Christi Street Services Traffic Operations Center	City of Corpus Christi	Existing
	Other TxDOT District TMCs	Other TxDOT Districts	Existing
	TCOON Data Collection Center	Conrad Blucher Institute	Existing
	TxDOT Corpus Christi Public Information Office	TxDOT	Existing
	TxDOT Corpus Christi TMC	TxDOT	Existing
	TxDOT Ferry System Operations Center	TxDOT	Existing
Transit Management Subsystem	Independent School District Transit Dispatch	Independent School Districts	Existing
	RTA ADART Server	Regional Transportation Authority	Existing
	RTA Paratransit Operations	Regional Transportation Authority	Existing
	RTA Transit System Dispatch Center	Regional Transportation Authority	Existing
	Rural Transit Districts	Rural Transit Providers	Existing
Transit Vehicle Subsystem	RTA ADART Vehicles	Regional Transportation Authority	Future
	RTA Transit Vehicles	Regional Transportation Authority	Existing
	School District Buses	Independent School Districts	Existing
Traveler Info Phone System	511 System	TxDOT	Future
Vehicle Subsystem	Private Vehicles	Private Vehicle Owners	Existing
Weather Service	National Weather Service	NOAA	Existing

4.2　Regional Market Packages

Upon completion of the system inventory, the next step in the development of the architecture was to identify the transportation services that are important to the Corpus Christi Region. In the National ITS Architecture, services are referred to as market packages. Market packages may include several stakeholders and elements that work together to provide a service in the Region. Examples of market packages from the National ITS Architecture include Network Surveillance, Traffic Information Dissemination, and Transit Vehicle Tracking. There are currently a total of 75 market packages identified in the National ITS Architecture.

In the Corpus Christi Region, the National ITS Architecture market packages were reviewed by the stakeholders and selected based on the relevance of the service that the market package could provide to the Region. The market packages that stakeholders in Corpus Christi selected for implementation in the Region are identified in **Table 5**, as well as the element (or system) in the Region that serves the key role in providing the market package service.

In several cases, there are multiple elements or systems in the Region that provide the same service at different levels. For example, Surface Street Control (ATMS03) is provided on highways through the TxDOT Corpus Christi TMC and on arterials by the City of Corpus Christi Street Services TOC. Market packages also are identified as either existing or planned for the Region. In many cases, existing market packages might still need to be enhanced to increase the service that the market package provides. For example, the market package for Network Surveillance is listed as existing for the TxDOT Corpus Christi TMC. Although TxDOT currently has this ability, additional cameras may be desired to increase the level of network surveillance on the highways.

Upon selecting of the market packages that were applicable for the Region, stakeholders then reviewed each market package and the elements that could be included to customize it for the Region. This customization is discussed further in Section 4.3.2.

Table 5 – Corpus Christi Region Selected Market Packages

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
ATMS01	Network Surveillance	City of Corpus Christi Field Equipment	TxDOT Corpus Christi District	Existing
		Corpus Christi Street Services Traffic Operations Center	City of Corpus Christi	Future
		TxDOT Corpus Christi CCTV		
		TxDOT Corpus Christi District Webpage		
		TxDOT Corpus Christi Field Sensors		
		TxDOT Corpus Christi TMC		
		TxDOT Ferry System Field Equipment		
		TxDOT Ferry System Operations Center		
		TxDOT Flood Warning Sensors		
ATMS03	Surface Street Control	City of Corpus Christi Field Equipment	City of Corpus Christi	Existing
		Corpus Christi Street Services Traffic Operations Center	TxDOT Corpus Christi District	Existing
		Independent School District Transit Dispatch		
		TxDOT Corpus Christi CCTV		
		TxDOT Corpus Christi Field Sensors		
		TxDOT Corpus Christi TMC		
		TxDOT Corpus Christi Traffic Signals		
ATMS04	Freeway Control	TxDOT Corpus Christi CCTV	TxDOT Corpus Christi District	Future
		TxDOT Corpus Christi Field Sensors		
		TxDOT Corpus Christi TMC		
ATMS05	HOV Lane Management	TxDOT Corpus Christi Field Sensors	TxDOT Corpus Christi District	Future
		TxDOT Corpus Christi HOV Lane Control Equipment		
		TxDOT Corpus Christi TMC		
ATMS06	Traffic Information Dissemination	City/County EOC	TxDOT Corpus Christi District	Future
		City/County Public Safety Dispatch		
		Corpus Christi Emergency Operations Center		
		Corpus Christi Police Department Metrocomm Dispatch		
		Corpus Christi Street Services Maintenance and Operations		
		Corpus Christi Street Services Traffic Operations Center		
		County Road and Bridge		
		DPS Communications Service		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
ATMS06 (continued)	Traffic Information Dissemination (continued)	Independent School District Transit Dispatch		
		NAS Security Office		
		Naval Station Ingleside Operations Center		
		POCCA Harbor Masters Office		
		Print and Broadcast Media		
		RefineryTerminal Fire Company Dispatch		
		RTA ADART Server		
		RTA Paratransit Operations		
		RTA Transit System Dispatch Center		
		Rural Transit Districts		
		State EOC		
		TxDOT Corpus Christi DMS		
		TxDOT Corpus Christi Emergency Control Center		
		TxDOT Corpus Christi HAR		
		TxDOT Corpus Christi Maintenance Section		
		TxDOT Corpus Christi TMC		
		TxDOT Ferry System Field Equipment		
		TxDOT Ferry System Operations Center		
		TxDOT Rural Maintenance Sections		
ATMS07	Regional Traffic Control	Corpus Christi Street Services Traffic Operations Center	TxDOT Corpus Christi District	Future
		Other TxDOT District TMCs		
		TxDOT Corpus Christi TMC		
		TxDOT Ferry System Operations Center		
ATMS08	Incident Management System	Christus Spohn Memorial Hospital	Traffic and Emergency Management Agencies	Existing
		City of Corpus Christi Convention and Visitors Bureau Web Page		
		City of Corpus Christi Field Equipment		
		City/County EOC		
		City/County Public Safety Dispatch		
		City/County Public Safety Vehicles		
		Coast Guard Marine Safety Office		
		Coast Guard Operations Center		
		Corpus Christi Convention/Visitor Bureau Web Page		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
ATMS08 (continued)	Incident Management System (continued)	Corpus Christi Emergency Operations Center		
		Corpus Christi Fire Vehicles		
		Corpus Christi International Airport Public Safety		
		Corpus Christi Mobile Communications Vehicles		
		Corpus Christi Police Department Metrocomm Dispatch		
		Corpus Christi Police Vehicles		
		Corpus Christi Street Services Maintenance and Operations		
		Corpus Christi Street Services Traffic Operations Center		
		County Road and Bridge		
		DPS Communications Service		
		Halo Flight Helicopter		
		Highway Patrol Vehicles		
		MetroComm Community Alerting Tools		
		NAS Security Office		
		Naval Station Ingleside Operations Center		
		Other TxDOT District Maintenance Sections		
		POCCA Harbor Masters Office		
		Print and Broadcast Media		
		Private Sector Traveler Information Services		
		Private Traveler Personal Computing Devices		
		Refinery Terminal Fire Company Dispatch		
		State EOC		
		Telco 911 Call Routing		
		TxDOT Corpus Christi CCTV		
		TxDOT Corpus Christi District Webpage		
		TxDOT Corpus Christi Emergency Control Center		
		TxDOT Corpus Christi Maintenance Section		
		TxDOT Corpus Christi TMC		
		TxDOT Highway Condition Reporting System		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
ATMS08 (continued)	Incident Management System (continued)	TxDOT Motor Carrier Routing Information		
		TxDOT Rural Maintenance Sections		
		Tule Lake Lift Bridge		
ATMS11	Emissions Monitoring and Management	Corpus Christi Office of Environmental Programs	Texas Commission on Air Quality	Existing
		Print and Broadcast Media		
		Private Traveler Personal Computing Devices		
		TCEQ Air Quality Monitoring Center		
		TCEQ Air Quality Monitoring Sensor Website		
		TCEQ Air Quality Monitoring Sensors		
		TxDOT Corpus Christi TMC		
ATMS13	Standard Railroad Grade Crossing	City of Corpus Christi Field Equipment	City of Corpus Christi	Existing
		Corpus Christi Street Services Traffic Operations Center	TxDOT Corpus Christi District	Existing
		Rail Operations		
		TxDOT Corpus Christi TMC		
		TxDOT Corpus Christi Traffic Signals		
ATMS15	Railroad Operations Coordination	City of Corpus Christi Field Equipment	City of Corpus Christi	Existing
		Corpus Christi Street Services Traffic Operations Center	TxDOT Corpus Christi District	Existing
		Rail Operations		
		TxDOT Corpus Christi TMC		
		TxDOT Corpus Christi Traffic Signals		
ATMS16	Parking Facility Management	Bayfront Arena Parking System	Bayfront Arena Parking Management	Future
		City of Corpus Christi Convention and Visitors Bureau Web Page		
		Private Sector Traveler Information Services		
		Private Vehicles		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
ATMS17	Regional Parking Management	Bayfront Arena Parking System	Bayfront Arena Parking Management	Future
		Corpus Christi Police Department Metrocomm Dispatch		
		Corpus Christi Street Services Traffic Operations Center		
		RTA Transit System Dispatch Center		
		TxDOT Corpus Christi TMC		
ATMS18	Reversible Lane Management	City of Corpus Christi Field Equipment	City of Corpus Christi	Future
		Corpus Christi Street Services Traffic Operations Center	TxDOT Corpus Christi District	Future
		TxDOT Corpus Christi TMC		
		TxDOT Corpus Christi Traffic Signals		
EM (Created for Corpus Christi Region)	Emergency Response – Hurricane Preparation and Evacuation Coordination	City/County EOC	Traffic and Emergency Management Agencies	Existing
		City/County Public Safety Dispatch		
		City/County Public Safety Vehicles		
		Coast Guard Marine Safety Office		
		Coast Guard Operations Center		
		Corpus Christi Emergency Operations Center		
		Corpus Christi International Airport Public Safety		
		Corpus Christi Police Department Metrocomm Dispatch		
		Corpus Christi Police Vehicles		
		Corpus Christi Street Services Traffic Operations Center		
		DPS Communications Service		
		NAS Security Office		
		Naval Station Ingleside Operations Center		
		Other TxDOT District TMCs		
		POCCA Harbor Masters Office		
		Private Ambulance Dispatch Center		
		Private Tow/Wrecker Dispatch		
		Private Vehicle Emergency Systems		
		Refinery Terminal Fire Company Dispatch		
		RTA ADART Server		
		RTA Transit System Dispatch Center		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
EM (Created for Corpus Christi Region) (continued)	Emergency Response – Hurricane Preparation and Evacuation Coordination (continued)	State EOC TxDOT Corpus Christi Emergency Control Center TxDOT Corpus Christi TMC		
EM1	Emergency Response	City/County EOC City/County Public Safety Dispatch City/County Public Safety Vehicles Coast Guard Marine Safety Office Coast Guard Operations Center Corpus Christi Emergency Operations Center Corpus Christi Fire Vehicles Corpus Christi International Airport Public Safety Corpus Christi Mobile Communications Vehicles Corpus Christi Police Department Metrocomm Dispatch Corpus Christi Police Vehicles Corpus Christi Street Services Traffic Operations Center DPS Communications Service Halo Flight Helicopter Highway Patrol Vehicles NAS Security Office Naval Station Ingleside Operations Center Other TxDOT District TMCs POCCA Harbor Masters Office Private Ambulance Dispatch Center Private Ambulances Private Tow/Wrecker Dispatch Private Vehicle Emergency Systems Refinery Terminal Fire Company Dispatch RTA ADART Server RTA Transit System Dispatch Center	Traffic and Emergency Management Agencies	Existing

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
EM1 (continued)	Emergency Response (continued)	State EOC TxDOT Corpus Christi Emergency Control Center TxDOT Corpus Christi TMC		
EM2	Emergency Routing	Christus Spohn Memorial Hospital Corpus Christi Emergency Operations Center Corpus Christi Fire Vehicles Corpus Christi Mobile Communications Vehicles Corpus Christi Police Department Metrocomm Dispatch Corpus Christi Police Vehicles Regional Hospitals	Metrocomm Dispatch/Christus Spohn Memorial Hospital	Existing
			Metrocomm Dispatch/Regional Hospitals	Existing
EM3	Mayday Support	City/County Public Safety Dispatch Corpus Christi Police Department Metrocomm Dispatch DPS Communications Service Local 911 Private Traveler Personal Computing Devices Private Vehicles Rest Areas/Visitor Centers/Service Plaza Kiosks	DPS Communications Service	Future
			Local 911	Future
MC01	Maintenance and Construction Vehicle Tracking	TxDOT Corpus Christi Maintenance Section TxDOT District Shop TxDOT Maintenance and Construction Vehicles TxDOT Rural Maintenance Sections	TxDOT Corpus Christi District	Future

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
MC02	Maintenance and Construction Vehicle Maintenance	Corpus Christi Fleet Maintenance	TxDOT Corpus Christi District	Future
		Corpus Christi Street Services Maintenance and Operations	City of Corpus Christi	Future
		TxDOT Corpus Christi Maintenance Section		
		TxDOT District Shop		
		TxDOT Maintenance and Construction Vehicles		
		TxDOT Rural Maintenance Sections		
MC03	Road Weather Data Collection	City of Corpus Christi Field Sensors	Corpus Christi Emergency Operations Center	Existing
		Corpus Christi Emergency Operations Center		
		Corpus Christi Police Department Metrocomm Dispatch		
		National Weather Service		
		TCOON Coastal Weather Sensors		
		TCOON Data Collection Center		
		USGS Flood Warning System		
MC04	Weather Information Processing and Distribution	Corpus Christi Street Services Traffic Operations Center	TCOON Data Collection Center	Future
		Corpus Christi Emergency Operations Center	Transit Management Agencies	Future
		Corpus Christi Police Department Metrocomm Dispatch	Emergency Management Agencies	Future
		DPS Communications Service		
		Independent School District Transit Dispatch		
		National Weather Service		
		Other TxDOT District Maintenance Sections		
		Other TxDOT District TMCs		
		Private Weather Service		
		RTA Transit System Dispatch Center		
		TCOON Data Collection Center		
		TxDOT Corpus Christi District Webpage		
		TxDOT Corpus Christi Emergency Control Center		
		TxDOT Corpus Christi TMC		
		USGS Flood Warning System		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
MC07	Roadway Maintenance and Construction	BRINSAP - Bridge Inventory Inspection System	TxDOT Corpus Christi District	Future
		City/County EOC	County Road and Bridge	Future
		City/County Public Safety Dispatch	City of Corpus Christi	Future
		Corpus Christi Emergency Operations Center		
		Corpus Christi Police Department Metrocomm Dispatch		
		Corpus Christi Street Services Maintenance and Operations		
		Corpus Christi Street Services Traffic Operations Center		
		County Road and Bridge		
		DPS Communications Service		
		Independent School District Transit Dispatch		
		TxDOT Area Engineering		
		TxDOT Corpus Christi Maintenance Section		
		TxDOT Corpus Christi TMC		
		TxDOT Maintenance and Construction Vehicles		
		TxDOT Rural Maintenance Sections		
MC08	Work Zone Management	Corpus Christi Police Department Metrocomm Dispatch	TxDOT Corpus Christi District	Future
		Corpus Christi Street Services Maintenance and Operations	City of Corpus Christi	Future
		County Road and Bridge		
		Independent School District Transit Dispatch		
		Other TxDOT District Maintenance Sections		
		RTA Paratransit Operations		
		RTA Transit System Dispatch Center		
		TxDOT Area Engineering		
		TxDOT Corpus Christi CCTV		
		TxDOT Corpus Christi District Webpage		
		TxDOT Corpus Christi DMS		
		TxDOT Corpus Christi Maintenance Section		
		TxDOT Corpus Christi TMC		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
MC08 (continued)	Work Zone Management (continued)	TxDOT Maintenance and Construction Vehicles		
		TxDOT Rural Maintenance Sections		
MC09	Work Zone Safety Monitoring	TxDOT Corpus Christi Field Sensors	TxDOT Corpus Christi District	Future
		TxDOT Corpus Christi Maintenance Section		
		TxDOT Maintenance and Construction Vehicles		
		TxDOT Rural Maintenance Sections		
MC10	Maintenance and Construction Activity Coordination	BRINSAP - Bridge Inventory Inspection System	TxDOT Corpus Christi District	Future
		Corpus Christi Street Services Maintenance and Operations	City of Corpus Christi	Future
		County Road and Bridge		
		Other TxDOT District Maintenance Sections		
		Private Sector Traveler Information Services		
		Rail Operations		
		RTA Transit System Dispatch Center		
		TxDOT Area Engineering		
		TxDOT Corpus Christi District Webpage		
		TxDOT Corpus Christi Maintenance Section		
		TxDOT Corpus Christi TMC		
		TxDOT Highway Condition Reporting System		
		TxDOT Rural Maintenance Sections		
APTS1	Transit Vehicle Tracking	RTA ADART Server	RTA Transit	Existing
		RTA ADART Vehicles	RTA ADART	Existing
		RTA Paratransit Operations		
		RTA Transit System Dispatch Center		
		RTA Transit Vehicles		
APTS2	Transit Fixed-Route Operations	Corpus Christi Street Services Maintenance and Operations	RTA Transit	Existing
		Corpus Christi Street Services Traffic Operations Center	Independent School Districts	Existing
		County Road and Bridge		
		Independent School District Transit Dispatch		
		Private Sector Traveler Information Services		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
APTS2 (continued)	Transit Fixed-Route Operations (continued)	RTA Transit System Dispatch Center RTA Transit Vehicles School District Buses TxDOT Corpus Christi Maintenance Section TxDOT Corpus Christi TMC TxDOT Rural Maintenance Sections		
APTS3	Demand Response Transit Operations	Corpus Christi Street Services Maintenance and Operations Corpus Christi Street Services Traffic Operations Center Private Sector Traveler Information Services RTA ADART Server RTA ADART Vehicles RTA Paratransit Operations RTA Transit Vehicles Rural Transit Districts TxDOT Corpus Christi Maintenance Section TxDOT Corpus Christi TMC	RTA Transit RTA ADART	Existing Existing
APTS4	Transit Passenger and Fare Management	RTA ADART Server RTA ADART Vehicles RTA Kiosks RTA Transit System Dispatch Center RTA Transit Vehicles	RTA Transit RTA ADART	Future Future
APTS5	Transit Security	Corpus Christi Emergency Operations Center Corpus Christi Police Department Metrocomm Dispatch RTA ADART Server RTA ADART Vehicles RTA Kiosks RTA Transit System Dispatch Center RTA Transit Vehicles	RTA Transit RTA ADART	Future Future

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
APTS7	Multi-modal Coordination	City of Corpus Christi Convention and Visitors Bureau Web Page	RTA Transit	Future
		Corpus Christi International Airport		
		Private Sector Traveler Information Services		
		RTA ADART Server		
		RTA Paratransit Operations		
		RTA Transit System Dispatch Center		
		Rural Transit Districts		
APTS8	Transit Traveler Information	Private Traveler Personal Computing Devices	RTA Transit	Future
		RTA ADART Server	RTA ADART	Future
		RTA Kiosks		
		RTA Transit System Dispatch Center		
CVO10	HAZMAT Management	City/County EOC	Emergency Management Agencies	Future
		City/County Public Safety Dispatch	Commercial Vehicle Operations	Future
		Commercial Vehicle Operations		
		Commercial Vehicles		
		Corpus Christi Emergency Operations Center		
		Corpus Christi Police Department Metrocomm Dispatch		
		DPS Communications Service		
		TxDOT Corpus Christi Emergency Control Center		
ATIS1	Broadcast Traveler Information	511 System	TxDOT Corpus Christi District	Future
		Bayfront Arena Parking System	City of Corpus Christi	Future
		Corpus Christi Street Services Traffic Operations Center		
		National Weather Service		
		Print and Broadcast Media		
		Private Traveler Personal Computing Devices		
		Rest Areas/Visitor Centers/Service Plaza Kiosks		
		TxDOT Corpus Christi District Webpage		
		TxDOT Corpus Christi HAR		

Table 5 – Corpus Christi Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Status
ATIS1 (continued)	Broadcast Traveler Information (continued)	TxDOT Corpus Christi Maintenance Section		
		TxDOT Corpus Christi Public Information Office		
		TxDOT Corpus Christi TMC		
		TxDOT Highway Condition Reporting System		
		TxDOT Rural Maintenance Sections		
ATIS5	ISP Based Route Guidance	Commercial Vehicle Operations	TxDOT Motor Carrier Routing	Existing
		Private Traveler Personal Computing Devices		
		TxDOT Corpus Christi Maintenance Section		
		TxDOT Corpus Christi TMC		
		TxDOT Motor Carrier Routing Information		
		TxDOT Rural Maintenance Sections		
AD1	ITS Data Mart	Corpus Christi MPO Office	TxDOT Crash Record Information System	Future
		Corpus Christi Police Department	TxDOT Planning STARS System	Future
		Corpus Christi Street Services Traffic Operations Center		
		Corpus Christi Traffic Engineering		
		DPS Communications Service		
		TxDOT Corpus Christi TMC		
		TxDOT Crash Record Information System		
		TxDOT Planning STARS Systems		
AD2	ITS Data Warehouse	Corpus Christi MPO Office	Joint City/County/RTA Data Warehouse	Future
		Corpus Christi Street Services Traffic Operations Center		
		Joint City/County/RTA Data Warehouse		
		RTA Transit System Dispatch Center		
		TxDOT Corpus Christi TMC		

4.3 Interconnections

4.3.1 Top Level Regional System Interconnect Diagram

A system interconnect diagram, or sausage diagram (shown previously in Section 4.1.1), shows the systems and primary interconnects in the Region. The National ITS Architecture interconnect diagram has been customized for the Corpus Christi Region based on the information gathered from the stakeholder and system inventory. **Figure 5** on the following page summarizes the existing, planned, and future ITS elements for the Corpus Christi Region in the context of a physical interconnect. Subsystems and elements specific to Corpus Christi are called out in the boxes surrounding the main interconnect diagram, and these are color-coded to the subsystem to which they are associated. The rectangles represent the architecture subsystems, and the terminators are represented by the rounded rectangles. Elements with an asterisk (*) are planned and future system elements.

4.3.2 Customized Market Packages

The market packages in the National ITS Architecture were customized to reflect the unique systems, subsystems, and terminators in the Corpus Christi Region. Each market package is shown graphically, with the market package name, Corpus Christi-specific element, and with the unique agency and system identifiers within the subsystems and terminators. Equipment packages, where applicable, also are shown for each market package. An equipment package is a functional capability that may be deployed at a specific time. While the market packages represent a service that will be deployed as an integrated capability, the equipment packages make up those market packages and are the most basic functions that will be developed or bought by implementers.

Figure 6 is an example of an ATMS market package for Surface Street Control that has been customized for the Corpus Christi Region. This market package shows the two subsystems, Traffic Management and Roadway, and the associated entities (City of Corpus Christi Street Services TOC and City of Corpus Christi Field Equipment) and equipment packages. The equipment packages are the rectangles inside of the subsystems, and represent the functions that deliver a particular service to support the market package. Data flows between the subsystems and the terminators (Other Roadway) indicate what information is being shared. The data flow lines are solid in this market package, which means that these are existing functions and information flows.

Market packages that were customized for the Corpus Christi Region are shown in **Appendix A**. These market packages also are included on the Corpus Christi Regional ITS Architecture web site by selecting the "Market Package" button. Market packages are grouped by functional area (Traffic Management, Maintenance and Construction, Public Transportation, etc.), and each of the customized market packages can be viewed by clicking on the Market Package Diagram icon under each area heading. It is important to note that while the market package table on the web site shows all of the available market packages from the National ITS Architecture, only those selected for the Corpus Christi Region are included in the diagrams. The selected market packages on the web site also are highlighted in the table with bold print, and are indicated as existing or planned.
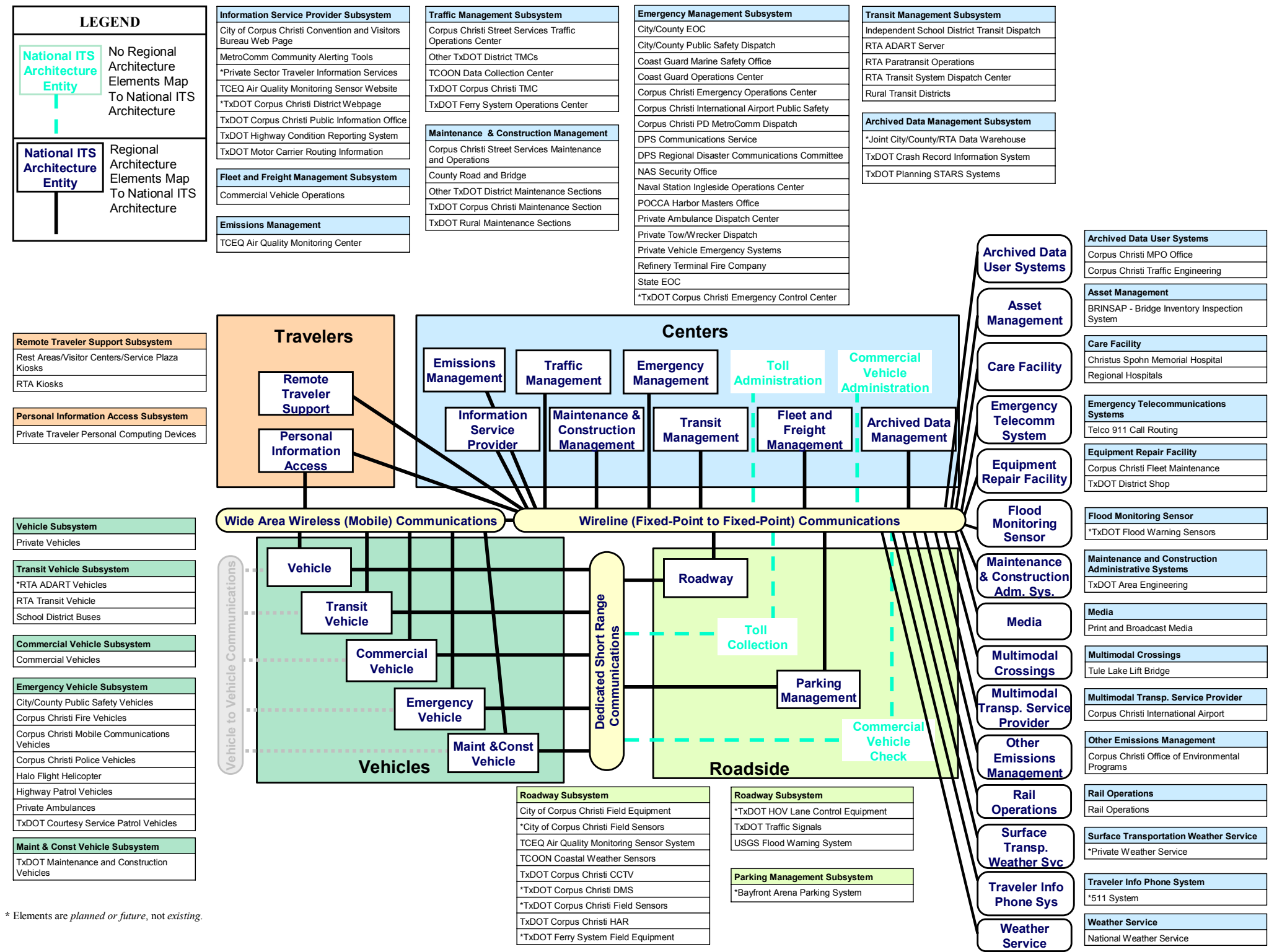
LEGEND

National ITS Architecture Entity	No Regional Architecture Elements Map To National ITS Architecture
National ITS Architecture Entity	Regional Architecture Elements Map To National ITS Architecture

Information Service Provider Subsystem
- City of Corpus Christi Convention and Visitors Bureau Web Page
- MetroComm Community Alerting Tools
- *Private Sector Traveler Information Services
- TCEQ Air Quality Monitoring Sensor Website
- *TxDOT Corpus Christi District Webpage
- TxDOT Highway Condition Reporting Office
- TxDOT Corpus Christi Public Information Office
- TxDOT Motor Carrier Routing Information

Fleet and Freight Management Subsystem
- Commercial Vehicle Operations

Emissions Management
- TCEQ Air Quality Monitoring Center

Traffic Management Subsystem
- Corpus Christi Street Services Traffic Operations Center
- Other TxDOT District TMCs
- TCOON Data Collection Center
- TxDOT Corpus Christi TMC
- TxDOT Ferry System Operations Center

Maintenance & Construction Management
- Corpus Christi Street Services Maintenance and Operations
- County Road and Bridge
- Other TxDOT District Maintenance Sections
- TxDOT Corpus Christi Maintenance Section
- TxDOT Rural Maintenance Sections

Emergency Management Subsystem
- City/County EOC
- City/County Public Safety Dispatch
- Coast Guard Marine Safety Office
- Coast Guard Operations Center
- Corpus Christi Emergency Operations Center
- Corpus Christi TMC
- Corpus Christi International Airport Public Safety
- Corpus Christi PD MetroComm Dispatch
- DPS Communications Service
- DPS Regional Disaster Communications Committee
- NAS Security Office
- Naval Station Ingleside Operations Center
- POCCA Harbor Masters Office
- Private Ambulance Dispatch Center
- Private Tow/Wrecker Dispatch
- Private Vehicle Emergency Systems
- Refinery Terminal Fire Company
- State EOC
- *TxDOT Corpus Christi Emergency Control Center

Transit Management Subsystem
- Independent School District Transit Dispatch
- RTA ADART Server
- RTA Paratransit Operations
- RTA Transit System Dispatch Center
- Rural Transit Districts

Archived Data Management Subsystem
- *Joint City/County/RTA Data Warehouse
- TxDOT Crash Record Information System
- TxDOT Planning STARS Systems

Remote Traveler Support Subsystem
- Rest Areas/Visitor Centers/Service Plaza Kiosks
- RTA Kiosks

Personal Information Access Subsystem
- Private Traveler Personal Computing Devices

Vehicle Subsystem
- Private Vehicles

Transit Vehicle Subsystem
- *RTA ADART Vehicles
- RTA Transit Vehicle
- School District Buses

Commercial Vehicle Subsystem
- Commercial Vehicles

Emergency Vehicle Subsystem
- City/County Public Safety Vehicles
- Corpus Christi Fire Vehicles
- Corpus Christi Mobile Communications Vehicles
- Corpus Christi Police Vehicles
- Halo Flight Helicopter
- Highway Patrol Vehicles
- Private Ambulances
- TxDOT Courtesy Service Patrol Vehicles

Maint & Const Vehicle Subsystem
- TxDOT Maintenance and Construction Vehicles

*Elements are *planned or future*, not *existing*.*

Travelers
- Remote Traveler Support
- Personal Information Access

Centers
- Emissions Management
- Traffic Management
- Emergency Management
- Toll Administration
- Commercial Vehicle Administration
- Information Service Provider
- Maintenance & Construction Management
- Transit Management
- Fleet and Freight Management
- Archived Data Management

Wide Area Wireless (Mobile) Communications

Wireline (Fixed-Point to Fixed-Point) Communications

Vehicle to Vehicle Communications

Vehicles
- Vehicle
- Transit Vehicle
- Commercial Vehicle
- Emergency Vehicle
- Maint &Const Vehicle

Dedicated Short Range Communications

Roadside
- Roadway
- Toll Collection
- Parking Management
- Commercial Vehicle Check

Roadway Subsystem
- City of Corpus Christi Field Equipment
- *City of Corpus Christi Field Sensors
- TCEQ Air Quality Monitoring Sensor System
- TCOON Coastal Weather Sensors
- TxDOT Corpus Christi CCTV
- *TxDOT Corpus Christi DMS
- *TxDOT Corpus Christi Field Sensors
- TxDOT Corpus Christi HAR
- *TxDOT Ferry System Field Equipment

Roadway Subsystem
- *TxDOT HOV Lane Control Equipment
- TxDOT Traffic Signals
- USGS Flood Warning System

Parking Management Subsystem
- *Bayfront Arena Parking System

Archived Data User Systems
- Corpus Christi MPO Office
- Corpus Christi Traffic Engineering

Asset Management
- BRINSAP - Bridge Inventory Inspection System

Care Facility
- Christus Spohn Memorial Hospital
- Regional Hospitals

Emergency Telecommunications Systems
- Telco 911 Call Routing

Equipment Repair Facility
- Corpus Christi Fleet Maintenance
- TxDOT District Shop

Flood Monitoring Sensor
- *TxDOT Flood Warning Sensors

Maintenance and Construction Administrative Systems
- TxDOT Area Engineering

Media
- Print and Broadcast Media

Multimodal Crossings
- Tule Lake Lift Bridge

Multimodal Transp. Service Provider
- Corpus Christi International Airport

Other Emissions Management
- Corpus Christi Office of Environmental Programs

Rail Operations
- Rail Operations

Surface Transportation Weather Service
- *Private Weather Service

Traveler Info Phone System
- *511 System

Weather Service
- National Weather Service

Left-side center column labels:
- Archived Data User Systems
- Asset Management
- Care Facility
- Emergency Telecomm System
- Equipment Repair Facility
- Flood Monitoring Sensor
- Maintenance & Construction Adm. Sys.
- Media
- Multimodal Crossings
- Multimodal Transp. Service Provider
- Other Emissions Management
- Rail Operations
- Surface Transp. Weather Svc
- Traveler Info Phone Sys
- Weather Service

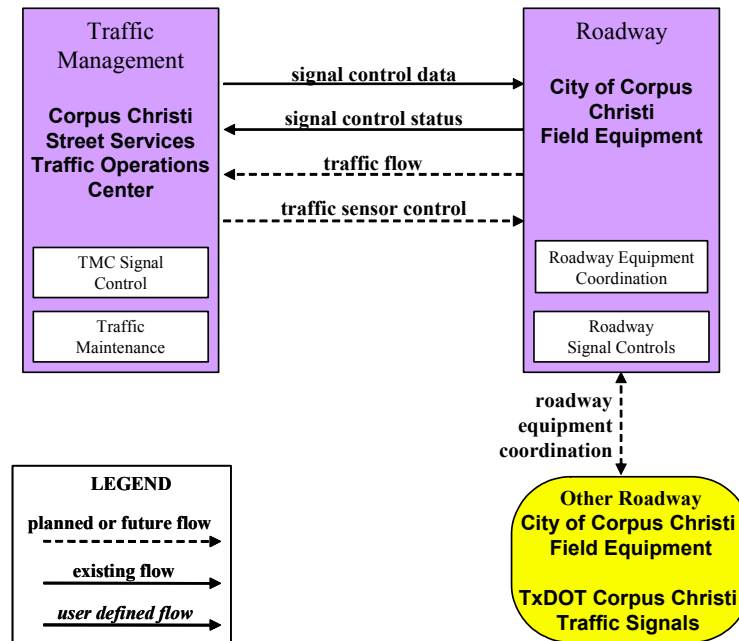**Figure 5 – Corpus Christi Regional System Interconnect Diagram**

Figure 6 – Custom Market Package for Corpus Christi Surface Street Control

4.3.3 Corpus Christi Architecture Interfaces

While it is important to identify the various systems and stakeholders as part of a regional ITS, a primary purpose of the architecture is to identify the *connectivity* between transportation systems in the Corpus Christi Region. The interconnect diagram shown previously in **Figure 5** showed the high-level relationships of the subsystems and terminators in the Corpus Christi Region and the associated local projects and systems. The customized market packages represent services that can be deployed as an integrated capability, and the market package diagrams show the information flows between the subsystems and terminators that are most important to the operation of the market packages. How these systems interface with each other is an integral part of the overall ITS architecture.

There are 102 different elements identified as part of the Corpus Christi Regional ITS Architecture. These elements include local and state traffic operations centers, transit vehicles, dispatch systems, emergency management agencies, media outlets, and others – essentially, all of the existing and planned physical components that contribute to the regional intelligent transportation system. Interfaces have been identified for each element in the Corpus Christi Regional ITS Architecture, and each element has been mapped to those other elements with which it must interface. For example, the City of Corpus Christi Street Services TOC has existing or planned interfaces with 22 other elements in the Corpus Christi Region, ranging from field equipment and dispatch centers to the Naval Station and TxDOT systems. Other interfaces are far less complex, such as the interface between the City of Corpus Christi Police Vehicles to Metrocomm Dispatch, Halo Helicopters, and Regional Hospitals.

An example of one of the system interfaces is shown in **Figure 7** on the following page. This graphic shows the TxDOT Corpus Christi District Web Site and the existing and planned interfaces with other elements throughout the Region. These interfaces are shown as existing, planned, or future. Interfaces defined as planned have funding identified, while future interfaces are desired by stakeholders but funding has not yet been identified.

Each element and its defined interfaces are listed in **Appendix B**. Elements and their interfaces also are accessible via the Corpus Christi Regional ITS Architecture web site by clicking on the "Interfaces" button. Elements are listed alphabetically in the column on the left, and each entry in the Interfacing Element column on the right is a link to more detailed information about the particular interface. The architecture flows between the individual element interfaces are described in more detail in the following section.

4.3.4 Physical Subsystem Architecture Flows

Architecture flows between the subsystems and terminators define the specific information (data) that is exchanged between subsystems and terminators. Each architecture flow has one or more data flows that specify what information is exchanged and the direction of the exchange. These data flows could be requests for information, alerts and messages, status requests, broadcast advisories, event messages, confirmations, electronic credentials, and other key information requirements. These architecture flows define the interface requirements between the various elements in the Corpus Christi Regional ITS Architecture.

An example of the architecture flows between two elements is shown in **Figure 8**. In this interface, the flows between the City of Corpus Christi Street Services Traffic Operations Center and the City's Field Equipment show information that must go from the TOC to the field equipment, as well as information that the TOC needs from devices. Similar to the interfaces, architecture flows also are defined as existing, planned, or future.

Each of the individual element interfaces can be accessed on the Corpus Christi Regional ITS Architecture web site by clicking on the "Interfaces" button. Selecting any of the Interfacing Elements from the column on the right will display an interface diagram and architecture flows between two specific elements, similar to the diagram shown in **Figure 8**. Each data flow is defined, and any standards associated with that data flow are noted. Standards as they apply to the Corpus Christi Region are discussed in more detail in Section 4.5.
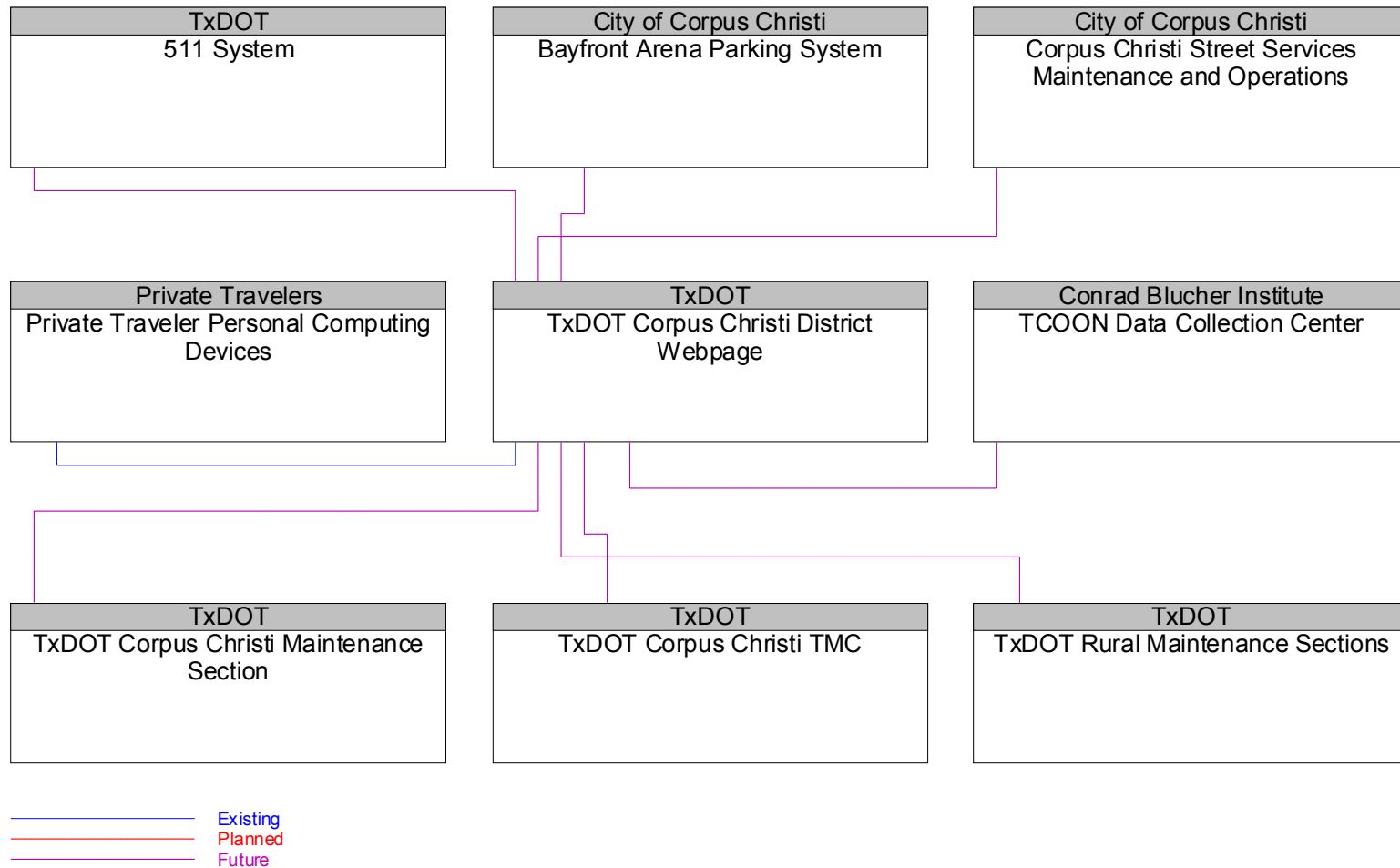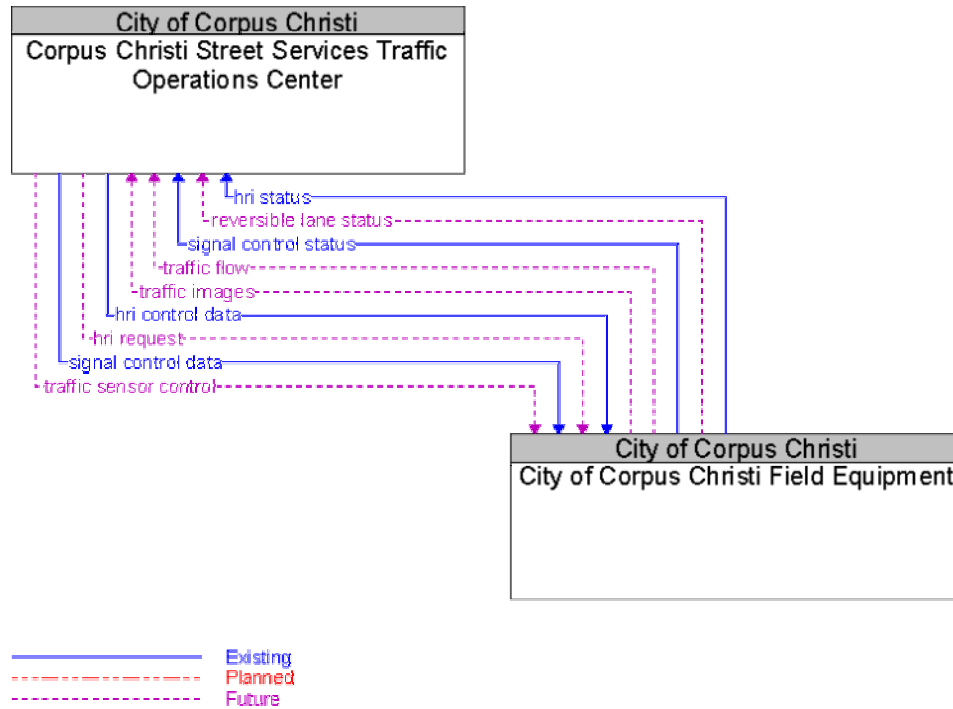
Figure 7 – TxDOT Corpus Christi District Web Page

Figure 8 – Corpus Christi TOC to Field Equipment Architecture Flows

4.4 Functional Requirements

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

For the Corpus Christi Regional ITS Architecture, functional requirements have been identified at two levels. The customized market packages, included in Section 4.3.2, describe the services that ITS needs to provide in the Region and the architecture flows between the elements. These market packages and data flows describe what the ITS system in Corpus Christi has to do and the data that needs to be shared among elements.

At a more detailed level, functional requirements for the Corpus Christi Region also are described in terms of equipment packages that are associated with one or more subsystems in the Corpus Christi Regional ITS Architecture as shown in **Table 6**. As described in Section 4.3.2, an equipment package is a functional capability that may be deployed at a specific time. Each equipment package can be linked in the National ITS Architecture to the Process Specifications that may be applicable. It is recommended that during the design concept stage of a project, the

applicable equipment package and associated Process Specifications from the National ITS Architecture be reviewed by the implementer to determine the appropriate functional requirements for the project. A link for each equipment package is available on the Corpus Christi Regional ITS Architecture web site by clicking on the "Functions" button.

Table 6 – Corpus Christi Region Equipment Packages

Subsystem	Equipment Package
Archived Data Management Subsystem	Government Reporting Systems Support
	ITS Data Repository
	On-Line Analysis and Mining
	Traffic and Roadside Data Archival
Commercial Vehicle Subsystem	On-board Cargo Monitoring
Emergency Management Subsystem	Emergency Call-Taking
	Emergency Data Collection
	Emergency Dispatch
	Emergency Environmental Monitoring
	Emergency Response Management
	Emergency Secure Area Surveillance
	Mayday Support
Emergency Vehicle Subsystem	On-board EV En Route Support
	On-board EV Incident Management Communication
Emissions Management Subsystem	Emissions Data Management
Fleet and Freight Management Subsystem	Fleet HAZMAT Management
Information Service Provider Subsystem	Basic Information Broadcast
	Infrastructure Provided Route Selection
	Interactive Infrastructure Information
	ISP Probe Information Collection
Maintenance and Construction Management Subsystem	MCM Data Collection
	MCM Environmental Information Collection
	MCM Environmental Information Processing
	MCM Incident Management
	MCM Maintenance Decision Support
	MCM Roadway Maintenance and Construction
	MCM Vehicle and Equipment Maintenance Management
	MCM Vehicle Tracking
	MCM Work Activity Coordination
	MCM Work Zone Management
	MCM Work Zone Safety Management

Table 6 – Corpus Christi Region Equipment Packages (continued)

Subsystem	Equipment Package
Maintenance and Construction Vehicle Subsystem	MCV Infrastructure Monitoring
	MCV Roadway Maintenance and Construction
	MCV Vehicle Location Tracking
	MCV Vehicle Safety Monitoring
	MCV Vehicle System Monitoring and Diagnostics
	MCV Work Zone Support
Parking Management Subsystem	Parking Coordination
	Parking Electronic Payment
	Parking Management
	Parking Surveillance
Personal Information Access Subsystem	Personal Basic Information Reception
	Personal Interactive Information Reception
	Personal Location Determination
	Personal Mayday I/F
	Personal Provider-Based Route Guidance
Remote Traveler Support Subsystem	Remote Basic Information Reception
	Remote Mayday I/F
	Remote Transit Fare Management
	Remote Transit Information Services
	Secure Area Monitoring
Roadway Subsystem	Roadway Basic Surveillance
	Roadway Emissions Monitoring
	Roadway Environmental Monitoring
	Roadway Equipment Coordination
	Roadway Freeway Control
	Roadway HOV Control
	Roadway Incident Detection
	Roadway Probe Beacons
	Roadway Reversible Lanes
	Roadway Signal Controls
	Roadway Traffic Information Dissemination
	Roadway Work Zone Safety
	Roadway Work Zone Traffic Control
	Standard Rail Crossing

Table 6 – Corpus Christi Region Equipment Packages (continued)

Subsystem	Equipment Package
Traffic Management Subsystem	Collect Traffic Surveillance
	HRI Traffic Management
	Rail Operations Coordination
	TMC Environmental Monitoring
	TMC Freeway Management
	TMC HOV Lane Management
	TMC Incident Detection
	TMC Incident Dispatch Coordination/Communication
	TMC Probe Information Collection
	TMC Regional Traffic Control
	TMC Reversible Lane Management
	TMC Signal Control
	TMC Traffic Information Dissemination
	TMC Work Zone Traffic Management
	Traffic Data Collection
	Traffic Maintenance
Transit Management Subsystem	Transit Center Fare and Load Management
	Transit Center Fixed-Route Operations
	Transit Center Information Services
	Transit Center Multi-Modal Coordination
	Transit Center Paratransit Operations
	Transit Center Security
	Transit Center Tracking and Dispatch
	Transit Data Collection
	Transit Environmental Monitoring
	Transit Garage Maintenance
	Transit Garage Operations
Transit Vehicle Subsystem	On-board Fixed Route Schedule Management
	On-board Maintenance
	On-board Paratransit Operations
	On-board Transit Fare and Load Management
	On-board Transit Security
	On-board Transit Trip Monitoring

Table 6 – Corpus Christi Region Equipment Packages (continued)

Subsystem	Equipment Package
Vehicle Subsystem	Vehicle Location Determination
	Vehicle Mayday I/F
	Vehicle Toll/Parking Interface

4.5 Standards

Standards are an important tool that will allow efficient implementation of the elements in the Corpus Christi Regional ITS Architecture over time. Standards facilitate deployment of interoperable systems at local, regional, and national levels without impeding innovation as technology advances, vendors change, and as new approaches evolve. The USDOT's ITS Joint Program Office is supporting Standards Development Organizations (SDOs) with an extensive, multi-year program of accelerated, consensus-based standards development to facilitate successful ITS deployment in the United States. **Table 7** identifies each of the ITS standards that may apply to the Corpus Christi Regional ITS Architecture. These standards are based on the physical subsystem architecture flows identified in Section 4.3.4. The connection of each standard to the applicable architecture flows between elements can be viewed on the Corpus Christi Regional ITS Architecture web site by clicking on the "Interfaces" or "Standards" buttons.

Table 7 – Applicable ITS Standards for the Corpus Christi Region

SDO	Document ID	Title	Type
AASHTO/ITE/NEMA	NTCIP 1201	Global Object Definitions	Message
	NTCIP 1202	Object Definitions for Actuated Traffic Signal Controller Units	Message
	NTCIP 1203	Object Definitions for Dynamic Message Signs	Message
	NTCIP 1204	Object Definitions for Environmental Sensor Stations and Roadside Weather Information System	Message
	NTCIP 1205	Data Dictionary for Closed Circuit Television	Message
	NTCIP 1207	Ramp Meter Controller Objects	Message
	NTCIP 1208	Object Definitions for Video Switches	Message
	NTCIP 1209	Transportation System Sensor Objects	Message
	NTCIP 1210	Objects for Signal Systems Master	Message
	NTCIP 1211	Objects for Signal Control Priority	Message
	NTCIP 1301	Message Set for Weather Reports	Message
	NTCIP 1401	TCIP - Common Public Transportation Business Area Standard	Message
	NTCIP 1402	TCIP - Incident Management Business Area Standard	Message
	NTCIP 1403	TCIP - Passenger Information Business Area Standard	Message

SDO	Document ID	Title	Type
AASHTO/ITE/NEMA (continued)	NTCIP 1404	TCIP - Scheduling/Runcutting Business Area Standard	Message
	NTCIP 1405	TCIP - Spatial Representation Business Area Standard	Message
	NTCIP 1406	TCIP - Onboard Business Area Standard	Message
	NTCIP 1407	TCIP - Control Center Business Area Standard	Message
	NTCIP 1408	TCIP - Fare Collection Business Area Standard	Message
	Various	NTCIP Center-to-Center Standards Group	Communication
	Various	NTCIP Center-to-Field Standards Group	Communication
ASTM	ASTM 5 GHz Data Link	Standard Specification for 5.9 GHz Data Link Layer	Communication
	ASTM 5 GHz Phys	Standard Specification for 5.9 GHz Physical Layer	Communication
	ASTM DD 17.54.00.2	ADMS Data Dictionary Specifications	Data
	ASTM PS 105-99	Specification for Dedicated Short Range Communication Data Link Layer: Medium Access and Logical Link Control	Communication
	ASTM PS 111-98	Specification for Dedicated Short Range Communication Physical Layer using Microwave in the 902-928 MHz	Communication
EIA/CEA	CEA/EIA-794	Data Radio Channel System	Communication
	CEA/EIA-795	Subcarrier Traffic Information Channel System	Communication
IEEE	IEEE P1512.1	Standard for Traffic Incident Management Message Sets for Use by EMCs	Message
	IEEE P1512.2	Standard for Public Safety IMMS for use by EMCs	Message
	IEEE P1512.3	Standard for Hazardous Material IMMS for use by EMCs	Message
	IEEE P1512.a	Standard for Emergency Management Data Dictionary	Data
	IEEE P1512-2000	Standard for Common Incident Management Message Sets for use by EMCs	Message
	IEEE P1556	Security/Privacy of Vehicle/RS Communications including Smart Card Communications	Communication
	IEEE Std 1455-1999	Standard for Message Sets for Vehicle/Roadside Communications	Message
ITE	ITE TM 1.03	Standard for Functional Level Traffic Management Data Dictionary	Data
	ITE TM 2.01	Message Sets for External TMC Communication	Message

SDO	Document ID	Title	Type
SAE	SAE J1746	ISP-Vehicle Location Referencing Standard	Data
	SAE J2313	On-Board Land Vehicle Mayday Reporting Interface	Message
	SAE J2353	Data Dictionary for Advanced Traveler Information System	Data
	SAE J2354	Message Set for Advanced Traveler Information System	Message
	SAE J2369	Standard for Advanced Traveler Information System Message Sets Delivered Over Bandwidth Restricted Media	Message
	SAE J2529	Rules for Standardizing Street Names and Route IDs	Message
	SAE J2540	Messages for Handling Strings and Look-Up Tables in Advanced Traveler Information System Standards	Message

4.6 Phases of Implementation

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

A sequence of projects and recommended time frames has been identified in the Corpus Christi Regional ITS Deployment Plan. These projects have been sequenced over a 20-year period, with projects identified for deployment in a 5-, 10-, and 20-year timeframe.

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

- Network Surveillance;
- Surface Street Control;
- Freeway Control;
- Road Weather Data Collections;
- Transit Vehicle Tracking;
- Broadcast Traveler Information; and
- ITS Data Warehouse.

In addition to the above market packages, the implementation of an appropriate communications system in the Region to support ITS is critical for continued deployment of projects.

5. OPERATIONAL CONCEPT

The operational concept for the Corpus Christi Region provides a description of the stakeholders' roles and responsibilities in the operation of the systems that exist or that are being proposed. This operational concept provides an "executive summary" view of the way the Corpus Christi Region's systems will work together, and it documents the roles and responsibilities for each of the services that the intelligent transportation system will provide. The approach to describing the operational concept is to present specific operational scenarios that describe and define the stakeholders' general roles in providing the services.

In addition to the operational scenarios that illustrate the roles and responsibilities of each agency, a list of the key agencies that are responsible for operations in the eight ITS areas is presented. This list will serve as a high level overview of the different roles and responsibilities in this operational concept. In addition, specific roles and coordination requirements for operations are illustrated through the customized market package diagrams presented in **Appendix A**.

With the integration, information sharing, and in some cases joint operations of systems, there will likely be a requirement for agency agreements. Descriptions of potential agreements that may be needed in the Corpus Christi Region are included in Section 5.3.

5.1 Operational Scenarios

Scenario 1

The first operational scenario describes how ITS technologies may be used during a major evacuation due to a hurricane. In this operational scenario, freeways in the urban areas of the Corpus Christi Region have been instrumented with CCTV cameras, detectors, DMS, and lane control signals. Connections between the City of Corpus Christi TOC, TxDOT Corpus Christi District TMC, City of Corpus Christi EOC, and other key agencies have been established. Road weather information system (RWIS) stations have been installed in areas that are prone to flooding or high winds. All the systems are continuously monitored using an integrated network of detection and monitoring systems providing real-time information to the Corpus Christi TOC and the TxDOT TMC. At the TxDOT TMC the surveillance information is assimilated and "packaged" so it can be effectively disseminated to the public through the Corpus Christi Region's traveler information system.

A hurricane is approaching the City of Corpus Christi and an alert is put out to citizens to begin evacuating the area. TxDOT monitors the freeway conditions through CCTV cameras and vehicle detectors to determine the level of congestion on roadways. DMS provide up to date information to motorist as they head inland on I-37 or north on US 77, and highway advisory radio (HAR) provides longer more detailed messages. The arterial streets are also closely monitored by the City of Corpus Christi Street Services through VIVDS at intersections as well as CCTV cameras on arterial streets. The data and camera feeds that TxDOT and the City of Corpus Christi have access to are shared with other key agencies, such as DPS, City of Corpus Christi Police and Fire, and the Corpus Christi EOC. The EOC alerts the RTA of a need to use their buses to assist with evacuations. Through AVL on the buses, all vehicles can be tracked and their location verified.

As the hurricane grows nearer and the evacuation traffic increases, a joint decision is made by local and state agencies to use all lanes of I-37 and US 77. Through a common radio frequency, all agencies are in communication together to coordinate this effort. TxDOT uses lane control

signals to indicate which lanes are open as well as DMS to warn vehicles that may be traveling in the wrong direction. As the rain begins falling, TxDOT and the City of Corpus Christi monitor their RWIS stations for flooding. Information from TCOON Data Collection Center is also provided to TxDOT and the EOC on weather conditions. Due to safety concerns, TxDOT decides to evacuate personnel from the TxDOT TMC. Monitoring and control of the TxDOT ITS infrastructure is switched to the TxDOT San Antonio District. An automatic notice is sent to the Corpus Christi TOC, Corpus Christi EOC, Metrocomm, and the DPS to let them know the status of the TxDOT TMC.

Throughout the evacuation, data and camera feeds have been continuously sent to the media for broadcast alerts on traffic conditions. The improved accuracy of traveler information and the ability to monitor and control the freeway and arterial systems have contributed to the successful evacuation of the Corpus Christi Region.

Scenario 2

In the second scenario, a multi-vehicle crash has occurred on South Padre Island Drive (SPID) just as the afternoon rush hour is about to begin. Motorists call 911 from cell phones and Metrocomm is quickly informed of the crash. An alert is automatically sent from Metrocomm to the City of Corpus Christi Street Services TMC and the TxDOT Corpus Christi TOC.   TxDOT activates DMSs and monitors the situation with a CCTV camera that is near the accident. The City of Corpus Christ Fire Department uses the video feed from TxDOT to determine the severity of the accident and the number and type of fire and rescue vehicles to dispatch. Using AVL on the fire vehicles, those vehicles that are closest to the scene with the appropriate equipment are dispatched. Christus Spohn Hospital is also put on alert through an automated message from Metrocomm so that they are aware of the possible incoming casualties.

Eastbound SPID is completely closed and the City of Corpus Christi police begin setting up a closure and detour. The City of Corpus Christi Street Services uses their closed loop signal system to implement a timing plan from the Corpus Christi TOC on alternate routes along the arterials to accommodate the large increases in traffic volume.

TxDOT enters the closure on the Highway Condition Reporting System, which also feeds the statewide 511 traveler information number. DMS and HAR continue to warn motorist that eastbound SPID is closed. The CCTV camera feed, which has been turned away from the crash to focus on the traffic condition on the freeway, is shared with the media which broadcasts the live shots of SPID on the evening news to warn motorist that eastbound SPID is still closed.

5.2 Roles and Responsibilities

The operational scenarios described in the previous section illustrate the interagency cooperation and coordination that is required in two situations that might occur in the Corpus Christi Region. During any operational scenario, a number of agencies will be required to coordinate closely to perform their operational responsibilities. The key agencies that have a lead role or responsibility during operations are listed below for each ITS area. It is recognized that a number of other agencies will also need to be involved during a scenario in addition to the ones listed below, although it is not expected that these agencies will play as critical a role in operations.

Travel and Traffic Management

- City of Corpus Christi (Police, Street Services)
- County Road and Bridge
- Other Texas Department of Transportation Districts
- Texas Department of Public Safety
- Texas Department of Transportation

Public Transportation Management

- Independent School Districts
- Regional Transportation Authority
- Rural Transit Providers

Electronic Payment

- Not Applicable

Commercial Vehicle Operations

- Texas Department of Public Safety
- Texas Department of Transportation

Emergency Management

- City of Corpus Christi (Police, Fire, Emergency Operations Center, Street Services)
- City/County Public Safety Agencies (Emergency Operations Center, Public Safety Dispatch)
- Port of Corpus Christi Authority
- Regional Hospitals
- Texas Department of Public Safety
- Texas Department of Transportation

Advanced Vehicle Safety System Needs

- Not Applicable

Information Management

- City of Corpus Christi (Future Joint City/County/RTA Data Warehouse)
- Coastal Bend Council of Governments
- Corpus Christi MPO
- Texas Department of Transportation

Maintenance and Construction Operations

- City of Corpus Christi (Street Services)
- County Road and Bridge
- Texas Department of Transportation

5.3 Corpus Christi Agreements

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

Currently, there are no formal agreements in place in the Corpus Christi Region with regards to ITS. Stakeholders indicated that while there is a high degree of cooperation among agencies, there hasn't been a need for formal agreements to facilitate multi-jurisdictional resource sharing and cooperation. With the implementation of ITS technologies, integrating systems from one or more agencies, the anticipated level of information exchange identified in the architecture, it is likely that more formal agreements will be needed. These agreements, while perhaps not requiring a financial commitment from agencies in the Region, should outline specific roles, responsibilities, data exchanges, levels of authority, and other facets of regional operations. Some agreements also will outline specific funding responsibilities, where appropriate and applicable.

Table 8 provides a list of potential agreements for the Corpus Christi Region based on the interfaces identified in the Regional Architecture. It is important to note that as ITS services and systems are implemented in the Region, part of the planning and review process for those projects should include a review of potential agreements that would be needed for implementation or operations.

Table 8 – Potential Agreements for the Corpus Christi Region

Agreement and Agencies	Status	Agreement Description	Considerations
Data Sharing and Usage (Public) TxDOT Corpus Christi District and Public Agencies within the Region	Future	This agreement would define the parameters, guidelines and policies for inter- and intra-agency ITS data sharing. This data sharing would support regional activities related to traffic management, incident management, and traveler information, and other functions. Data also would include video images from CCTV cameras. The terms of this agreement should generally address such items as: ▪ Types of data and information to be shared ▪ Repository for information (i.e., TxDOT Corpus Christi TMC as central hub) ▪ How the information will be used (traffic incident management, displayed on web site for travel information, distributed to private media, etc.) ▪ Parameters for data format, quality, security	These agreements are typically zero-dollar agreements, in that there is no charge among agencies for the actual data, although there might be some cost incurred for infrastructure, systems or fiber to enable communications between agencies.
Data Sharing and Usage (Public-Private) TxDOT Corpus Christi District and Private Media/Information Service Providers	Future	This agreement would define the parameters, guidelines and policies for private media use of regional ITS-related information from TxDOT Corpus Christi. This type of agreement is recommended between TxDOT (data provider) and the media (data user) to define terms of use for broadcasting public-agency information regarding traffic conditions, closures, restrictions, as well as video images. Agreements can also include requirements for the media to 'source' the information (i.e., using the TxDOT logo on all video images broadcast).	These agreements can be zero-dollar agreements, although some agencies have stipulated identifying the information, public service announcements by the media, or other requirements as a term of use. The private media entity is typically responsible for paying any necessary costs for access (i.e., communications infrastructure to link to the TxDOT database or video switch). These agreements also typically include a sunset clause to allow the agency to periodically review the agreement and make any modifications prior to renewal.

Table 8 – Potential Agreements for the Corpus Christi Region

Agreement and Agencies	Status	Agreement Description	Considerations
Shared Video Monitoring (Public) TxDOT Corpus Christi District, City of Corpus Christi, Corpus Christi EOC, MetroComm Dispatch, State EOC	Future	This agreement would enable shared video monitoring of TxDOT CCTV cameras by public safety and emergency services agencies in the Corpus Christi Region for incident management purposes. This agreement would define the parameters and policies for public safety agencies to access video images via the TxDOT video switch. It is recommended that the agreement include any TxDOT policies relating to video images (including archiving, privacy, disclaimers, use of video and redistribution) as well as processes for agency requests for specific views. Shared video monitoring does not address shared use or shared control of video equipment functions.	These agreements are typically zero-dollar agreements, in that there is no charge among agencies for the actual data, although there might be some cost incurred for infrastructure, systems or fiber to enable communications between agencies, particularly with the high bandwidth required for transmitting live video images.
Mutual Aid Agreements (Public) TxDPS, TxDOT Corpus Christi District, Corpus Christi Police, Corpus Christi Fire, Corpus Christi EOC	Existing (Informal)	Mutual aid agreements currently exist as informal arrangements in the Corpus Christi Region, although they are a routine practice among public safety and emergency services agencies. Formal mutual aid agreements will become more important as agencies integrate systems and capabilities, particularly automated dispatch and notification.	These agreements are typically zero-dollar agreements, although there might be some funding required to support regional incident management activities. The agreement also would outline resource commitments that would be part of any mutual aid arrangement (personnel, equipment, facilities, etc.).
Joint Operations/Shared Control Agreements (Public) TxDOT Corpus Christi District, City of Corpus Christi, TxDPS (potential)	Future	These agreements are formal arrangements to allow joint operations or control of certain systems and equipment. The agreement would need to define the terms of this arrangement, such as hours of operation and time of day/time of week where shared control would take effect, circumstances or incidents where shared control would take effect, notification procedures between the agencies agreeing to shared control arrangements, etc. Additional agencies (such as TxDPS) could be part of a joint operations/shared control agreement for certain types of devices.	Joint operations/shared control agreements could consider some form of mutual funding for certain system elements, primarily communication links.