State of Texas
Regional ITS Architectures and Deployment Plans

San Angelo Region

Regional ITS Architecture Report

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AASHTO	American Association of State Highway and Transportation Officials
ADMS	Archived Data Management Subsystem
ASTM	American Society for Testing and Materials
ATIS	Advanced Travel Information System
ATMS	Advanced Traffic Management System
AVL	Automated Vehicle Location
BCBP	Bureau of Customs and Border Protection
BRINSAP	Bridge Inventory Inspection System
CAD	Computer-Aided Dispatch
CC	Control Center
CCTV	Closed-Circuit Television
CEA	Consumer Electronics Association
CPT	Common Public Transportation
CV	Commercial Vehicle
CVCOG	Concho Valley Council of Governments
CVISN	Commercial Vehicle Information Systems and Networks
DARC	Data Radio Channel
DMS	Dynamic Message Sign
DMV	Department of Motor Vehicles
DPS	Department of Public Safety
DSRC	Dedicated Short Range Communications
EIA	Electronic Industries Association
EMS	Emergency Medical Services
EOC	Emergency Operations Center
ETMCC	External TMC Communication
EV	Emergency Vehicle
FC	Fare Collection
FHWA	Federal Highway Administration
GIS	Geographic Information System

LIST OF ACRONYMS

HAR	Highway Advisory Radio
HAZMAT	Hazardous Materials
HCRS	Highway Condition Reporting System
HRI	Highway-Rail Intersections
I/F	Interface
IEEE	Institute of Electrical and Electronics Engineers
IM	Incident Management
IMMS	Incident Management Message Sets
ISP	Information Service Provider
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
MCM	Maintenance and Construction Management
MCV	Maintenance and Construction Vehicle
MDT	Mobile Data Terminal
MOU	Memorandum of Understanding
MS	Message Sets
NEMA	National Electrical Manufacturers Association
NOAA	National Oceanic and Atmospheric Administration
NTCIP	National Transportation Communications for ITS Protocol
OB	Onboard
PI	Passenger Information
PSAP	Public Safety Access Point
PTMS	Public Transportation Management System
PWD	Public Works Department
SAE	Society of Automotive Engineers
SAMPO	San Angelo Metropolitan Planning Organization
SDO	Standards Development Organization
SP	Spatial Representation
STIC	Subcarrier Traffic Information Channel

LIST OF ACRONYMS

STS	Specialized Transportation Service
TCIP	Transit Communication Interface Protocol
TEA-21	Transportation Equity Act for the 21st Century
TM	Traffic Management
TMC	Traffic Management Center
TMDD	Traffic Management Data Directory
TOC	Traffic Operations Center
TxDOT	Texas Department of Transportation
USDOT	United States Department of Transportation
USGS	United States Geological Survey
VIVDS	Video Image Vehicle Detection Systems

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 San Angelo Region was the fifteenth in the series of Regional ITS Architectures to be prepared as part of this initiative.

The San Angelo Region is made up of the TxDOT San Angelo District. The San Angelo Region is bordered by the TxDOT Abilene District to the north, the TxDOT Laredo and San Antonio Districts to the south, the TxDOT Brownwood and Austin Districts to the east, and the TxDOT Odessa District to the west.

The Architecture development for the San Angelo Region followed a comprehensive process focused on stakeholder outreach and education, identifying market packages and interfaces tailored to the needs of the San Angelo 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 San Angelo Region over the next 20 years.

Stakeholders from throughout the Region participated in the development of the Regional ITS Architecture, including representatives from TxDOT, cities, counties, transit agencies, the metropolitan planning organization and council of governments, and federal agencies. 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. High priority needs focused on traffic management, traffic information dissemination, emergency management, and public transportation management.

Market packages were selected that corresponded to the desired services and functions identified for the Region, and were customized for San Angelo Region agencies and equipment. These market packages included high priority 'foundation' services and functions, such as network surveillance and traveler information, as well as market packages to address coordination needs, including incident management and regional emergency response. 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 San Angelo Region.

An interconnect diagram, or "Sausage Diagram," was developed for the San Angelo 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 San Angelo 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 San Angelo 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 San Angelo Region also were identified as part of the architecture development process.

An Operational Concept for the San Angelo 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 San Angelo Region. Potential agreements that could be required for maintenance and operations, data sharing (among agencies and with the private sector), or joint operations are listed.

The Regional ITS Architecture for the San Angelo 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, cities, counties, transit agencies, the metropolitan planning organization and council of governments, and federal agencies. A series of five meetings were held with the ITS stakeholders to discuss the development and gather input into the San Angelo Regional ITS Architecture and Deployment Plan. In addition, a project web site was developed which contains all of the information on the San Angelo 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 San Angelo 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 San Angelo Region have been identified. An operational concept has been developed that focuses on the roles and responsibilities of the various agencies involved in the San Angelo Region. A separate ITS Deployment Plan was developed that identifies projects in the San Angelo Region that are required to implement the architecture.

1.2 Document Overview

The San Angelo 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 San Angelo Region, as well as an overview of some of the key features and stakeholders in the San Angelo Region.

Section 2 – Integration Strategy

This section discusses San Angelo 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. Stakeholders and their contact information are also included.

Section 3 – Regional ITS Architecture Development Process

An overview of the key steps involved in developing the ITS architecture for the San Angelo 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 San Angelo Regional ITS Architecture. The inventory of existing and planned systems is presented in Section 4, and is sorted by stakeholder as well as by entity for easy reference. The market packages that were selected for the San Angelo Region are also included in this section, as are the system functional requirements. The San Angelo 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 San Angelo 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 San Angelo Region. As part of this concept, operational scenarios are described and roles and responsibilities of stakeholders are discussed. Potential public-public and public-private agreements also have been identified.

The San Angelo Regional ITS Architecture also contains two appendices:

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

A web site has been established that contains the architecture documentation, inventories, interconnects, market packages, interfaces, and functional requirements. This web site can be accessed from www.consystec.com, and by selecting the link to the Texas Regional ITS Architecture Home Page, and then San Angelo Region. The web site provides hyperlinks to more detailed information about the San Angelo Regional ITS Architecture than what could feasibly be included in the printed document. In certain sections of the document, readers are referred to the web site for additional information and details. At the time this report was published, the San Angelo 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.

1.3 The San Angelo Region

1.3.1 Geographic Overview

The San Angelo Region is bordered by the TxDOT Abilene District to the north, the TxDOT Laredo and San Antonio Districts to the south, the TxDOT Brownwood and Austin Districts to the east, and the TxDOT Odessa District to the west. For the San Angelo Regional ITS Architecture and Deployment Plan, the study area included all 15 counties that comprise the TxDOT San Angelo District. The geographic boundaries of the San Angelo Region are highlighted in **Figure 1**.

The counties included in the San Angelo Region area are:

- Coke;
- Concho;
- Crockett;
- Edwards;
- Glasscock;
- Irion;
- Kimble;
- Menard;
- Reagan;
- Real;
- Runnels;
- Schleicher;
- Sterling;
- Sutton; and
- Tom Green.

San Angelo is one of the largest cities in the United States that does not benefit from direct access to an Interstate Highway. U.S. and State Highways provide excellent access to the area from I-10, 64 miles to the south, and I-20, approximately 80 miles to the north.

TxDOT partners with local governments for roadway construction, maintenance, and traffic operations support, and serves as the responsible agency for on-system roadways in cities with populations less than 50,000. The City of San Angelo is the only city in the project Region with a population that exceeds the 50,000 threshold. The City of San Angelo maintains their own traffic signals.

1.3.2 Transportation Infrastructure

As illustrated in **Figure 1**, the San Angelo Region has an extensive transportation infrastructure. The primary roadway facilities include I-10, US-67, US-83, US-87, US-190, US-277, and US-377.

I-10 is an east-west, divided interstate highway. The effective operation of this highway is critical to the movement of goods and people through the State of Texas and the United States. I-10 starts in Jacksonville, Florida at I-95 and ends in Santa Monica, California at

the Pacific Ocean. Blockages along I-10 can have serious implications for drive-time for commercial vehicles and motorists alike due to the lack of obvious alternate routes. Knowing the road and travel conditions within this transportation corridor and having the ability to disseminate this information to motorists are important elements for this project. For example, if I-10 has been closed 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 or wait to begin their travels.

San Angelo is served by the Texas Pacifico Nuevo Railroad, a shortline railroad operating between the major U.S. railroads in Fort Worth and the U.S./Mexico border crossing at Presidio, Texas and Ojinaga, Mexico in the State of Chihuahua.

The San Angelo Street Railroad Company is operated by the City of San Angelo. In addition, San Angelo is served by two motor bus lines with direct schedules to all major cities in Texas and the nation, which include Kerrville Bus Lines and Sunset Stages. Concho Coaches provides daily van service to the Midland-Odessa Airport.
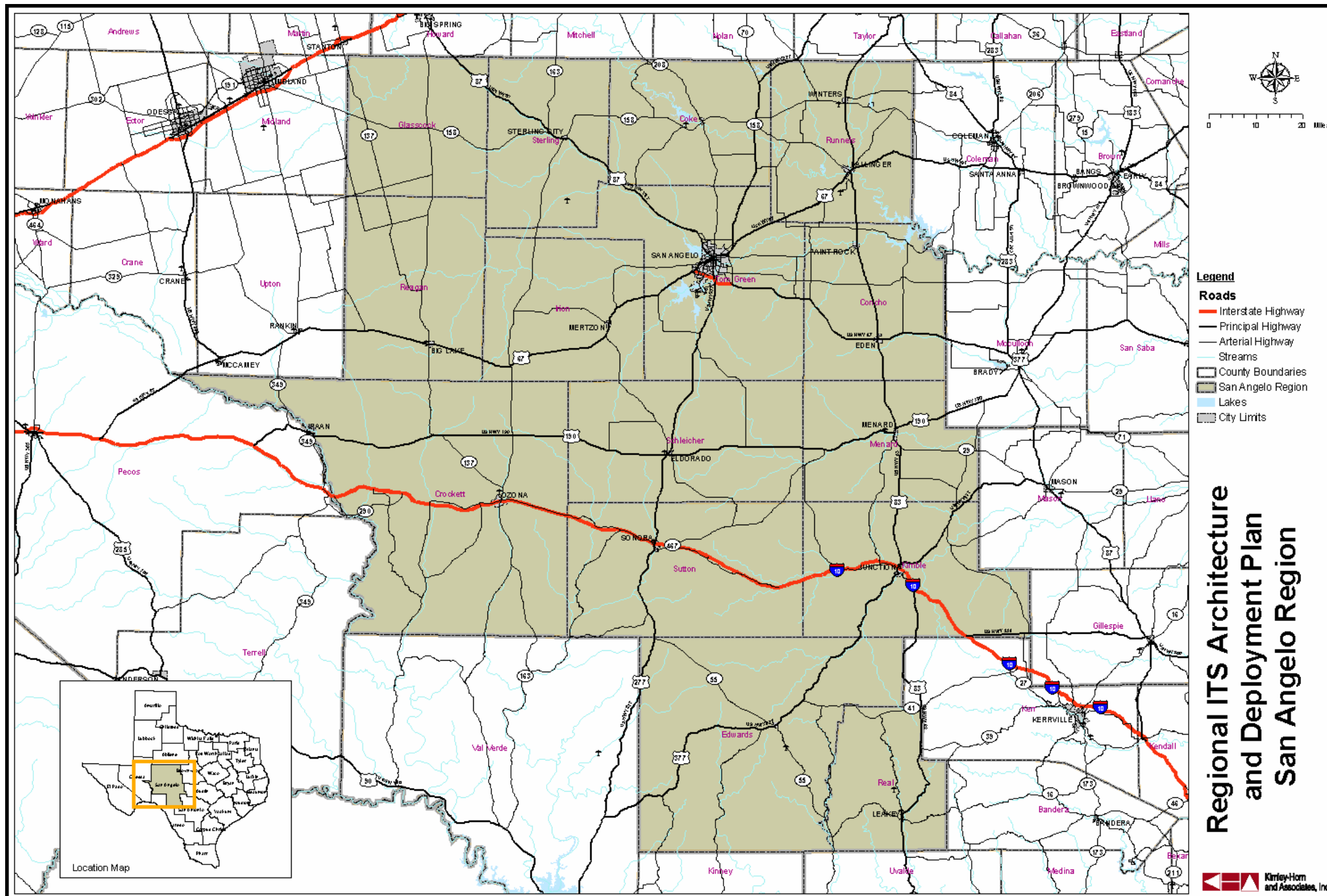
Figure 1 – San Angelo Region Map

1.3.3 San Angelo Region ITS Plans

Currently, there is limited deployment of ITS in the San Angelo Region. It is important to recognize the initial deployment of ITS infrastructure in a Region because in order for that Region to receive federal funding for ITS projects, the United States Department of Transportation (USDOT) requires that the Region have an ITS architecture by April 2005. This requirement is only for Regions with existing ITS infrastructure deployed. For Regions that do not have any ITS infrastructure deployed, the USDOT requires that they have an ITS architecture within four years of their first ITS project entering final design. As the San Angelo 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.

Travel and Traffic Management

TxDOT operates their traffic management center from the TxDOT Signal Shop at the TxDOT San Angelo District complex.

TxDOT is using video image vehicle detection systems (VIVDS) at two intersections within the Region. 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 can place a call for service of the appropriate phase for that vehicle.

Over-height truck detection is utilized by the TxDOT San Angelo district in one location in the Region.

The City of San Angelo currently utilizes a closed loop signal system to manage their traffic signals.

Public Transportation Management

The City of San Angelo's bus system, referred to as the San Angelo Street Railroad Company, uses a computer aided dispatch system and is operated through the City of San Angelo.

The Thunderbird Rural Public Transportation System is operated through the Concho Valley Council of Governments (CVCOG) and uses radio/cell dispatch. The Thunderbird Transportation System currently offers Rural Public Transportation and Medicaid Transportation services in the counties of Coke, Concho, Crockett, Irion, Kimble, McCulloch, Menard, Reagan, Schleicher, Sterling, Sutton, and Tom Green.

Commercial Vehicle Operations

The Texas Department of Public Safety (DPS) utilizes weigh stations in the Region to assist in enforcement of motor vehicle laws.

Incident and Emergency Management

Currently, the City of San Angelo has signal preemption installed at intersections within the city limits for fire and police vehicles. Emergency vehicle preemption works when a vehicle equipped with a preemption emitter approaches an intersection and the detector activates a change in signal timing to allow fast and safe passage.

CVCOG is responsible for implementing and providing 911 service to the following counties in the Concho Valley: Coke, Concho, Crockett, Irion, Kimble, Mason, McCulloch, Menard, Reagan, Schleicher, Sterling, Sutton, and Tom Green.

DPS and the County/City 911 Public Safety Access Point (PSAP) have implemented Computer Aided Dispatch (CAD) systems. CAD systems enhance dispatch capabilities and allow dispatch records and any incident information entered by the dispatcher to be saved for future reference in a dispatch log.

The San Angelo Police Department has mobile data terminals (MDTs) for communications between their dispatch center and the individual police vehicles.

The City of San Angelo has a website and a public access channel which provide a means to inform travelers of weather and roadway conditions.

The National Oceanic and Atmospheric Administration (NOAA) Weather Radio is used frequently to advise residents of forecasted weather conditions and to alert listeners to storm warnings and watches.

The City of San Angelo operates a central dispatch center and also hosts an Emergency Operations Center (EOC) for both the City and Tom Green County. The Regional EOC is operated in the Region by the Regional Emergency Management Agency.

Information Management

TxDOT obtains traffic count data from count stations located on State Highways around the region.

Geographic information systems (GIS) mapping is maintained by the CVCOG.

Maintenance and Construction Management

TxDOT currently has several portable dynamic message signs (DMS) in the San Angelo Region. These are operated by TxDOT and are used to display incident and construction related messages.

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 San Angelo Region.

The following is a list of stakeholders in the San Angelo 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 San Angelo Regional ITS Architecture.

- Angelo State University;
- City of Fort Stockton;
- City of San Angelo;
- Concho County;

- Concho Valley Council of Governments;
- Concho Valley Rural Transit District;
- Goodfellow Air Force Base;
- Irion County;
- Kimble County;
- National Weather Service;
- San Angelo Community Medical Center;
- San Angelo Metropolitan Planning Organization (SAMPO);
- Tom Green County;
- TxDOT Odessa District;
- TxDOT Public Transportation Division;
- TxDOT San Angelo District;
- TxDOT San Antonio District;
- TxDOT Traffic Operations Division; and
- US Geological Survey.

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 San Angelo Region.

For each operating agency or stakeholder entity identified through the development of the Regional ITS Architecture, there are operations that currently exist as a normal practice in order to accomplish the primary business goals and objectives for each stakeholder. As an example, a primary operation of the City of San Angelo Police Dispatch is to dispatch emergency personnel to the appropriate locations when a call for help is placed within the city. The integration of the dispatch with any of the other stakeholders will not change this primary function of the dispatch or disrupt typical business practices. The integration of the City of San Angelo Police Dispatch with another agency, such as the TxDOT San Angelo 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.

This section will provide an overview of the major issues and stakeholders' needs within the San Angelo Region and the primary areas of concern that were uncovered in the preparation of the San Angelo Regional ITS Architecture. This section also will discuss the need for interregional integration with agencies external to the San Angelo Region, such as the need for integration with other TxDOT Districts.

A key step in developing any regional ITS architecture is the identification of major stakeholders in the Region. Key stakeholder agencies that participated in the development of the San Angelo 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.

Table 1 – San Angelo Stakeholder Agencies and Contacts

Stakeholder Agency	Contact	Address	Phone Number	E-Mail
Angelo State University	James Adams	1905 S. Johnson San Angelo, Texas 76904	325-942-2071	james.adams@angelo.edu
City of Fort Stockton	Daniel Valenzuela	121 West 2nd Street Fort Stockton, Texas 79735	432-336-8525	N/A
City of San Angelo	Alonzo Carrasco	1729-B St. Ann Street San Angelo, Texas 76905	325-657-4377	sasignal@wcc.net
City of San Angelo	Noe Flores	700 E. Ave. K San Angelo, Texas 76903	325-657-4281	N/A
City of San Angelo Police Department	Mark Englert	401 E Beauregard San Angelo, Texas 76903	325-657-4464	mark.englert@sanangelopolice.org

Table 1 – San Angelo Stakeholder Agencies and Contacts (continued)

Stakeholder Agency	Contact	Address	Phone Number	E-Mail
Concho County	Allen Amos	152 N. Roberts Ave. Paint Rock, Texas 76866	325-732-4321	conchojudge@yahoo.com
Concho Valley Council of Governments	Hilda Arredondo-Garibay	5002 Knickerbocker Road San Angelo, Texas 76904	325-944-9666	hilda@cvcog.org
Concho Valley Council of Governments	Jeffery Sutton	5002 Knickerbocker Road San Angelo, Texas 76904	325-944-9666	jsutton@cvcog.org
Concho Valley Rural Transit District	Robert Stephens	5002 Knickerbocker Road San Angelo, Texas 76904	325-944-9666	rob@cvcog.org
Goodfellow AFB	James Creighton	460 E Kearney Blvd San Angelo, Texas 76908	325-654-5718	james.creighton@goodfellow.af.mil
Irion County	Leon Standard	209 N. Park View Mertzon, Texas 76941	325-835-4361	leon.standard@co.irion.tx.us
Kimble County	Delbert Roberts	501 Main Junction, Texas 76849	325-446-2724	N/A
National Weather Service	Hector Guerrero	San Angelo Weather Forecast Office 7654 Knickerbocker Road San Angelo, Texas 76904	325-944-3030	hector.guerrero@noaa.gov
National Weather Service	Jason Johnson	San Angelo Weather Forecast Office 7654 Knickerbocker Road San Angelo, Texas 76904	325-944-3030	jason.johnson@noaa.gov
National Weather Service	Curt Kockx	San Angelo Weather Forecast Office 7654 Knickerbocker Road San Angelo, Texas 76904	325-944-3030	curt.kockx@noaa.gov
San Angelo Community Medical Center	Samuel Feazell	3501 Knickerbocker Road San Angelo, Texas 76904	325-949-9511	N/A
San Angelo Metropolitan Planning Organization	Alicia Ramirez	P.O. Box 1751 San Angelo, Texas 76902	325-657-4210	aramirez@sanangelompo.org
San Angelo Metropolitan Planning Organization	E'Lisa Smetana	P.O. Box 1751 San Angelo, Texas 76902	325-657-4210	smetanae@sanangelompo.org
Tom Green County	Michael Brown	112 W Beauregard San Angelo, TX 76903	325-653-3318	mike.brown@co.tom-green.tx.us
TxDOT Odessa District	Robert Martinez	3901 E. Hwy 80 Odessa, Texas 79761	432-498-4748	N/A
TxDOT Public Transportation Division	Ben Herr	125 E. 11th Street Austin, Texas 78701-2483	512-416-2812	lherr@dot.state.tx.us
TxDOT San Angelo District	John DeWitt	4502 Knickerbocker Road San Angelo, Texas 76904	325-947-9265	jdewitt@dot.state.tx.us
TxDOT San Angelo District	Juan Flores	2802 Armstrong San Angelo, Texas 76903	325-653-5811	jflore2@dot.state.tx.us

Table 1 – San Angelo Stakeholder Agencies and Contacts (continued)

Stakeholder Agency	Contact	Address	Phone Number	E-Mail
TxDOT San Angelo District	Donna Hill	4502 Knickerbocker Road San Angelo, Texas 76904	325-947-9206	dhill1@dot.state.tx.us
TxDOT San Angelo District	Edwin Kloboucnik	4502 Knickerbocker Road San Angelo, Texas 76904	325-947-9213	eklobou@dot.state.tx.us
TxDOT San Angelo District	Walter McCullough	4502 Knickerbocker Road San Angelo, Texas 76904	325-944-1501	wmccull@dot.state.tx.us
TxDOT San Angelo District	Angie Ortegon	4502 Knickerbocker Road San Angelo, Texas 76904	325-947-9211	aortego@dot.state.tx.us
TxDOT San Angelo District	Donald Peterson	2802 Armstrong San Angelo, Texas 76903	325-653-5811	dpeters@dot.state.tx.us
TxDOT San Angelo District	Tommy Robinson	4502 Knickerbocker Road San Angelo, Texas 76904	325-944-1501	trobins@dot.state.tx.us
TxDOT San Angelo District	Hilario Rodarte	708 US 277 North Sonora, Texas 76950	325-387-3166	hrodart@dot.state.tx.us
TxDOT San Angelo District	Diane Weishuhn	4502 Knickerbocker Road San Angelo, Texas 76904	325-947-9285	dweishu@dot.state.tx.us
TxDOT San Angelo District	Dennis Wilde	4502 Knickerbocker Road San Angelo, Texas 76904	325-944-1501	dwilde@dot.state.tx.us
TxDOT San Antonio District	David Rodrigues	3500 NW Loop 410 San Antonio, Texas 78229	210-738-0111	drodri@dot.state.tx.us
TxDOT Traffic Operations Division	Alesia Gamboa	Attn: TRF-Cedar Park #51 125 East 11th Street Austin, Texas 78701-2483	512-506-5154	agamboa@dot.state.tx.us
USGS	Dave Holmes	3010 Buchanan Wichita Falls, Texas 76308	940-692-4283	dholmes@usgs.gov
USGS	Jimmy Pond	944 Arroyo Drive San Angelo, Texas 76903	325-944-4600	jgpond@usgs.gov

2.2 Regional Needs

Needs from the Region were identified in the project kick-off meeting held on October 2, 2003. Stakeholders participating in that meeting identified the needs in the Region according to the eight user service areas defined in the National ITS Architecture. The needs identified in the project kick-off meeting are documented in **Table 2**.

Table 2 – San Angelo Region: Summary of ITS Needs

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San Angelo Region
Summary of ITS Needs
San Angelo Regional ITS Architecture and Deployment Plan Kick-Off Meeting
October 2, 2003

Travel and Traffic Management Needs

- Need pager activated school zone flashers
- Need low water crossing flood detection system in southern area of Region
- Need DMS on I-10, US 87 and other key routes in area
- Need highway advisory radio (HAR) improvements
- Need signage to educate driving public about ways to obtain more information on roadway conditions
- Need ice detection
- Need increased public information/education/awareness
- Need weather stations (coordinate with USGS)
- Need road condition information available at rest areas
- Need increased media coordination for information dissemination
- Need improved coordination with NOAA
- Need interagency communication

Public Transportation Management Needs

- Need electronic fare payment for San Angelo Street Railroad Company
- Need automated vehicle location (AVL) for Thunderbird Transit

Electronic Payment Needs

None Identified

Commercial Vehicle Operations Needs

- Commercial Vehicle Information Systems and Networks (CVISN) will address commercial vehicle operations needs for the Region

Emergency Management Needs

- Need communication with Texas Forest Service
- Need automated call out system for Concho Valley COG area
- Need Regional Emergency Management Plan (in progress)
- Need Regional Emergency Operations Center (EOC)
- Need communications connection from EOC to TxDOT
- Need to improve interagency communications

Advanced Vehicle Safety Systems Needs

None Identified

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Table 2 – San Angelo Region: Summary of ITS Needs (continued)

Information Management Needs (Data Archiving)

- Need to coordinate with USGS to maximize use of available data
- Need improved accident data management
- Need to coordinate data sharing between agencies, possibly a web-based clearinghouse

Maintenance and Construction Management Needs

- Need semi-permanent DMS
- Need additional portable DMS
- Need ice detection information

2.3 Regional Integration and Interoperability

A vision for the San Angelo Region is to integrate systems both on an intra-regional and an inter-regional basis. Within the San Angelo Region, nearly every stakeholder identified is involved in emergency management. Management of incidents that occur on major roadways either in the San Angelo Region or on roadways that could impact the movement of people and goods in the San Angelo Region should be shared. The integration of the State EOC and the local EOCs can facilitate the clearing of such an incident more efficiently. As an example, a chemical spill along I-10 between San Antonio and El Paso 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 local EOCs status reports on the clean-up and potential timing for return to normal operations.

The San Angelo Region is bordered by seven other TxDOT Districts. Improved coordination with these surrounding Districts for incident management and roadway closures is a very important need in San Angelo. Coordination with the TxDOT San Antonio, Odessa, and El Paso Districts for incidents and closures on I-10 is especially critical to the Region.

Road closures due to maintenance or incidents also lead to a number of opportunities for improved operations through integration. TxDOT and other transportation agencies would like to be able to share this information throughout the Region so that as soon as one agency is aware of a closure, whether planned or unplanned, other agencies can also be made aware of the closure and make appropriate plans.

Operators of the transportation system have many opportunities to improve performance through integration. San Angelo Street Railroad Company and Thunderbird Transit can improve performance and schedule adherence by integrating closure information from operators of the transportation network.

Systems such as TxDOT's Highway Condition Reporting System (HCRS) provide an integrated method to gather consistent traveler information on a statewide basis. This type of system could eventually feed into a 511 traveler information number that would provide consistent traveler information throughout the state.

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 San Angelo 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 commonalities 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 San Angelo 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 San Angelo Process

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

Prior to the 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.
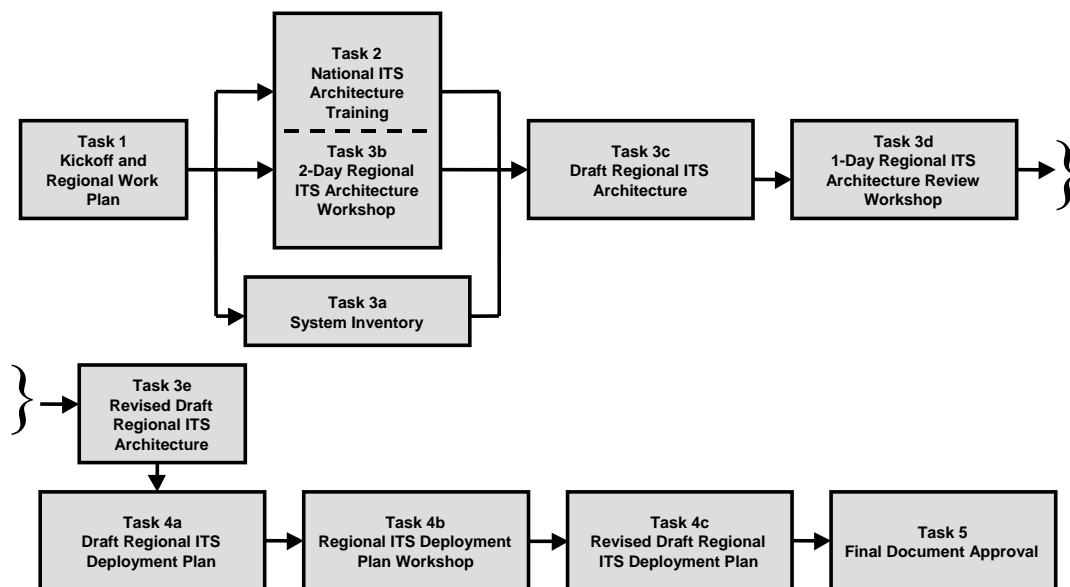
Figure 2 – San Angelo Regional ITS Architecture and Deployment Plan Development Process

A total of five meetings and workshops with stakeholders over a period of eleven months were used to develop the San Angelo Regional ITS Architecture and Deployment Plan. These meetings and workshops 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 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 San Angelo 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 San Angelo 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 the selection and editing of these elements. The result of the 2-Day Regional ITS Architecture Workshop was a Regional ITS Architecture for San Angelo, 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 San Angelo 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 San Angelo 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 San Angelo Regional ITS Architecture.
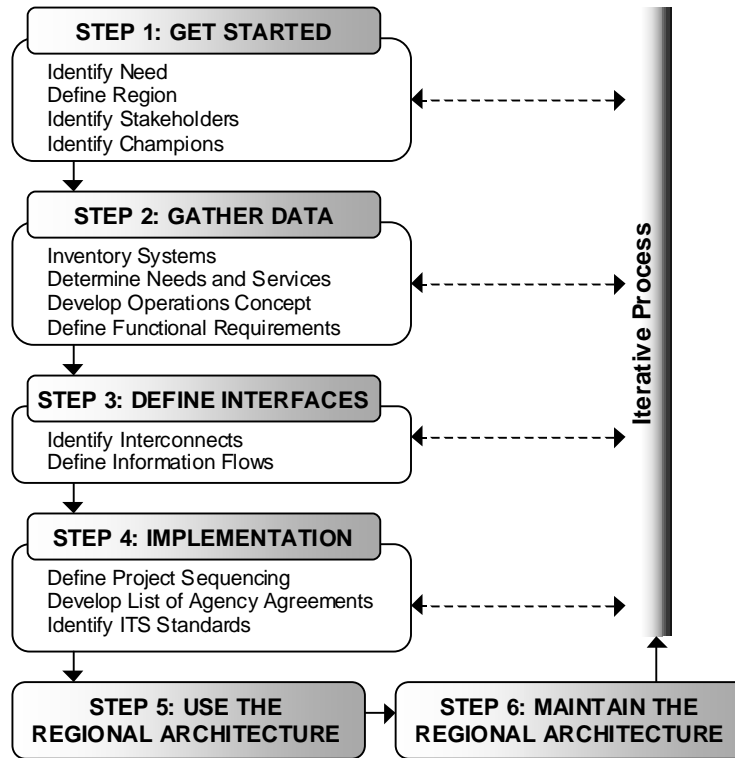
Task 4B – Regional ITS Deployment Plan Workshop: The Draft Regional ITS Deployment Plan was presented to stakeholders at the Regional ITS Deployment Plan Workshop. Stakeholders were asked to provide input on the recommended projects, priority, and deployment timeframe.

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 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.

STEP 1: GET STARTED
Identify Need
Define Region
Identify Stakeholders
Identify Champions

STEP 2: GATHER DATA
Inventory Systems
Determine Needs and Services
Develop Operations Concept
Define Functional Requirements

STEP 3: DEFINE INTERFACES
Identify Interconnects
Define Information Flows

STEP 4: IMPLEMENTATION
Define Project Sequencing
Develop List of Agency Agreements
Identify ITS Standards

STEP 5: USE THE REGIONAL ARCHITECTURE

STEP 6: MAINTAIN THE REGIONAL ARCHITECTURE

Iterative Process

(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

The process used to develop the San Angelo 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 San Angelo 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 San Angelo 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. Based on the envisioned information exchanges and integration outlined in the Regional ITS Architecture, potential agreements were identified.

4. CONCEPTUAL DESIGN

4.1 Systems Inventory

An important initial step 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, San Angelo 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 San Angelo Region were identified in the following categories:

- *Travel and Traffic Management* – includes state traffic management center, center-to-center links, detection systems, closed-circuit television (CCTV), fixed and portable dynamic message signs, broadcast traveler information, and other related technologies.
- *Public Transportation Management* – includes transit and paratransit automated vehicle location, and transit travel information systems.
- *Commercial Vehicle Operations* – includes weigh-in-motion and hazardous materials management.
- *Emergency Management* – includes emergency operations/management centers and improved information sharing among traffic and emergency services.
- *Information Management* – includes electronic data management and archiving systems.
- *Maintenance and Construction Management* – includes road weather information systems, and automated vehicle location for maintenance vehicles.

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 San Angelo 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 San Angelo 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, and ice), telecommunications systems, and government reporting systems, among others.
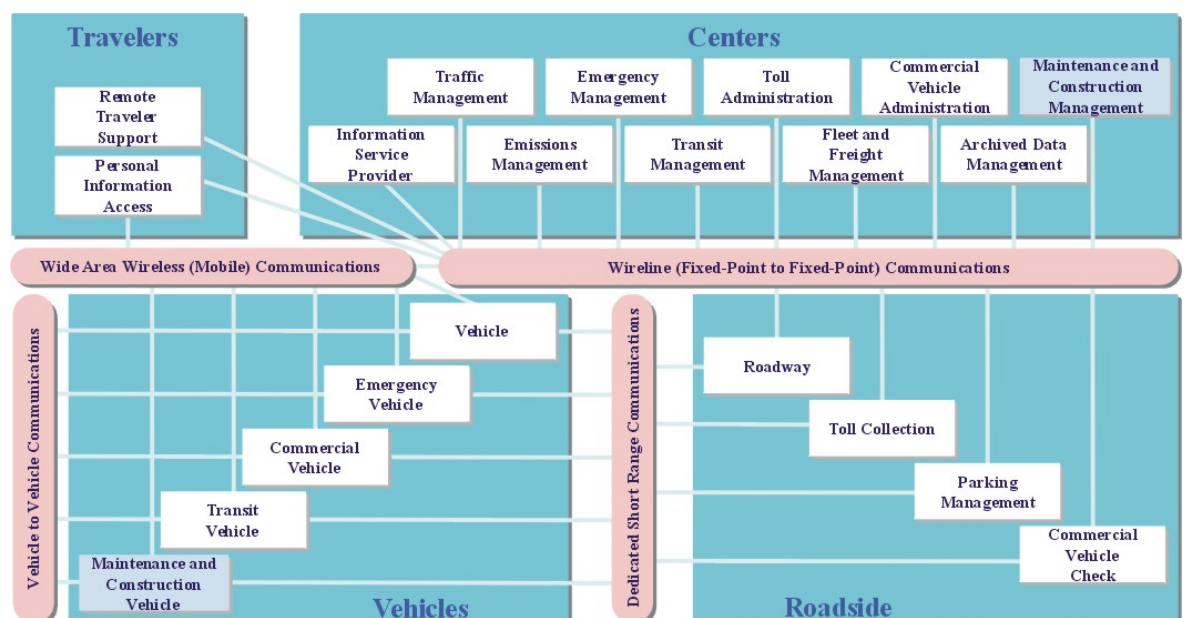
Figure 4 – Physical Subsystem Interconnect Diagram

4.1.2   San Angelo 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 San Angelo Region. **Table 3** sorts the inventory by stakeholder, so each stakeholder can easily identify and review all their relevant assets that are identified in the San Angelo Regional ITS Architecture.

The information in **Table 3** also is included on the San Angelo ITS Architecture web site, which is accessible by selecting the link to the Texas Regional ITS Architecture, the San Angelo 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 San Angelo 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 San Angelo ITS Inventory by Entity

The San Angelo 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 San Angelo 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 San Angelo Regional ITS Architecture web site by selecting the "Inventory by Entity" button.

Table 3 – San Angelo Inventory of Regional Subsystems/Terminators (sorted by Stakeholder)

Stakeholder	Element	Entity	Status
Angelo State University	Angelo State University	Event Promoters	Future
	Angelo State University Police Dispatch	Emergency Management Subsystem	Existing
Bureau of Customs and Border Protection (BCBP)	Bureau of Customs and Border Protection Office	Emergency Management Subsystem	Existing
City of San Angelo	City of San Angelo Convention and Visitors Bureau	Event Promoters	Existing
	City of San Angelo Crash Database	Archived Data Management Subsystem	Existing
	City of San Angelo Equipment Repair	Equipment Repair Facility	Existing
	City of San Angelo Local Government Channel	Information Service Provider Subsystem	Existing
	City of San Angelo Public Information Office	Information Service Provider Subsystem	Existing
	City of San Angelo Public Safety Communications	Emergency Management Subsystem	Existing
	City of San Angelo Public Safety Communications	Enforcement Agency	Existing
	City of San Angelo Public Safety Communications	Traffic Management Subsystem	Existing
	City of San Angelo Public Works Dispatch	Maintenance and Construction Management Subsystem	Existing
	City of San Angelo Public Works Vehicles	Maintenance and Construction Vehicle Subsystem	Existing
	City of San Angelo School Pager System	Roadway Subsystem	Existing
	City of San Angelo Website	Information Service Provider Subsystem	Existing
	Mathis Field Regional Airport	Multimodal Transportation Service Provider	Existing
	San Angelo/Tom Green County EOC	Emergency Management Subsystem	Existing
	San Angelo Chamber of Commerce Visitors Center	Remote Traveler Support Subsystem	Future
City of San Angelo Traffic Services Department	City of San Angelo Field Equipment	Roadway Subsystem	Existing
	City of San Angelo Traffic Operations Center	Traffic Management Subsystem	Existing
	City of San Angelo Vehicle Maintenance Shop	Equipment Repair Facility	Existing
Colorado River Municipal Water District	Colorado River Municipal Water District	Maintenance and Construction Management Subsystem	Existing

Stakeholder	Element	Entity	Status
Commercial Vehicle Operators	Commercial Vehicles	Commercial Vehicle Subsystem	Existing
	Private Fleet Management Systems	Fleet and Freight Management Subsystem	Future
Correctional Facilities	Correctional Facilities Operations	Emergency Management Subsystem	Existing
County Emergency Management Agencies	County EOC	Emergency Management Subsystem	Existing
County Road and Bridge	County Road and Bridge	Maintenance and Construction Management Subsystem	Existing
	County Road and Bridge Equipment Repair	Equipment Repair Facility	Existing
	County Road and Bridge Field Equipment	Roadway Subsystem	Existing
	County Road and Bridge Vehicles	Maintenance and Construction Vehicle Subsystem	Existing
County Sheriff	County Public Safety Dispatch	Emergency Management Subsystem	Existing
	County Public Safety Dispatch	Enforcement Agency	Existing
CVCOG	CVCOG Finance	Financial Institution	Existing
	CVCOG Website	Information Service Provider Subsystem	Existing
	Regional Transit Card	Traveler Card	Future
	Thunderbird Rural Public Transportation Dispatch	Transit Management Subsystem	Existing
	Thunderbird Rural Transit Vehicles	Transit Vehicle Subsystem	Existing
	Thunderbird Transit Ridership Database	Archived Data Management Subsystem	Future
DPS	DPS Administration	Emergency Management Subsystem	Existing
	DPS Communications Service	Emergency Management Subsystem	Existing
	DPS Division of Emergency Management	Emergency Management Subsystem	Existing
	DPS Emergency Vehicles	Emergency Vehicle Subsystem	Existing
	Statewide Crash Records Information System	Archived Data Management Subsystem	Existing
	Statewide Crash Records Information System Users	Archived Data User Systems	Existing
Financial Institution	City of San Angelo Finance Office	Financial Institution	Future

Stakeholder	Element	Entity	Status
Independent School Districts	Independent School District Buses	Transit Vehicle Subsystem	Existing
	Independent School District Dispatch	Transit Management Subsystem	Existing
Local Media	Local Print and Broadcast Media	Media	Existing
Lower Colorado River Authority	Lower Colorado River Authority	Maintenance and Construction Management Subsystem	Existing
Municipal or County Government	Municipal Visitors Center	Remote Traveler Support Subsystem	Future
	Municipal Websites	Information Service Provider Subsystem	Existing
Municipal or County Public Safety	County Emergency Vehicles	Emergency Vehicle Subsystem	Existing
	Municipal Emergency Vehicles	Emergency Vehicle Subsystem	Existing
	Municipal ITS Field Equipment	Roadway Subsystem	Future
	Municipal Public Safety Dispatch	Emergency Management Subsystem	Existing
	Municipal Public Safety Dispatch	Enforcement Agency	Existing
	Tom Green County Volunteer Fire Vehicles	Emergency Vehicle Subsystem	Existing
Municipal Public Works Department	Municipal PWD	Maintenance and Construction Management Subsystem	Existing
	Municipal PWD Vehicles	Maintenance and Construction Vehicle Subsystem	Existing
NOAA	San Angelo National Weather Service Office	Weather Service	Existing
Other Transit System Providers	Other Transit Systems	Transit Management Subsystem	Existing
Pipeline Companies	Pipeline Company Systems	Maintenance and Construction Management Subsystem	Existing
Private Ambulance	Private Ambulance Vehicle	Emergency Vehicle Subsystem	Existing
Private Information Service Providers	Private Sector Traveler Information Services	Information Service Provider	Future
Private Maintenance Contractor	Private Maintenance Contractor	Maintenance and Construction Management Subsystem	Existing
Private Taxi Providers	Private Taxi Provider Dispatch	Transit Management Subsystem	Existing
Private Tow/Wrecker Providers	Private Tow/Wrecker Dispatch	Emergency Management Subsystem	Existing

Stakeholder	Element	Entity	Status
Private Transit Providers	Private Transit Systems	Transit Management Subsystem	Existing
Private Travelers	Driver	Driver	Existing
	Private Travelers Personal Computing Devices	Personal Information Access Subsystem	Future
	Private Vehicles	Vehicle Subsystem	Existing
Rail Operators	Rail Operations Centers	Rail Operations	Existing
	Rail Operators Wayside Equipment	Wayside Equipment	Existing
Regional Emergency and Public Safety Agencies	Crash Records Users	Archived Data User Systems	Future
Regional Medical Center	Regional Medical Centers	Care Facility	Existing
SAMPO	SAMPO Crash Database	Archived Data Management Subsystem	Existing
	SAMPO Traffic Counts Archived Data Users	Archived Data User Systems	Future
	SAMPO Traffic Counts Database	Archived Data Management Subsystem	Future
	SAMPO Transportation Database	Archived Data Management Subsystem	Future
	SAMPO Transportation Warehouse Users	Archived Data User Systems	Future
	SAMPO Website	Information Service Provider	Existing
San Angelo Fire Department	City of San Angelo Fire and EMS Vehicles	Emergency Vehicle Subsystem	Existing
San Angelo Police Department	City of San Angelo Police Vehicles	Emergency Vehicle Subsystem	Existing
San Angelo Street Railroad Company	San Angelo Street Railroad Company Fixed Route Transit Vehicles	Transit Vehicle Subsystem	Existing
	San Angelo Street Railroad Company Point of Sale/ Customer Information Systems	Remote Traveler Support Subsystem	Existing
	San Angelo Street Railroad Company Ridership Database	Archived Data Management Subsystem	Existing
	San Angelo Street Railroad Company STS Vehicles	Transit Vehicle Subsystem	Existing
	San Angelo Street Railroad Company Transit Dispatch	Transit Management Subsystem	Existing
	Transit Database Users	Archived Data User Systems	Existing
State of Texas	Service Agencies	Information Service Provider	Existing

Stakeholder	Element	Entity	Status
Texas Department of Motor Vehicles	Texas DMV	DMV	Existing
Texas Forest Service	Texas Forest Service San Angelo	Emergency Management Subsystem	Existing
TxDOT	Other TxDOT District Maintenance Sections	Maintenance and Construction Management Subsystem	Existing
	Other TxDOT Districts TMCs	Traffic Management Subsystem	Existing
	TransGuide TMC	Traffic Management Subsystem	Existing
	TxDOT 511 System	Information Service Provider	Planned
	TxDOT BRINSAP	Asset Management	Existing
	TxDOT Fort Worth TMC (TransVision)	Traffic Management Subsystem	Existing
	TxDOT Highway Conditions Reporting System	Information Service Provider	Existing
	TxDOT Highway Conditions Reporting System	Maintenance and Construction Management Subsystem	Existing
	TxDOT Motor Carrier Routing Information	Information Service Provider	Existing
	TxDOT Public Transportation Division	Archived Data User Systems	Existing
	TxDOT Rest Areas/Visitor Centers/Truck Stops/Service Plaza Kiosks	Remote Traveler Support Subsystem	Planned
	TxDOT San Angelo District Area Engineers Office	Maintenance and Construction Administrative Systems	Existing
	TxDOT San Angelo District Area Engineers Office	Maintenance and Construction Management Subsystem	Existing
	TxDOT San Angelo District CCTV	Roadway Subsystem	Planned
	TxDOT San Angelo District DMS	Roadway Subsystem	Existing
	TxDOT San Angelo District Field Sensors	Roadway Subsystem	Existing
	TxDOT San Angelo District Maintenance Sections	Maintenance and Construction Management Subsystem	Existing
	TxDOT San Angelo District Maintenance Vehicles	Maintenance and Construction Vehicle Subsystem	Existing

Stakeholder	Element	Entity	Status
TxDOT (continued)	TxDOT San Angelo District Pavement Management System	Archived Data Management Subsystem	Existing
	TxDOT San Angelo District Pavement Management System	Asset Management	Existing
	TxDOT San Angelo District Pavement Management System Users	Archived Data User Systems	Existing
	TxDOT San Angelo District Public Information Office	Information Service Provider	Existing
	TxDOT San Angelo District Public Transportation Management System (PTMS)	Archived Data Management Subsystem	Existing
	TxDOT San Angelo District School Pager System	Roadway Subsystem	Planned
	TxDOT San Angelo District Shop	Equipment Repair Facility	Existing
	TxDOT San Angelo District TMC	Maintenance and Construction Management Subsystem	Existing
	TxDOT San Angelo District TMC	Traffic Management Subsystem	Existing
	TxDOT San Angelo District Traffic Signal Shop	Maintenance and Construction Management Subsystem	Existing
	TxDOT San Angelo District Traffic Signals	Roadway Subsystem	Existing
	TxDOT San Angelo District Web Page	Information Service Provider	Existing
	TxDOT San Angelo District Work Zone Equipment	Roadway Subsystem	Future
	TxDOT Statewide Pavement Management System	Archived Data Management Subsystem	Existing
	TxDOT Transportation Planning and Programming Division	Traffic Management Subsystem	Existing
US Air Force	Goodfellow Air Force Base Disaster Control Center	Emergency Management Subsystem	Existing
USGS	USGS Website	Information Service Provider	Existing
Utility Services	Utility Dispatch	Maintenance and Construction Management Subsystem	Existing

Table 4 – San Angelo Inventory of Regional Subsystems/Terminators (sorted by Entity)

Entity	Element	Stakeholder	Status
Archived Data Management Subsystem	City of San Angelo Crash Database	City of San Angelo	Existing
	SAMPO Crash Database	SAMPO	Existing
	SAMPO Traffic Counts Database	SAMPO	Future
	SAMPO Transportation Database	SAMPO	Future
	San Angelo Street Railroad Company Ridership Database	San Angelo Street Railroad Company	Existing
	Statewide Crash Records Information System	DPS	Existing
	Thunderbird Transit Ridership Database	CVCOG	Future
	TxDOT San Angelo District Pavement Management System	TxDOT	Existing
	TxDOT San Angelo District Public Transportation Management System (PTMS)	TxDOT	Existing
	TxDOT Statewide Pavement Management System	TxDOT	Existing
Archived Data User Systems	Crash Records Users	Regional Emergency and Public Safety Agencies	Future
	SAMPO Traffic Counts Archived Data Users	SAMPO	Future
	SAMPO Transportation Warehouse Users	SAMPO	Future
	Statewide Crash Records Information System Users	DPS	Existing
	Transit Database Users	San Angelo Street Railroad Company	Existing
	TxDOT Public Transportation Division	TxDOT	Existing
	TxDOT San Angelo District Pavement Management System Users	TxDOT	Existing
Asset Management	TxDOT BRINSAP	TxDOT	Existing
	TxDOT San Angelo District Pavement Management System	TxDOT	Existing
Care Facility	Regional Medical Centers	Regional Medical Center	Existing
Commercial Vehicle Subsystem	Commercial Vehicles	Commercial Vehicle Operators	Existing

Entity	Element	Stakeholder	Status
DMV	Texas DMV	Texas Department of Motor Vehicles	Existing
Driver	Driver	Private Travelers	Existing
Emergency Management Subsystem	Angelo State University Police Dispatch	Angelo State University	Existing
	Bureau of Customs and Border Protection Office	BCBP – Bureau of Customs and Border Protection	Existing
	City of San Angelo Public Safety Communications	City of San Angelo	Existing
	Correctional Facilities Operations	Correctional Facilities	Existing
	County EOC	County Emergency Management Agencies	Existing
	County Public Safety Dispatch	County Sheriff	Existing
	DPS Administration	DPS	Existing
	DPS Communications Service	DPS	Existing
	DPS Division of Emergency Management	DPS	Existing
	Goodfellow Air Force Base Disaster Control Center	US Air Force	Existing
	Municipal Public Safety Dispatch	Municipal or County Public Safety	Existing
	Private Tow/Wrecker Dispatch	Private Tow/Wrecker Providers	Existing
	San Angelo/Tom Green County EOC	City of San Angelo	Existing
	Texas Forest Service San Angelo	Texas Forest Service	Existing
Emergency Vehicle Subsystem	City of San Angelo Fire and EMS Vehicles	San Angelo Fire Department	Existing
	City of San Angelo Police Vehicles	San Angelo Police Department	Existing
	County Emergency Vehicles	Municipal or County Public Safety	Existing
	DPS Emergency Vehicles	DPS	Existing
	Municipal Emergency Vehicles	Municipal or County Public Safety	Existing
	Private Ambulance Vehicle	Private Ambulance	Existing
	Tom Green County Volunteer Fire Vehicles	Municipal or County Public Safety	Existing

Entity	Element	Stakeholder	Status
Enforcement Agency	City of San Angelo Public Safety Communications	City of San Angelo	Existing
	County Public Safety Dispatch	County Sheriff	Existing
	Municipal Public Safety Dispatch	Municipal or County Public Safety	Existing
Equipment Repair Facility	City of San Angelo Equipment Repair	City of San Angelo	Existing
	City of San Angelo Vehicle Maintenance Shop	City of San Angelo Traffic Services Department	Existing
	County Road and Bridge Equipment Repair	County Road and Bridge	Existing
	TxDOT San Angelo District Shop	TxDOT	Existing
Event Promoters	Angelo State University	Angelo State University	Future
	City of San Angelo Convention and Visitors Bureau	City of San Angelo	Existing
Financial Institution	City of San Angelo Finance Office	Financial Institution	Future
	CVCOG Finance	CVCOG	Existing
Fleet and Freight Management Subsystem	Private Fleet Management Systems	Commercial Vehicle Operators	Future
Information Service Provider	City of San Angelo Local Government Channel	City of San Angelo	Existing
	City of San Angelo Public Information Office	City of San Angelo	Existing
	City of San Angelo Website	City of San Angelo	Existing
	CVCOG Website	CVCOG	Existing
	Municipal Websites	Municipal or County Government	Existing
	Private Sector Traveler Information Services	Private Information Service Providers	Future
	SAMPO Website	SAMPO	Existing
	Service Agencies	State of Texas	Existing
	TxDOT 511 System	TxDOT	Planned
	TxDOT Highway Conditions Reporting System	TxDOT	Existing
	TxDOT Motor Carrier Routing Information	TxDOT	Existing
	TxDOT San Angelo District Public Information Office	TxDOT	Existing

Entity	Element	Stakeholder	Status
Information Service Provider Subsystem (continued)	TxDOT San Angelo District Web Page	TxDOT	Existing
	USGS Website	USGS	Existing
Maintenance and Construction Administrative Systems	TxDOT San Angelo District Area Engineers Office	TxDOT	Existing
Maintenance and Construction Management Subsystem	City of San Angelo Public Works Dispatch	City of San Angelo	Existing
	Colorado River Municipal Water District	Colorado River Municipal Water District	Existing
	County Road and Bridge	County Road and Bridge	Existing
	Lower Colorado River Authority	Lower Colorado River Authority	Existing
	Municipal PWD	Municipal Public Works Department	Existing
	Other TxDOT District Maintenance Sections	TxDOT	Existing
	Pipeline Company Systems	Pipeline Companies	Existing
	Private Maintenance Contractor	Private Maintenance Contractor	Existing
	TxDOT Highway Conditions Reporting System	TxDOT	Existing
	TxDOT San Angelo District Area Engineers Office	TxDOT	Existing
	TxDOT San Angelo District Maintenance Sections	TxDOT	Existing
	TxDOT San Angelo District TMC	TxDOT	Existing
	TxDOT San Angelo District Traffic Signal Shop	TxDOT	Existing
	Utility Dispatch	Utility Services	Existing
Maintenance and Construction Vehicle Subsystem	City of San Angelo Public Works Vehicles	City of San Angelo	Existing
	County Road and Bridge Vehicles	County Road and Bridge	Existing
	Municipal PWD Vehicles	Municipal Public Works Department	Existing
	TxDOT San Angelo District Maintenance Vehicles	TxDOT	Existing
Media	Local Print and Broadcast Media	Local Media	Existing
Multimodal Transportation Service Provider	Mathis Field Regional Airport	City of San Angelo	Existing
Personal Information Access Subsystem	Private Travelers Personal Computing Devices	Private Travelers	Future

Entity	Element	Stakeholder	Status
Rail Operations	Rail Operations Centers	Rail Operators	Existing
Remote Traveler Support Subsystem	Municipal Visitors Center	Municipal or County Government	Future
	San Angelo Chamber of Commerce Visitors Center	City of San Angelo	Future
	San Angelo Street Railroad Company Point of Sale/ Customer Information Systems	San Angelo Street Railroad Company	Existing
	TxDOT Rest Areas/Visitor Centers/Truck Stops/Service Plaza Kiosks	TxDOT	Planned
Roadway Subsystem	City of San Angelo Field Equipment	City of San Angelo Traffic Services Department	Existing
	City of San Angelo School Pager System	City of San Angelo	Existing
	County Road and Bridge Field Equipment	County Road and Bridge	Existing
	Municipal ITS Field Equipment	Municipal or County Public Safety	Future
	TxDOT San Angelo District CCTV	TxDOT	Planned
	TxDOT San Angelo District DMS	TxDOT	Existing
	TxDOT San Angelo District Field Sensors	TxDOT	Existing
	TxDOT San Angelo District School Pager System	TxDOT	Planned
	TxDOT San Angelo District Traffic Signals	TxDOT	Existing
	TxDOT San Angelo District Work Zone Equipment	TxDOT	Future
Traffic Management Subsystem	City of San Angelo Public Safety Communications	City of San Angelo	Existing
	City of San Angelo Traffic Operations Center	City of San Angelo Traffic Services Department	Existing
	Other TxDOT Districts TMCs	TxDOT	Existing
	TransGuide TMC	TxDOT	Existing
	TxDOT Fort Worth TMC (TransVision)	TxDOT	Existing
	TxDOT San Angelo District TMC	TxDOT	Existing
	TxDOT Transportation Planning and Programming Division	TxDOT	Existing

Entity	Element	Stakeholder	Status
Transit Management Subsystem	Independent School District Dispatch	Independent School Districts	Existing
	Other Transit Systems	Other Transit System Providers	Existing
	Private Taxi Provider Dispatch	Private Taxi Providers	Existing
	Private Transit Systems	Private Transit Providers	Existing
	San Angelo Street Railroad Company Transit Dispatch	San Angelo Street Railroad Company	Existing
	Thunderbird Rural Public Transportation Dispatch	CVCOG	Existing
Transit Vehicle Subsystem	Independent School District Buses	Independent School Districts	Existing
	San Angelo Street Railroad Company Fixed Route Transit Vehicles	San Angelo Street Railroad Company	Existing
	San Angelo Street Railroad Company STS Vehicles	San Angelo Street Railroad Company	Existing
	Thunderbird Rural Transit Vehicles	CVCOG	Existing
Traveler Card	Regional Transit Card	CVCOG	Future
Vehicle Subsystem	Private Vehicles	Private Travelers	Existing
Wayside Equipment	Rail Operators Wayside Equipment	Rail Operators	Existing
Weather Service	San Angelo National Weather Service Office	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 San Angelo Region. In the National ITS Architecture, services are referred to as market packages. Market packages could 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 a total of 75 market packages identified in the National ITS Architecture Version 4.0.

In the San Angelo 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. All of the market packages that stakeholders in the San Angelo Region selected for implementation in the Region are identified in **Table 5**, as well as the elements in the Region that serve a role in providing the market package service and the primary stakeholders responsible for implementing the market packages.

In several cases, there are multiple stakeholders in the Region that provide the same service at different levels. For example, Surface Street Control (ATMS03) could be provided on arterials by the City of San Angelo and by TxDOT on highways throughout the San Angelo District. The market packages status is identified as existing, planned, or future for each of the primary stakeholders in the Region. In many cases market packages classified as existing might still need to be enhanced to increase the service that the market package provides and establish all of the elements associated with it.

Upon selecting 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 the following section.

Table 5 – San Angelo Region Selected Market Packages

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
ATMS01	Network Surveillance	City of San Angelo Field Equipment	City of San Angelo	Future
		City of San Angelo Local Government Channel	TxDOT San Angelo District	Future
		City of San Angelo Public Information Office		
		City of San Angelo Public Safety Communications		
		City of San Angelo Traffic Operations Center		
		City of San Angelo Website		
		Private Sector Traveler Information Services		
		SAMPO Website		
		TxDOT San Angelo District CCTV		
		TxDOT San Angelo District Field Sensors		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Web Page		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
ATMS02	Probe Surveillance	Commercial Vehicles	TxDOT San Angelo District	Future
		Private Vehicles		
		TxDOT San Angelo District Field Sensors		
		TxDOT San Angelo District TMC		
ATMS03	Surface Street Control	City of San Angelo Field Equipment	City of San Angelo	Existing
		City of San Angelo School Pager System	TxDOT San Angelo District	Existing
		City of San Angelo Traffic Operations Center		
		TxDOT San Angelo District CCTV		
		TxDOT San Angelo District Field Sensors		
		TxDOT San Angelo District School Pager System		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Traffic Signals		
		TxDOT San Angelo District Web Page		
ATMS06	Traffic Information Dissemination	City of San Angelo Field Equipment	City of San Angelo	Future
		City of San Angelo Local Government Channel	TxDOT San Angelo District	Future
		City of San Angelo Public Information Office		
		City of San Angelo Public Safety Communications		
		City of San Angelo Public Works Dispatch		
		City of San Angelo Traffic Operations Center		
		City of San Angelo Website		
		County Public Safety Dispatch		
		County Road and Bridge		
		DPS Communications Service		
		Goodfellow Air Force Base Disaster Control Center		
		Independent School District Dispatch		
		Local Print and Broadcast Media		
		Municipal Public Safety Dispatch		
		Private Sector Traveler Information Services		
		Private Transit Systems		
		SAMPO Website		
		San Angelo Street Railroad Company Transit Dispatch		
		Thunderbird Rural Public Transportation Dispatch		
		TxDOT 511 System		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
ATMS06 (continued)	Traffic Information Dissemination (continued)	TxDOT San Angelo District Area Engineers Office		
		TxDOT San Angelo District DMS		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Web Page		
ATMS07	Regional Traffic Control	City of San Angelo Traffic Operations Center	TxDOT San Angelo District	Future
		Other TxDOT Districts TMCs		
		TransGuide TMC		
		TxDOT Fort Worth TMC (TransVision)		
		TxDOT San Angelo District TMC		
ATMS08	Incident Management System	Angelo State University	Transportation and Emergency Management Agencies	Future
		City of San Angelo Convention and Visitors Bureau		
		City of San Angelo Field Equipment		
		City of San Angelo Fire and EMS Vehicles		
		City of San Angelo Police Vehicles		
		City of San Angelo Public Safety Communications		
		City of San Angelo Public Works Dispatch		
		City of San Angelo Traffic Operations Center		
		Colorado River Municipal Water District		
		County Emergency Vehicles		
		County EOC		
		County Public Safety Dispatch		
		County Road and Bridge		
		DPS Communications Service		
		DPS Emergency Vehicles		
		Goodfellow Air Force Base Disaster Control Center		
		Independent School District Dispatch		
		Lower Colorado River Authority		
		Municipal Emergency Vehicles		
		Municipal Public Safety Dispatch		
		Municipal PWD		
		Other TxDOT District Maintenance Sections		
		Private Maintenance Contractor		
		Rail Operations Centers		
		San Angelo National Weather Service Office		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
ATMS08 (continued)	Incident Management System (continued)	San Angelo Street Railroad Company Transit Dispatch		
		Texas Forest Service San Angelo		
		Thunderbird Rural Public Transportation Dispatch		
		TxDOT San Angelo District Field Sensors		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District TMC		
ATMS13	Standard Railroad Grade Crossing	City of San Angelo Field Equipment	City of San Angelo	Future
		City of San Angelo Traffic Operations Center	TxDOT San Angelo District	Future
		Rail Operations Centers		
		Rail Operators Wayside Equipment		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Traffic Signals		
ATMS15	Railroad Operations Coordination	City of San Angelo Traffic Operations Center	City of San Angelo	Future
		Rail Operations Centers	TxDOT San Angelo District	Future
		TxDOT San Angelo District TMC		
ATMS19	Speed Monitoring	Driver	TxDOT San Angelo District	Future
		TxDOT San Angelo District DMS		
		TxDOT San Angelo District School Pager System		
		TxDOT San Angelo District TMC		
ATMS22	Red Light Running	City of San Angelo Field Equipment	City of San Angelo	Future
		City of San Angelo Public Safety Communications		
		City of San Angelo Traffic Operations Center		
		Texas DMV		
EM01	Emergency Response	Angelo State University Police Dispatch	Emergency Management Agencies	Future
		Bureau of Customs and Border Protection Office		
		City of San Angelo Public Safety Communications		
		Correctional Facilities Operations		
		County EOC		
		County Public Safety Dispatch		
		DPS Administration		
		DPS Communications Service		
		DPS Division of Emergency Management		
		Goodfellow Air Force Base Disaster Control Center		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
EM01 (continued)	Emergency Response (continued)	Municipal Public Safety Dispatch Private Sector Traveler Information Services Private Tow/Wrecker Dispatch San Angelo/Tom Green County EOC San Angelo Region Incident and Mutual Aid Network State EOC Texas Forest Service San Angelo		
EM02	Emergency Routing	City of San Angelo Field Equipment City of San Angelo Fire and EMS Vehicles City of San Angelo Police Vehicles City of San Angelo Public Safety Communications City of San Angelo Traffic Operations Center County Emergency Vehicles County Public Safety Dispatch DPS Communications Service DPS Emergency Vehicles Municipal Public Safety Dispatch Municipal Emergency Vehicles Private Ambulance Vehicle Regional Medical Centers Tom Green County Volunteer Fire Vehicles TxDOT San Angelo District TMC TxDOT San Angelo District Traffic Signals	City of San Angelo — Future Counties — Future DPS — Future Municipalities — Future TxDOT San Angelo District — Future	
MC01	Maintenance and Construction Vehicle Tracking	City of San Angelo Public Works Dispatch City of San Angelo Public Works Vehicles County Road and Bridge County Road and Bridge Vehicles Municipal PWD Municipal PWD Vehicles TxDOT San Angelo District Maintenance Sections TxDOT San Angelo District Maintenance Vehicles	City of San Angelo — Future Counties — Future Municipalities — Future TxDOT San Angelo District — Future	

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
MC02	Maintenance and Construction Vehicle Maintenance	City of San Angelo Equipment Repair	City of San Angelo	Future
		City of San Angelo Public Works Dispatch	Counties	Future
		City of San Angelo Public Works Vehicles	TxDOT San Angelo District	Future
		County Road and Bridge		
		County Road and Bridge Equipment Repair		
		County Road and Bridge Vehicles		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District Maintenance Vehicles		
		TxDOT San Angelo District Shop		
MC03	Road Weather Data Collection	San Angelo National Weather Service Office	TxDOT San Angelo District	Future
		TxDOT San Angelo District Field Sensors		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District TMC		
MC04	Weather Information Processing and Distribution	City of San Angelo Public Safety Communications	National Weather Service	Future
		City of San Angelo Public Works Dispatch	TxDOT San Angelo District	Future
		City of San Angelo Traffic Operations Center	USGS	Future
		County EOC		
		County Public Safety Dispatch		
		County Road and Bridge		
		DPS Communications Service		
		Independent School District Dispatch		
		Local Print and Broadcast Media		
		Municipal Public Safety Dispatch		
		Municipal PWD		
		San Angelo/Tom Green County EOC		
		San Angelo National Weather Service Office		
		San Angelo Street Railroad Company Transit Dispatch		
		Thunderbird Rural Public Transportation Dispatch		
		TxDOT Highway Conditions Reporting System		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District TMC		
		USGS Website		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
MC06	Winter Maintenance	City of San Angelo Local Government Channel	City of San Angelo	Future
			TxDOT San Angelo District	Future
		City of San Angelo Public Information Office		
		City of San Angelo Public Safety Communications		
		City of San Angelo Public Works Dispatch		
		City of San Angelo Website		
		County Public Safety Dispatch		
		DPS Communications Service		
		Independent School District Dispatch		
		Other TxDOT District Maintenance Sections		
		San Angelo National Weather Service Office		
		San Angelo Street Railroad Company Transit Dispatch		
		Thunderbird Rural Public Transportation Dispatch		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District Maintenance Vehicles		
		TxDOT San Angelo District Public Information Office		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Web Page		
MC07	Roadway Maintenance and Construction	City of San Angelo Field Equipment	City of San Angelo	Future
		City of San Angelo Public Safety Communications	Counties	Future
		City of San Angelo Public Works Dispatch	Municipalities	Future
		City of San Angelo Public Works Vehicles	TxDOT San Angelo District	Future
		City of San Angelo Traffic Operations Center		
		County Road and Bridge		
		County Road and Bridge Field Equipment		
		County Road and Bridge Vehicles		
		Municipal PWD		
		Municipal PWD Vehicles		
		TxDOT BRINSAP		
		TxDOT San Angelo District Area Engineers Office		
		TxDOT San Angelo District CCTV		
		TxDOT San Angelo District DMS		
		TxDOT San Angelo District Field Sensors		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
MC07 (continued)	Roadway Maintenance and Construction (continued)	TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District Maintenance Vehicles		
		TxDOT San Angelo District Pavement Management System		
		TxDOT San Angelo District School Pager System		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Traffic Signal Shop		
		TxDOT San Angelo District Traffic Signals		
		TxDOT San Angelo District Work Zone Equipment		
MC08	Work Zone Management	City of San Angelo Field Equipment	City of San Angelo	Future
		City of San Angelo Public Safety Communications	Counties	Future
		City of San Angelo Public Works Dispatch	Municipalities	Future
		City of San Angelo Public Works Vehicles	TxDOT San Angelo District	Future
		City of San Angelo Traffic Operations Center		
		County EOC		
		County Public Safety Dispatch		
		County Road and Bridge		
		County Road and Bridge Field Equipment		
		County Road and Bridge Vehicles		
		DPS Communications Service		
		Independent School District Dispatch		
		Municipal Public Safety Dispatch		
		Municipal PWD		
		Municipal PWD Vehicles		
		Other TxDOT District Maintenance Sections		
		Private Tow/Wrecker Dispatch		
		San Angelo Street Railroad Company Transit Dispatch		
		State EOC		
		Thunderbird Rural Public Transportation Dispatch		
		TxDOT Highway Conditions Reporting System		
		TxDOT San Angelo District Area Engineers Office		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
MC08 (continued)	Work Zone Management (continued)	TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District Maintenance Vehicles		
		TxDOT San Angelo District Public Information Office		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Web Page		
		TxDOT San Angelo District Work Zone Equipment		
		Utility Dispatch		
MC09	Work Zone Safety Monitoring	City of San Angelo Field Equipment	City of San Angelo	Future
		City of San Angelo Public Works Dispatch	Counties	Future
		City of San Angelo Public Works Vehicles	Municipalities	Future
		County Road and Bridge	TxDOT San Angelo District	Future
		County Road and Bridge Field Equipment		
		County Road and Bridge Vehicles		
		Municipal ITS Field Equipment		
		Municipal PWD		
		Municipal PWD Vehicles		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District Maintenance Vehicles		
		TxDOT San Angelo District Work Zone Equipment		
MC10	Maintenance and Construction Activity Coordination	Angelo State University Police Dispatch	City of San Angelo	Future
		City of San Angelo Public Safety Communications	Counties	Future
		City of San Angelo Public Works Dispatch	Municipalities	Future
		City of San Angelo Traffic Operations Center	TxDOT San Angelo District	Future
		City of San Angelo Website		
		County Public Safety Dispatch		
		County Road and Bridge		
		CVCOG Website		
		DPS Communications Service		
		Goodfellow Air Force Base Disaster Control Center		
		Independent School District Dispatch		
		Municipal Public Safety Dispatch		
		Municipal PWD		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
MC10 (continued)	Maintenance and Construction Activity Coordination (continued)	Municipal Websites		
		Other TxDOT District Maintenance Sections		
		Pipeline Company Systems		
		Private Sector Traveler Information Services		
		Private Tow/Wrecker Dispatch		
		SAMPO Website		
		San Angelo Street Railroad Company Transit Dispatch		
		Thunderbird Rural Public Transportation Dispatch		
		TxDOT Highway Conditions Reporting System		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District Public Information Office		
		TxDOT San Angelo District TMC		
		TxDOT San Angelo District Web Page		
		Utility Dispatch		
APTS1	Transit Vehicle Tracking	Independent School District Buses	Independent School Districts	Future
		Independent School District Dispatch		
		San Angelo Street Railroad Company Fixed Route Transit Vehicles	San Angelo Street Railroad Company	Future
		San Angelo Street Railroad Company STS Vehicles	Thunderbird Transit	Future
		San Angelo Street Railroad Company Transit Dispatch		
		Thunderbird Rural Public Transportation Dispatch		
		Thunderbird Rural Transit Vehicles		
APTS2	Transit Fixed-Route Operations	City of San Angelo Local Government Channel	Independent School Districts	Future
		City of San Angelo Public Works Dispatch	San Angelo Street Railroad Company	Future
		City of San Angelo Traffic Operations Center		
		City of San Angelo Website		
		County Road and Bridge		
		Independent School District Buses		
		Independent School District Dispatch		
		Municipal PWD		
		Private Sector Traveler Information Services		
		SAMPO Website		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
APTS2 (continued)	Transit Fixed-Route Operations (continued)	San Angelo Street Railroad Company Fixed Route Transit Vehicles		
		San Angelo Street Railroad Company Transit Dispatch		
		TxDOT 511 System		
		TxDOT San Angelo District TMC		
APTS3	Demand Response Transit Operations	City of San Angelo Local Government Channel	San Angelo Street Railroad Company	Future
		City of San Angelo Public Works Dispatch	Thunderbird Transit	Future
		City of San Angelo Traffic Operations Center		
		City of San Angelo Website		
		CVCOG Website		
		Private Sector Traveler Information Services		
		SAMPO Website		
		San Angelo Street Railroad Company STS Vehicles		
		San Angelo Street Railroad Company Transit Dispatch		
		Service Agencies		
		Thunderbird Rural Public Transportation Dispatch		
		Thunderbird Rural Transit Vehicles		
		TxDOT 511 System		
		TxDOT San Angelo District TMC		
APTS4	Transit Passenger and Fare Management	City of San Angelo Finance Office	San Angelo Street Railroad Company	Future
		CVCOG Finance	Thunderbird Transit	Future
		Regional Transit Card		
		San Angelo Street Railroad Company Fixed Route Transit Vehicles		
		San Angelo Street Railroad Company Transit Dispatch		
		San Angelo Street Railroad Transit Point of Sale/Customer Information Systems		
		Service Agencies		
		Thunderbird Rural Public Transportation Dispatch		
		Thunderbird Rural Transit Vehicles		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
APTS5	Transit Security	City of San Angelo Public Safety Communications	San Angelo Street Railroad Company	Future
		County Public Safety Dispatch	Thunderbird Transit	Future
		Municipal Public Safety Dispatch		
		San Angelo Street Railroad Company Transit Dispatch		
		San Angelo Street Railroad Transit Point of Sale/Customer Information Systems		
		Thunderbird Rural Public Transportation Dispatch		
APTS6	Transit Maintenance	City of San Angelo Vehicle Maintenance Shop	San Angelo Street Railroad Company	Future
		San Angelo Street Railroad Company Fixed Route Transit Vehicles	Thunderbird Transit	Future
		San Angelo Street Railroad Company STS Vehicles		
		San Angelo Street Railroad Company Transit Dispatch		
		Thunderbird Rural Public Transportation Dispatch		
		Thunderbird Rural Transit Vehicles		
APTS7	Multi-modal Coordination	Mathis Field Regional Airport	San Angelo Street Railroad Company	Future
		Other Transit Systems	Thunderbird Transit	Future
		Private Taxi Provider Dispatch		
		Private Transit Systems		
		San Angelo Street Railroad Company Fixed Route Transit Vehicles		
		San Angelo Street Railroad Company STS Vehicles		
		San Angelo Street Railroad Company Transit Dispatch		
		Thunderbird Rural Public Transportation Dispatch		
		Thunderbird Rural Transit Vehicles		
APTS8	Transit Traveler Information	City of San Angelo Website	San Angelo Street Railroad Company	Future
		CVCOG Website	Thunderbird Transit	Future
		Private Travelers Personal Computing Devices		
		SAMPO Website		
		San Angelo Street Railroad Company Transit Dispatch		
		San Angelo Street Railroad Transit Point of Sale/Customer Information Systems		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
APTS8 (continued)	Transit Traveler Information (continued)	Thunderbird Rural Public Transportation Dispatch TxDOT 511 System TxDOT Rest Areas/Visitor Centers/Truck Stops/Service Plaza Kiosks		
CVO10	HAZMAT Management	City of San Angelo Public Safety Communications Commercial Vehicles County Public Safety Dispatch DPS Communications Service Municipal Public Safety Dispatch Private Fleet Management Systems	Private Fleets DPS	Future Future
ATIS1	Broadcast Traveler Information	City of San Angelo Public Information Office City of San Angelo Public Works Dispatch City of San Angelo Traffic Operations Center City of San Angelo Website County Road and Bridge CVCOG Website Local Print and Broadcast Media Private Travelers Personal Computing Devices SAMPO Website San Angelo Chamber of Commerce Visitors Center San Angelo Street Railroad Company Transit Dispatch TxDOT 511 System TxDOT Rest Areas/Visitor Centers/Truck Stops/Service Plaza Kiosks TxDOT San Angelo District Area Engineers Office TxDOT San Angelo District Maintenance Sections TxDOT San Angelo District Public Information Office TxDOT San Angelo District TMC TxDOT San Angelo District Web Page	City of San Angelo SAMPO TxDOT San Angelo District	Future Future Future

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
ATIS5	ISP Based Route Guidance	City of San Angelo Traffic Operations Center	CVCOG	Future
		County Road and Bridge	TxDOT Motor Carrier	Future
		CVCOG Website		
		Municipal Visitors Center		
		Private Fleet Management Systems		
		San Angelo Chamber of Commerce Visitors Center		
		Thunderbird Rural Public Transportation Dispatch		
		TxDOT Motor Carrier Routing Information		
		TxDOT Rest Areas/Visitor Centers/Truck Stops/Service Plaza Kiosks		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District TMC		
AD1	ITS Data Mart	City of San Angelo Crash Database	City of San Angelo	Future
		City of San Angelo Public Safety Communications	DPS	Future
		City of San Angelo Traffic Operations Center	SAMPO	Future
		Crash Records Users	San Angelo Street Railroad Company	Future
		DPS Administration	Thunderbird Transit	Future
		SAMPO Crash Database	TxDOT San Angelo District	Future
		SAMPO Traffic Counts Archived Data Users		
		SAMPO Traffic Counts Database		
		San Angelo Street Railroad Company Transit Dispatch		
		San Angelo Street Railroad Transit Ridership Database		
		Statewide Crash Records Information System		
		Statewide Crash Records Information System Users		
		Thunderbird Rural Public Transportation Dispatch		
		Thunderbird Transit Ridership Database		
		Transit Database Users		
		TxDOT Public Transportation Division		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District Pavement Management System		

Table 5 – San Angelo Region Selected Market Packages (continued)

Market Package	Market Package Name	Elements Associated with Market Package	Primary Stakeholders Responsible for Implementation	Market Package Status
AD1 (continued)	ITS Data Mart (continued)	TxDOT San Angelo District Pavement Management System Users		
		TxDOT San Angelo District Public Transportation Management System (PTMS)		
		TxDOT San Angelo District TMC		
		TxDOT Statewide Pavement Management System		
		TxDOT Transportation Planning and Programming Division		
AD2	ITS Data Warehouse	City of San Angelo Public Works Dispatch	SAMPO	Future
		City of San Angelo Traffic Operations Center		
		County Road and Bridge		
		Mathis Field Regional Airport		
		Municipal PWD		
		Rail Operations Centers		
		SAMPO Transportation Database		
		SAMPO Transportation Warehouse Users		
		San Angelo Street Railroad Company Transit Ridership Database		
		Thunderbird Rural Public Transportation Ridership Database		
		TxDOT San Angelo District Maintenance Sections		
		TxDOT San Angelo District TMC		

4.3 Interconnections

4.3.1 Top Level Regional System Interconnect Diagram

A system interconnect diagram, or sausage diagram (shown previously in **Figure 4**), shows the systems and primary interconnects in the Region. The National ITS Architecture interconnect diagram has been customized for the San Angelo Region based on the information gathered from the stakeholders and system inventory. **Figure 5** summarizes the existing, planned, and future ITS elements for the San Angelo Region in the context of a physical interconnect. Subsystems and elements specific to San Angelo are called out in the boxes surrounding the main interconnect diagram, and these are color-coded to the subsystem to which they are associated.

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 |

Remote Traveler Support Subsystem
- *Municipal Visitors Center
- *San Angelo Chamber of Commerce Visitors Center
- San Angelo Street Railroad Company Point of Sale / Customer Information Systems
- *TxDOT Rest Areas/Visitor Centers/Service/Truck Stops/ Plaza Kiosks

Personal Information Access Subsystem
- *Private Travelers Personal Computing Devices

Transit Vehicle Subsystem
- Independent School District Buses
- San Angelo Street Railroad Company Fixed Route Transit Vehicles
- San Angelo Street Railroad Company STS Vehicles
- Thunderbird Rural Transit Vehicles

Vehicle Subsystem
- Private Vehicles

Commercial Vehicle Subsystem
- Commercial Vehicles

Maintenance and Const Vehicle Subsystem
- City of San Angelo Public Works Vehicles
- County Road and Bridge Vehicles
- Municipal PWD Vehicles
- TxDOT San Angelo District Maintenance Vehicles

Emergency Vehicle Subsystem
- City of San Angelo Fire and EMS Vehicles
- City of San Angelo Police Vehicles
- County Emergency Vehicles
- DPS Emergency Vehicles
- Municipal Emergency Vehicles
- Private Ambulance Vehicle
- Tom Green County Volunteer Fire Vehicles

Maintenance & Construction Management
- City of San Angelo Public Works Dispatch
- Colorado River Municipal Water District
- County Road and Bridge
- Lower Colorado River Authority
- Municipal PWD
- Other TxDOT District Maintenance Sections
- Pipeline Company Systems
- Private Maintenance Contractor
- TxDOT Highway Conditions Reporting System
- TxDOT San Angelo Dist. Area Engineers Office
- TxDOT San Angelo Dist. Maintenance Sections
- TxDOT San Angelo District TMC
- TxDOT San Angelo District Traffic Signal Shop
- Utility Dispatch

Fleet and Freight Management Subsystem
- *Private Fleet Management Systems

Emergency Management Subsystem
- Angelo State University Police Dispatch
- Bureau of Customs and Border Protection Office
- City of San Angelo Public Safety Communications
- Correctional Facilities Operations
- County EOC
- County Public Safety Dispatch
- DPS Administration
- DPS Communications Service
- DPS Division of Emergency Management
- Goodfellow Air Force Base Disaster Control Center
- Municipal Public Safety Dispatch
- Private Tow/Wrecker Dispatch
- San Angelo / Tom Green County EOC
- Texas Forest Service San Angelo

Information Service Provider Subsystem
- City of San Angelo Local Government Channel
- City of San Angelo Public Information Office
- City of San Angelo Website
- CVCOG Website
- Municipal Websites
- *Private Sector Traveler Information Services
- SAMPO Website
- Service Agencies
- *TxDOT 511 System
- TxDOT Highway Conditions Reporting System
- TxDOT Motor Carrier Routing Information
- TxDOT San Angelo District Public Info. Office
- TxDOT San Angelo District Web Page
- USGS Website

Transit Management Subsystem
- Independent School District Dispatch
- Other Transit Systems
- Private Taxi Provider Dispatch
- Private Transit Systems
- San Angelo Street Railroad Co. Transit Dispatch
- Thunderbird Rural Public Transportation Dispatch

Archived Data Management Subsystem
- City of San Angelo Crash Database
- SAMPO Crash Database
- *SAMPO Traffic Counts Database
- *SAMPO Transportation Database
- San Angelo Street Railroad Company Ridership Database
- Statewide Crash Records Information System
- *Thunderbird Transit Ridership Database
- TxDOT San Angelo District Pavement Management System
- TxDOT San Angelo Dist. Public Transportation Management System (PTMS)
- TxDOT Statewide Pavement Management System

Traffic Management Subsystem
- City of San Angelo Public Safety Communications
- City of San Angelo Traffic Operations Center
- Other TxDOT Districts TMCs
- TransGuide TMC
- TxDOT Fort Worth TMC (TransVision)
- TxDOT San Angelo District TMC
- TxDOT Transport. Planning & Programming Div.

Archived Data User Systems
- *Crash Records Users
- *SAMPO Traffic Counts Archived Data Users
- *SAMPO Transportation Warehouse Users
- Statewide Crash Records Info. System Users
- Transit Database Users
- TxDOT Public Transportation Division
- TxDOT San Angelo Dist. Pvmt. Mgmt. Sys. Users

Asset Management
- TxDOT BRINSAP
- TxDOT San Angelo Dist. Pavement Mgmt. Sys.

Care Facility
- Regional Medical Centers

DMV
- Texas DMV

Driver
- Driver

Enforcement Agency
- City of San Angelo Public Safety Comm.
- County Public Safety Dispatch
- Municipal Public Safety Dispatch

Equipment Repair Facility
- City of San Angelo Equipment Repair
- City of San Angelo Vehicle Maintenance Shop
- County Road and Bridge Equipment Repair
- TxDOT San Angelo District Shop

Event Promoters
- *Angelo State University
- City of San Angelo Convention & Visit. Bureau

Financial Institution
- *City of San Angelo Finance Office
- CVCOG Finance

Maintenance & Construction Admin
- TxDOT San Angelo Dist Area Engineers Office

Media
- Local Print and Broadcast Media

Multimodal Transportation Service Provider
- Mathis Field Regional Airport

Rail Operations
- Rail Operations Centers

Traveler Card
- *Regional Transit Card

Wayside Equipment
- Rail Operators Wayside Equipment

Weather Service
- San Angelo National Weather Service Office

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 Communications

Vehicle to Vehicle Communications

Vehicles: Vehicle; Transit Vehicle; Commercial Vehicle; Emergency Vehicle; Maintenance & Construction Vehicle

Dedicated Short Range Communications

Roadside: Roadway; Toll Collection; Parking Management; Commercial Vehicle Check

Terminators

Roadway Subsystem
- City of San Angelo Field Equipment
- City of San Angelo School Pager System
- County Road and Bridge Field Equipment
- *Municipal ITS Field Equipment
- *TxDOT San Angelo District CCTV
- TxDOT San Angelo District DMS

Roadway Subsystem
- TxDOT San Angelo District Field Sensors
- *TxDOT San Angelo District School Pager System
- TxDOT San Angelo District Traffic Signals
- *TxDOT San Angelo District Work Zone Equipment

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

Last Updated: October 7, 2004

Figure 5 – San Angelo Regional System Interconnect Diagram

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 San Angelo Region. Each market package is shown graphically, with the market package name, San Angelo-specific element, and with the unique agency and system identifiers within the subsystems and terminators. Market packages represent a service that will be deployed as an integrated capability. Market packages are often comprised of one or more equipment packages, which are functional capabilities that could be deployed at a specific time. Equipment packages are the most basic functions that will be developed or bought by implementers.

Figure 6 is an example of an Advanced Traffic Management System (ATMS) market package for Surface Street Control that has been customized for the TxDOT San Angelo District. This market package shows the two subsystems, Traffic Management and Roadway, and the associated entities (TxDOT San Angelo District Traffic Signals, TxDOT San Angelo District Field Sensors, etc.) for the TxDOT San Angelo District signal system. Data flows between the subsystems indicate what information is being shared.

Market packages that were customized for the San Angelo Region are shown in **Appendix A**. These market packages also are included on the San Angelo 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 San Angelo 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.
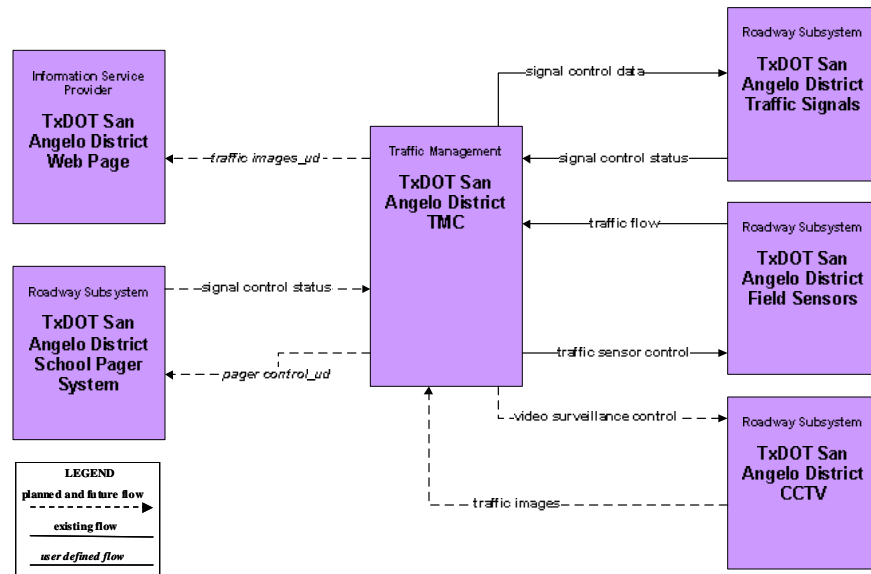
**Figure 6 – Custom Market Package for Surface Street Control**

4.3.3 San Angelo 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 San Angelo Region. The interconnect diagram shown previously in **Figure 5** showed the high-level relationships of the subsystems and terminators in the San Angelo 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 122 different elements identified as part of the San Angelo Regional ITS Architecture. These elements include traffic management centers, transit vehicles, dispatch systems, emergency management agencies, media outlets, and others – essentially, all of the existing and planned physical components that contribute to the regional intelligent transportation system. Interfaces have been identified for each element in the San Angelo Regional ITS Architecture, and each element has been mapped to those other elements with which it must interface. For example, the TxDOT San Angelo District Traffic Management Center (TMC) has existing or planned interfaces with 40 other elements in the TxDOT San Angelo District, ranging from field equipment and dispatch centers, to other TxDOT District TMCs. Other interfaces are far less complex, such as the interface between the DPS emergency vehicles and the DPS Communications Service.

An example of one of the system interfaces is shown in **Figure 7**. This graphic shows the TxDOT San Angelo District Traffic Signals 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 San Angelo 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.
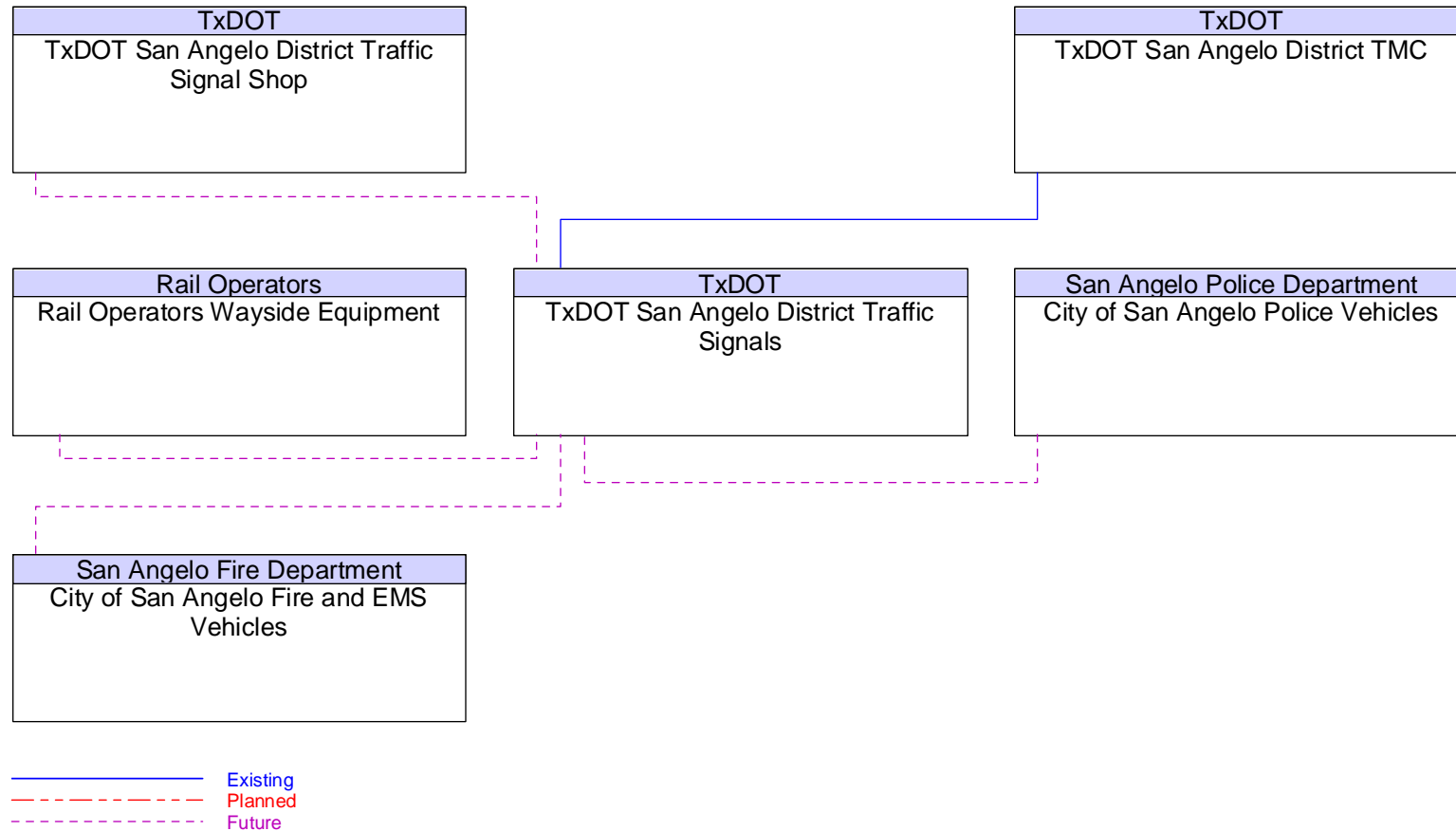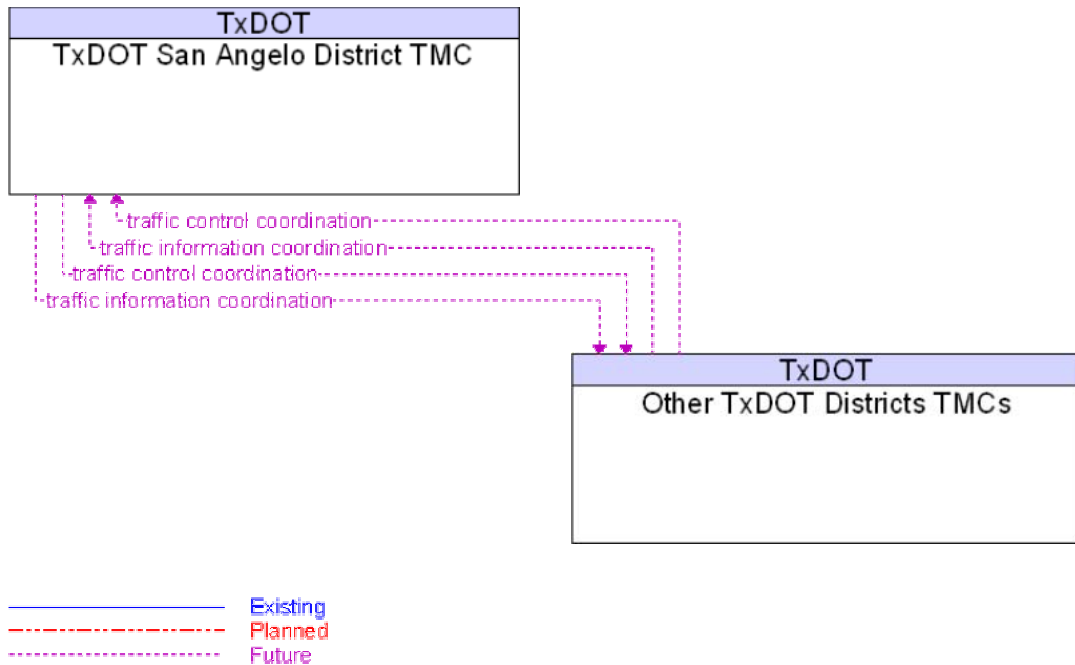
Figure 7 – TxDOT San Angelo District Traffic Signals Interface

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 San Angelo Regional ITS Architecture.

An example of the architecture flows between two elements is shown in **Figure 8**. In this interface, the flows between the TxDOT San Angelo District TMC and Other Texas Region TMCs show information that must go from the San Angelo District TMC to other Texas TMCs, as well as information that the District TMC 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 San Angelo 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 San Angelo Region are discussed in more detail in Section 4.5.

Figure 8 – TxDOT San Angelo District TMC to Other TxDOT Districts TMCs 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 San Angelo 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 San Angelo Regional ITS Architecture, functional requirements have been identified at two levels. The customized market packages, discussed previously 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 San Angelo has to do and the data that needs to be shared among elements.

At a more detailed level, functional requirements for the San Angelo Region also are described in terms of equipment packages that are associated with one or more subsystems in the San Angelo Regional ITS Architecture as shown in **Table 6**. An equipment package is a functional capability that could be deployed at a specific time. Each equipment package can be linked in the National ITS Architecture to the Process Specifications that might 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 San Angelo Regional ITS Architecture web site by clicking on the "Functions" button.

Table 6 – San Angelo 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 Administration Subsystem	CV Data Collection
Commercial Vehicle Subsystem	On-board Cargo Monitoring
Emergency Management Subsystem	Emergency Call-Taking
	Emergency Data Collection
	Emergency Dispatch
	Emergency Environmental Monitoring
	Emergency Response Management
	Mayday Support
Emergency Vehicle Subsystem	On-board EV En Route Support
	On-board EV Environmental Monitoring
	On-board EV Incident Management Communication

Table 6 – San Angelo Region Equipment Packages (continued)

Subsystem	Equipment Package
Emissions Management Subsystem	Emissions Data Collection
Fleet and Freight Management Subsystem	Fleet HAZMAT Management
Information Service Provider Subsystem	Basic Information Broadcast
	Infrastructure Provided Route Selection
	Interactive Infrastructure Information
	ISP Data Collection
	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 Speed Monitoring
	MCM Vehicle and Equipment Maintenance Management
	MCM Vehicle Tracking
	MCM Winter Maintenance Management
	MCM Work Activity Coordination
	MCM Work Zone Management
	MCM Work Zone Safety Management
Maintenance and Construction Vehicle Subsystem	MCV Environmental Monitoring
	MCV Infrastructure Monitoring
	MCV Roadway Maintenance and Construction
	MCV Vehicle Location Tracking
	MCV Vehicle Safety Monitoring
	MCV Vehicle System Monitoring and Diagnostics
	MCV Winter Maintenance
	MCV Work Zone Support
Parking Management Subsystem	Parking Data Collection
Personal Information Access Subsystem	Personal Basic Information Reception
	Personal Interactive Information Reception
	Personal Location Determination
	Personal Provider-Based Route Guidance
Remote Traveler Support Subsystem	Remote Basic Information Reception
	Remote Interactive Information Reception
	Remote Mayday I/F
	Remote Transit Fare Management
	Remote Transit Information Services
	Secure Area Monitoring

Table 6 – San Angelo Region Equipment Packages (continued)

Subsystem	Equipment Package
Roadway Subsystem	Roadside Data Collection
	Roadside Signal Priority
	Roadway Basic Surveillance
	Roadway Environmental Monitoring
	Roadway Equipment Coordination
	Roadway Incident Detection
	Roadway Infrastructure Monitoring
	Roadway Probe Beacons
	Roadway Signal Controls
	Roadway Speed Monitoring
	Roadway Traffic Information Dissemination
	Roadway Work Zone Safety
	Roadway Work Zone Traffic Control
	Standard Rail Crossing
Toll Administration Subsystem	Toll Data Collection
Traffic Management Subsystem	Collect Traffic Surveillance
	HRI Traffic Management
	Rail Operations Coordination
	TMC Environmental Monitoring
	TMC Incident Detection
	TMC Incident Dispatch Coordination/Communication
	TMC Multimodal Coordination
	TMC Probe Information Collection
	TMC Regional Traffic Control
	TMC Signal Control
	TMC Speed Monitoring
	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

Table 6 – San Angelo Region Equipment Packages (continued)

Subsystem	Equipment Package
Transit Management Subsystem (continued)	Transit Garage Maintenance
	Transit Garage Operations
Transit Vehicle Subsystem	On-board Environmental Monitoring
	On-board Fixed Route Schedule Management
	On-board Maintenance
	On-board Paratransit Operations
	On-board Transit Fare and Load Management
	On-board Transit Information Services
	On-board Transit Security
	On-board Transit Signal Priority
	On-board Transit Trip Monitoring
Vehicle Subsystem	Basic Vehicle Reception
	Smart Probe
	Vehicle Location Determination
	Vehicle Mayday I/F
	Vehicle Probe Support
	Vehicle Provider-Based Route Guidance
	Vehicle Safety Monitoring System

4.5 Standards

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

Table 7 – Applicable ITS Standards for the San Angelo 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

Table 7 – Applicable ITS Standards for the San Angelo Region (continued)

SDO	Document ID	Title	Type
AASHTO/ITE/NEMA (continued)	NTCIP 1204	Object Definitions for Environmental Sensor Stations and Roadside Weather Information System	Message
	NTCIP 1205	Data Dictionary for Closed Circuit Television (CCTV)	Message
	NTCIP 1206	Data Collection and Monitoring Devices	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 (CPT) Business Area Standard	Message
	NTCIP 1402	TCIP – Incident Management (IM) Business Area Standard	Message
	NTCIP 1403	TCIP – Passenger Information (PI) Business Area Standard	Message
	NTCIP 1404	TCIP – Scheduling/Runcutting (SCH) Business Area Standard	Message
	NTCIP 1405	TCIP – Spatial Representation (SP) Business Area Standard	Message
	NTCIP 1406	TCIP – Onboard (OB) Business Area Standard	Message
	NTCIP 1407	TCIP – Control Center (CC) Business Area Standard	Message
	NTCIP 1408	TCIP – Fare Collection (FC) 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 (DSRC) Data Link Layer: Medium Access and Logical Link Control	Communication
	ASTM PS 111-98	Specification for DSRC Physical Layer using Microwave in the 902-928 MHz	Communication
EIA/CEA	CEA/EIA-794	Data Radio Channel (DARC) System	Communication
	CEA/EIA-795	Subcarrier Traffic Information Channel (STIC) 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 (IMMS) for use by EMCs	Message

Table 7 – Applicable ITS Standards for the San Angelo Region (continued)

SDO	Document ID	Title	Type
IEEE (continued)	IEEE P1556	Security/Privacy of Vehicle/RS Communications including Smart Card Communications	Communication
	IEEE P1570	Standard for Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection	Message
	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 (TMDD)	Data
	ITE TM 2.01	Message Sets for External TMC Communication (MS/ETMCC)	Message
SAE	SAE J1746	ISP-Vehicle Location Referencing Standard	Data
	SAE J2353	Data Dictionary for Advanced Travel Information System (ATIS)	Data
	SAE J2354	Message Set for ATIS	Message
	SAE J2369	Standard for ATIS 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 ATIS 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 achieve the final Regional ITS Architecture build out will occur over many years.

A sequence of projects and their respective time frames have been identified in the San Angelo Regional ITS Deployment Plan. These projects have been sequenced over a 20-year period, with projects identified for deployment in 5-, 10- and 20-year timeframes.

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

- Network Surveillance;
- Surface Street Control;
- Traffic Information Dissemination;
- Transit Vehicle Tracking; and
- Broadcast Traveler Information.

5. OPERATIONAL CONCEPT

The operational concept for the San Angelo Region provides a description of the stakeholders' roles and responsibilities in the operation of the systems that currently exist or that are being proposed. This operational concept provides an "executive summary" view of the way the San Angelo Region's systems will work together, and it documents the roles and responsibilities for each of the services that ITS 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 San Angelo 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 multi-vehicle crash on I-10. Motorists call 911 from cellular telephones and the Department of Public Safety Dispatch is quickly informed of the crash. An alert is automatically sent from the Department of Public Safety Dispatch to the TxDOT San Angelo TMC. TxDOT activates DMS and monitors the situation with a CCTV camera that is near the crash.

Westbound I-10 is completely closed and the Department of Public Safety, in coordination with the TxDOT San Angelo District, begins setting up a closure and detour. The TxDOT San Angelo TMC also contacts TransGuide in San Antonio so that motorists leaving San Antonio westbound on I-10 can be forewarned of the impending delay.

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 motorists that westbound I-10 is closed. The CCTV camera feed, which has been turned away from the crash to focus on the traffic condition on the Interstate, is shared with the media which broadcasts the live shots of I-10 on the evening news to warn motorists that I-10 remains closed.

Scenario 2

Road construction along US-87 in the northern area of the City of San Angelo is expected to result in the long-term closure of one lane of traffic as well as the shoulders. The TxDOT San Angelo TMC reports the closure to the City of San Angelo Traffic Operations Center (TOC). The City of San Angelo TOC implements detour timing plans on its closed-loop signal system. Signal technicians reset signal detectors using their VIVDS to account for changes in approaches to the signalized intersections. The TxDOT San Angelo TMC posts messages on the DMS along US-87 alerting motorists of the construction and potential detour routes.

The City of San Angelo TOC also sends a message to the San Angelo Public Safety Communications so that when emergency vehicles are dispatched the drivers are cognizant of the closures and can take the appropriate detours. Additionally, the San Angelo Street Railroad and Thunderbird Transit are also notified in case the closure will have an impact on the transit system.

Once the construction is complete, the TxDOT San Angelo TMC removes the messages from the TxDOT DMS and sends out a message to the City of San Angelo TOC that all lanes are once again open. The San Angelo TOC then sets the traffic signal timing back to normal operations and sends out a message to the San Angelo Public Safety Communications and the transit agencies regarding the re-opening of the lanes.

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 San Angelo 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 San Angelo
- County Road and Bridge
- Texas Department of Transportation San Angelo District
- Other Texas Department of Transportation Districts
- Texas Department of Public Safety

Public Transportation Management

- Independent School Districts
- Thunderbird Transit
- San Angelo Street Railroad Company

Electronic Payment

- San Angelo Street Railroad Company
- Service Providers

Commercial Vehicle Operations

- Texas Department of Public Safety
- Texas Department of Transportation

Emergency Management

- City of San Angelo Public Safety Communications
- County Public Safety (Sheriff's Office, Emergency Operations Center)
- Regional Hospitals
- Texas Department of Public Safety
- Texas Department of Transportation

Advanced Vehicle Safety System Needs

- Not Applicable

Information Management

- City of San Angelo
- Concho Valley Council of Governments
- Department of Public Safety
- San Angelo Metropolitan Planning Organization
- Texas Department of Transportation

Maintenance and Construction Management

- City of San Angelo
- County Road and Bridge
- Texas Department of Transportation

5.3   San Angelo Agreements

The Regional ITS Architecture for the San Angelo 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 San Angelo 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 San Angelo 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 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 San Angelo 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 San Angelo Region

Agreement and Agencies	Status	Agreement Description	Considerations
Data Sharing and Usage (Public) TxDOT San Angelo 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. 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 San Angelo 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 San Angelo 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 San Angelo. 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 San Angelo Region (continued)

Agreement and Agencies	Status	Agreement Description	Considerations
Shared Video Monitoring (Public) TxDOT San Angelo District, City of San Angelo, State EOC, DPS	Future	This agreement would enable shared video monitoring of TxDOT CCTV cameras by public safety and emergency services agencies in the San Angelo 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) DPS, TxDOT San Angelo District, San Angelo Police, San Angelo Fire, County Sheriffs, Rural Volunteer Fire	Existing (Informal)	Mutual aid agreements currently exist as informal arrangements in the San Angelo 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 San Angelo District, City of San Angelo, DPS (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 DPS) 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.