REGIONAL ARCHITECTURE FOR SOUTHEASTERN COLORADO INTELLIGENT TRANSPORTATION SYSTEM
Regional Intelligent Transportation Systems Architecture for Southeastern Colorado

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TABLE OF CONTENTS

Executive Summary ...................................................................................................................i
A. Project Area ............................................................................................................................i
B. Issues and Needs ......................................................................................................................iv
C. Core ITS Services ....................................................................................................................v
D. Market Packages ....................................................................................................................vi
E. Roles and Responsibilities .......................................................................................................viii
F. Functional Requirements ........................................................................................................viii
G. Recommended ITS Projects ...................................................................................................xi
H. Financial Summary ..................................................................................................................xiv

I. Introduction ................................................................................................................................1
   I.A. Purpose of the Regional ITS Architecture ................................................................................1
   I.B. Project Process .......................................................................................................................3
   I.C. Related Planning Efforts .......................................................................................................6
   I.D. Conformance with the National ITS Architecture ..................................................................10
   I.E. Organization of this Report ..................................................................................................12

II. Description of the Region .....................................................................................................13
   II.A. Geography of the Region .....................................................................................................13
   II.B. Transportation ....................................................................................................................15
   II.C. Existing ITS Services and Infrastructure .........................................................................19

III. Transportation Issues and Needs ........................................................................................25
   III.A. TPR Goals .........................................................................................................................25
   III.B. Stakeholder Needs and Issues Identified .........................................................................26

IV. Market Package Plan ............................................................................................................32
   IV.A. Advanced Traffic Management Systems ............................................................................32
   IV.B. Advanced Traveler Information Systems ...........................................................................33
   IV.C. Advanced Public Transportation Systems ...........................................................................33
   IV.D. Emergency Management ....................................................................................................34
   IV.E. Maintenance and Construction Management .......................................................................35
   IV.F. Archived Data Management .............................................................................................36

V. Operational Concept ............................................................................................................37
   V.A. Strategic Goals ....................................................................................................................37
   V.B. Operational Scenarios .........................................................................................................39
   V.C. Freeway and Incident Management on I-70 West of Denver .............................................40
   V.D. Regional Traffic and Transit Management in Colorado Springs .......................................42
   V.E. Freeway and Incident Management in Pueblo ....................................................................43
   V.F. Rural Highway Management on US 287 (Ports to Plains) ..................................................45
   V.G. Functional Requirements ....................................................................................................47

VI. Implementation Plan ............................................................................................................58
   VI.A. Recommended ITS Projects ............................................................................................58
   VI.B. Projects of Statewide Significance ....................................................................................61
   VI.C. Projects of Regional Significance .....................................................................................64
   VI.D. Relating Projects to Goals ................................................................................................67
   VI.E. Agreements ........................................................................................................................69
   VI.F. ITS Standards ....................................................................................................................70
   VI.G. Financial Summary ............................................................................................................72

VII. Next Steps ...........................................................................................................................75
Figure 1: Project Process Flow Chart ................................................................. 5
Figure 2: Project Area ...................................................................................... 13
Figure 3: Project Area Roadway Systems .......................................................... 17
Figure 4: Project Area ITS Infrastructure .......................................................... 23
Figure 5: Recommended ITS Strategic Projects .................................................. 60

Tables

Table 1: ITS Benefits and Performance Measures ............................................... 3
Table 2: Project Area Average Daily Traffic: East – West Highways (2003) .......... 15
Table 3: Project Area Daily Traffic: North-South Highways (2003) ...................... 15
Table 4: Existing CDOT ITS Infrastructure ....................................................... 22
Table 5: Selected ATMS Market Packages ....................................................... 33
Table 6: Selected ATIS Market Packages ......................................................... 33
Table 7: Selected APTS Market Packages ....................................................... 34
Table 8: Selected EM Market Packages ............................................................ 34
Table 9: Selected MCM Market Packages ....................................................... 35
Table 10: Selected Archived Data Market Packages ......................................... 36
Table 11: Strategic Goals to Projects ............................................................... 68
Table 12: Financial Summary .......................................................................... 73
# ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>ACRONYM</th>
<th>ABBREVIATION</th>
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<tr>
<td>AD</td>
<td>Advanced Data Management</td>
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<td>APTS</td>
<td>Advanced Public Transportation Systems</td>
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<td>Advanced Traveler Information Systems</td>
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<td>ATMS</td>
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<td>AVL</td>
<td>Automated Vehicle Location</td>
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<td>Advanced Vehicle Safety Systems</td>
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<td>Closed Circuit Television</td>
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<td>CDOT</td>
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<td>City of Grand Junction</td>
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<td>CSP</td>
<td>Colorado State Patrol</td>
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<td>CSTMC</td>
<td>Colorado Springs Traffic Management Center</td>
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<td>CTMC</td>
<td>Colorado Transportation Management Center</td>
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<tr>
<td>CVO</td>
<td>Commercial Vehicles Operations</td>
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<td>DOIT</td>
<td>Department of Information Technology</td>
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<td>DRCOG</td>
<td>Denver Regional Council of Governments</td>
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<tr>
<td>DTR</td>
<td>Digital Truck Radio</td>
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<td>DVR</td>
<td>Digital Video Recorders</td>
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<td>ECO</td>
<td>Eagle County Regional Transportation Authority</td>
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<td>EJT</td>
<td>Eisenhower-Johnson Tunnel</td>
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<td>Emergency Management</td>
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<td>ES</td>
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<td>GIS</td>
<td>Geographical Information System</td>
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<td>Global Positioning System</td>
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<td>HAR</td>
<td>Highway Advisory Radio</td>
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<td>HLT</td>
<td>Hanging Lake Tunnel</td>
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<td>Hanging Lake Tunnel Traffic Management Center</td>
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<td>HQ</td>
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<td>ITS</td>
<td>Intelligent Transportation Systems</td>
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<td>MCM</td>
<td>Maintenance and Construction Management</td>
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<td>MP</td>
<td>Market Package</td>
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<td>MPO</td>
<td>Metropolitan Planning Organization</td>
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<td>NRF</td>
<td>North Front Range</td>
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<td>O&amp;M</td>
<td>Operations and Management</td>
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<td>PDA</td>
<td>Personal Digital Assistant</td>
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<td>POE</td>
<td>Port of Entry</td>
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<td>RFTA</td>
<td>Roaring Fork Transit Authority</td>
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<td>Road and Weather Information Systems</td>
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<td>STIP</td>
<td>Statewide Transportation Improvement Plan</td>
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<td>UP</td>
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<td>VMS</td>
<td>Variable Message Sign</td>
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Executive Summary

This Architecture for intelligent transportation systems (ITS) in Southeastern Colorado describes the ITS elements, their relationship to each other, the roles and responsibilities of the stakeholders and a systematic approach for implementation of intelligent transportation systems in Colorado Department of Transportation Region 1 and Region 2 over the next 10 years. Intelligent transportation systems consist of the application of computers, electronics, communications, and data management used for the purpose of effectively and efficiently managing the transportation system to improve transportation mobility and safety and to provide information to travelers.

The vision for ITS in Southeastern Colorado is to:

*Improve the mobility, safety, and comfort of the multi-modal transportation system and support economic development in the region while protecting the natural environment through real-time management of the transportation system and providing reliable, timely and accurate traveler information to all users of the system.*

A. Project Area

The project area consists of all of CDOT Region 2 and that portion of Region 1 that is not in the Denver Regional Council of Governments (DRCOG) Region (see figure ES-1). The Project Area includes the Central Front Range, Pikes Peak Area, Pueblo, South Central and the Southeast Transportation Planning Regions plus the Counties of Summit, Elbert, Lincoln, Kit Carson, and Cheyenne. Due to the geography, Region 1 and Region 2 have similar issues and needs with respect to ITS. Combining the two CDOT Regions creates a number of synergies for ITS planning purposes.

Southeastern Colorado is a mix of two large urbanized areas, several small urban areas and vast rural areas characterized by the following:

- I-70 is the dominant east-west corridor in the north; US 24 in the middle; US 50 in the south;
- I-25 is the dominant north-south corridor; US 287 carries significant truck traffic north-south;
- Recurring congestion in major urbanized centers – Colorado Springs, Pueblo, Summit County;
- West of I-25, the region is predominantly mountainous and rural, with a sparse roadway network;
- From Monument to Pueblo, the I-25 corridor is predominately urban and inter-urban;
- East of the I-25 corridor, the region is predominately rural plains with few state highways and major roads. Secondary roads tend to only support low speed travel;
- The western part of the region is renown for its scenic and natural resources, drawing visitors from around the world;
- Tourism and recreation use provide significant economic benefits to parts of the region, as well as generating significant travel demands;
- A large array of wildlife abounds, including several large animal species, such as moose, elk, and deer, bear and mountain lion, which has resulted in significant numbers of animal/vehicle collisions;
- The mountainous portions have many geometric constraints such as steep grades, sharp curves, and narrow roads where minimal or no shoulders are common, and many of the major roads cross high mountain passes;
- There is a wide mix of users including rural-based travel, urban-based travel, through travel, and commercial;
- East of I-25, long distances separate many destinations with few services in between, and little power or communications infrastructure;
- There are few alternate or detour routes available;
- Long-haul trucking represents a large percentage of travel on many routes;
- Significant military presence in and around Colorado Springs and to a lesser extent in the Pueblo area;
- Significant special event generators – Air Force Academy, Pikes Peak International Raceway, Colorado State Fairgrounds.
Figure ES-1: Project Area
(CDOT Regions 2 and 1)
B. Issues and Needs

Transportation issues and needs that could potentially be addressed through ITS were identified through a series of stakeholder workshops and review of Incident Management Plans, the Regional Transportation Plans (for more detail see Section I.C.) that were developed for each of the Transportation Planning Regions in the Project Area and other transportation plans.

Several critical issues related to ITS were identified both from stakeholder input, as well as review of existing planning documents. These include:

- Weather and crash related incidents on I-25 and I-70 cause major disruption to travel in the region and statewide;
- Weather related closures on mountain passes occur frequently and sometimes suddenly, leading to delay and inconvenience for travelers and increased expense for freight trucking;
- Weather related closures on the eastern plains disrupt east-west travel.
- Traffic congestion in Colorado Springs, Pueblo, and Summit County is growing within the region and will become a major issue if not proactively addressed;
- Traffic congestion is becoming a major issue around tourism/recreation destinations—especially Summit County and Cripple Creek – leading to delay, safety concerns and increased pollution emissions, and disruption to the economy;
- Non-recurring congestion from incidents is a major problem due to limited alternate or detour routes;
- Limited law enforcement invites excess speed and other safety infractions;
- Long distances, limited route choices, and geographic constraints impede rapid emergency response in rural areas;
- Collisions with wildlife are a significant safety issue endangering lives, damaging wildlife populations, and disrupting the system. On some sections of road, such collisions represent as much as 50% of all accidents;
- Natural or manmade emergencies, such as wildfires, rock slides, and avalanches occur suddenly and without warning, disrupting the transportation system and leading to delay, inconvenience, and economic impacts;
- Homeland security issues have become a new concern for all transportation systems. ITS must be protected from intrusion and made available to security officials;
- Maintenance of ITS is a critical issue. As ITS becomes more common, the public relies on it more; therefore, downtime due to maintenance and repair becomes even more disruptive. Furthermore, by their very nature, the electronics required for ITS have greater ownership and maintenance costs (as a percentage of construction) than typical roadways and bridges.
- Electrical power and communications infrastructure are very limited in the mountainous areas and in the rural portions of the eastern plains.
C. Core ITS Services

Based on analysis of the major needs in the Project Area, discussions with Stakeholders, and review of other transportation and ITS plans, as mentioned earlier, seven core ITS services have been identified to address regional issues and needs.

Incident Management – Relates to the management of recurring and non-recurring disruptions to traffic due to crashes, weather, or other natural causes. The goals of incident management are to detect, verify and reduce the response time and the time required clearing the accident as well as using traveler information to suggest alternate routes for traffic during the incident. Due to the large distances and limited infrastructure, incident management in Southeastern Colorado will be focused on I-70, I-25, other major state highways, and locations of frequent special events. In rural areas, close coordination with county emergency management groups will facilitate incident management planning and responses.

Traveler Information – Refers to the collection and dissemination of road condition data so that travelers can make choices regarding the time, route and mode for their travel. This includes providing information before travelers depart as well as while en-route. CDOT currently operates a statewide traveler information system consisting of interactive web and automated phone system, which is 511-capable, cell phone and PDA based services as well as broadcast fax and e-mail announcements. Information is also disseminated in the field via message boards and highway advisory radios.

Freeway Traffic Management – Involves the active management of traffic flow on the freeway mainline and ramps to ensure efficient use of capacity during normal operations and during accidents. It includes active management strategies such as ramp metering, video surveillance, traffic volume and speed sensors, and location specific information dissemination using message sings and advisory radio. CDOT Region 1 is implementing a freeway management system on I-70 in the mountains; Colorado Springs currently operates a freeway management system on I-25 through El Paso County and CDOT Region 2 operates a freeway management system on I-25 through Pueblo.

Arterial Traffic Management – Involves the management of traffic on arterial roadways to improve the efficiency of the system for all users. It includes active traffic signal management strategies, video surveillance, traffic volume and speed sensors, and the selective use of information dissemination through variable message signs and advisory radios. Colorado Springs operates an Advanced Traffic Management System, Region 2 operates a signal control system in Pueblo, and Region 1 operates a signal control system in Summit County. These traffic signal systems will provide a foundation for arterial traffic management.

Transit Management and Multi-modal Coordination – Transit agencies in Southeastern Colorado vary greatly in the size, sophistication, and resources. Colorado Springs transit plans on employing several highly sophisticated management strategies while others will choose simpler, less costly approaches. The types of transit management tools available include: automated fare collection, automated vehicle location, passenger security systems, real-time transit traveler information, automated annunciator systems, and automated scheduling systems. In addition, transit signal priority systems are needed in heavy transit corridors in Colorado Springs and Summit County.

Safety Management – Refers to the several strategies used to reduce the number and severity of crashes. In Southeastern Colorado, a major focus is on reducing the response time for emergency
services. Studies have shown that the ability to reduce the severity of accidents increases dramatically as the response time approaches and exceeds one hour. Strategies are proposed to shorten the reporting time and to facilitate quicker dispatch and response. Also, a significant cause of crashes in Southeastern Colorado is collisions with wildlife. Systems have been deployed and others are being developed. The goal of these systems is to automatically detect wildlife and alert drivers for the purpose of preventing crashes.

**Communications and Connectivity** – Intelligent transportation systems are dependent on communications to collect and transmit sensor data from the field to management centers where it can be processed to transmit information between various centers. Providing high-speed communication between centers and along key corridors is essential for the effective operation of ITS. Also, the sharing of data, especially between different functional centers can significantly improve the quality of the ITS. Emergency management centers need video data from CDOT so they can rapidly assess situations and respond in the most appropriate way. Communities and transit agencies need more direct access to CDOT road and weather information so they can provide better, more user specific, travel information to their patrons. CDOT needs reliable, accurate local information from other stakeholders to improve the quality of the traveler information CDOT provides.

**D. Market Packages**

Market packages are the building blocks of the National ITS Architecture. The process of identifying local issues, needs, and plans, and correlating them to ITS market packages provides the systems engineering perspective that is crucial to ITS planning (and required by the FHWA and FTA). Market packages provide an accessible, deployment-oriented perspective to the National Architecture and are tailored to fit - separately or in combination - real world transportation problems and needs. Market packages identify physical ITS elements that are required to implement a particular transportation service.

Market packages for the study area were selected to address the issues and needs as identified through the stakeholder process.

Market packages are grouped in the National ITS Architecture based upon the type of transportation service provided, as follows:

**Advanced Traffic Management Systems (ATMS):** Manage operation of the roadway network.

- Network Surveillance (exist.)
- Surface Street Control (exist.)
- Freeway Control (exist.)
- HOV Lane Management (prop.)
- Traffic Information Dissemination (exist.)
- Regional Traffic Control (prop.)
- Incident Management System (exist.)
- Standard Railroad Grade Crossing (exist.)
- Reversible Lane Management (exist.)
- Speed Monitoring (exist.)
- Roadway Closure Management (prop.)

**Advanced Traveler Information Systems (ATIS):** Provide real-time information to travelers.
• Broadcast Traveler Information (exist.)
• Interactive Traveler Information (exist.)

**Advanced Public Transportation Systems (APTS):** Manage transit operations and make transit use more convenient and safe.

• Transit Vehicle Tracking (prop.)
• Transit Fixed-Route Operations (exist.)
• Demand Response Transit Operations (exist.)
• Transit Passenger and Fare Management (prop.)
• Transit Security (prop.)
• Transit Maintenance (prop.)
• Multi-modal Coordination (prop.)
• Transit Traveler Information (exist.)

**Emergency Management (EM):** Manage emergency response operations.

• Emergency Response (exist.)
• Emergency Routing (prop.)
• Mayday Support (exist.)
• Transportation Infrastructure Protection (prop.)
• Wide-Area Alert (exist.)
• Early Warning System (exist.)
• Disaster Response and Recovery (exist.)
• Evacuation and Re-entry Management (exist.)
• Disaster Traveler Information (exist.)

**Maintenance and Construction Management (MCM):** Manage maintenance and construction activities and operations.

• Maintenance and Construction Vehicle and Equipment Tracking (prop.)
• Maintenance and Construction Vehicle Maintenance (prop.)
• Road Weather Data Collection (exist.)
• Weather Information Processing and Distribution (exist.)
• Roadway Automated Treatment (exist.)
• Winter Maintenance (exist.)
• Roadway Maintenance and Construction (exist.)
• Work Zone Management (prop.)
• Work Zone Safety Monitoring (prop.)
• Maintenance and Construction Activity Coordination (prop.)

**Archived Data Management (AD):** Store and retrieve transportation system information for future analysis.

• ITS Data Mart (prop.)
• ITS Virtual Data Warehouse (prop.)

The National ITS Architecture contains two additional service areas, Commercial Vehicle Operations and Advanced Vehicle Safety Systems, which are not included in this regional architecture. Commercial Vehicle Operations, while important, are a statewide issue and are more appropriately addressed in the statewide architecture. While Advanced Vehicle Safety Systems may become significant in the future, they do not directly interface with the
infrastructure in Southeastern Colorado at this time; hence, they are not relevant to this regional architecture within the stated time frame.

E. Roles and Responsibilities

The principle stakeholders in southeastern Colorado and their primary responsibilities are provided below:

The CDOT EJT TOC controls all the ITS devices in and around the Eisenhower-Johnson tunnel complex. This includes collecting information from sensors and cameras along the tunnels, controlling lane use signs, and posting messages on DMS and HAR. EJT TOC also functions as a point of contact for CDOT in the I-70 corridor for incident management purposes.

The CTMC manages the statewide traveler information system as well as functioning as a surrogate for Information Service providers. In the latter role, public information offices at CTMC provide all coordination with media. CTMC staff also update the CoTrip website, disseminate broadcast fax and email, update the 511 and telephone advisory system, and place messages on DMS and HAR as needed. CTMC also acts as a backup to EJT TOC and CS TMC.

The CS TMC manages all the devices on both the freeway and the surface street system in Colorado Springs. CS TMC gathers local road conditions from sensors and forwards them to the statewide traveler information system as well as using them for more localized management. CS TMC manages signal priority at signalized intersections.

Colorado Springs Transit manages the transit system in the service area. CS Transit provides transit traveler information via a website and telephone. The vision for the region also includes transit traveler information at stops and on vehicles, which would be operated by CS Transit.

CDOT Region 1 and Region 2 Traffic Operations is responsible for control of ramp meters and traffic signals on the state highway system within the region. In the event of an incident, traffic operations staff would make any needed adjustments to signal timing or meter operation. After hours or on weekends, the CTMC will operate the signals and ramps.

CDOT Region 1 and Region 2 Maintenance forces provide resource such as signs, cones and barricades, and heavy equipment as may be needed to clear incident or control traffic during an incident. This may also include signing and control for detours and alternate routes. In this effort, they may call upon county and local maintenance forces for additional resources. CDOT Maintenance is also responsible for clearing debris and restoring the roadway to operating conditions after the incident has been cleared.

CSP and local law enforcement are responsible for traffic enforcement and accident investigation. They are also usually the first response on site and therefore usually provide incident command for short duration events. They provide an initial assessment of the incident, take control of the scene, and initiate the appropriate incident management plans. They also determine any necessary lanes closures and when to reopen lanes to traffic. This includes determining the need to establish detours and alternate routes.

F. Functional Requirements

Functional requirements are one of the mandatory components of a regional ITS architecture as identified in the FHWA/FTA rules and policies. Functional requirements identify the tasks or
activities that are, or will be, performed by each system or subsystem in the region. Detailed functional requirements are generally best left to project architectures or design. At the regional architecture level these are high-level descriptions of the tasks derived from the operational concept. In the context of the National ITS Architecture functional requirements can be stated in terms of Equipment Packages, implementable groupings of processes within a given subsystem.

The major physical entities in the regional architecture and the equipment packages that define the functional requirements are:

**CDOT ITS Branch**
- Government Reporting System Support
- ITS Data Repository
- Traffic and Roadside Data Archival
- Virtual Data Warehouse Services

**Colorado Transportation Management System**
- Traffic Data Collection
- Collect Traffic Surveillance
- Traffic Maintenance
- TMC Freeway Management
- TMC HOV Lane Management
- TMC Traffic Information Dissemination
- TMC Incident Detection
- TMC Incident Dispatch Coordination/Communication
- TMC Speed Monitoring
- Barrier System Management
- TMC Evacuation Support
- TMC Environmental Monitoring
- ISP Data Collection
- Basic Information Processing
- ISP Traveler Data Collection
- Traveler Telephone Information
- ISP Emergency Traveler Information

**Eisenhower-Johnson Tunnel TOC**
- Traffic Data Collection
- Collect Traffic Surveillance
- Traffic Maintenance
- TMC Freeway Management
- TMC Traffic Information Dissemination
- TMC Incident Detection
- TMC Incident Dispatch Coordination/Communication
- TMC Reversible Lane Management
- TMC Speed Monitoring
- Barrier System Management
- Safeguard System Management
- TMC Evacuation Support
Regional ITS Architecture for Southeastern Colorado

Executive Summary

CDOT Region 1 and Region 2 Traffic

- Traffic Maintenance
- TMC Signal Control
- TMC Regional Traffic Control
- TMC Standard Railroad Grade Crossing
- TMC Multimodal Coordination
- TMC Work Zone Traffic Management

CDOT Region 1 and Region 2 Maintenance

- MCM Data Collection
- MCM Incident Management
- MCM Vehicle Tracking
- MCM Vehicle and Equipment Maintenance Management
- MCM Environmental Information Collection
- MCM Automated Treatment System Control
- MCM Work Zone Management
- MCM Work Activity Coordination

CDOT Maintenance Vehicles

- MCV Vehicle Location Tracking
- MCV Environmental Monitoring

CDOT Roadside Devices

- Roadway Data Collection
- Roadway Signal Priority
- Roadway Basic Surveillance
- Roadway Equipment Coordination
- Roadway Signal Controls
- Roadway Freeway Control
- Roadway Traffic Information Dissemination
- Roadway Speed Monitoring
- Field Barrier System Control

Colorado Springs TMC

- Traffic Data Collection
- Collect Traffic Surveillance
- Traffic Maintenance
- TMC Freeway Management
- TMC Traffic Information Dissemination
- TMC Incident Detection
- TMC Incident Dispatch Coordination/Communication
- TMC Speed Monitoring
- Barrier System Management
- Safeguard System Management
TMC Evacuation Support
TMC Environmental Monitoring
Traffic Maintenance
TMC Signal Control
TMC Regional Traffic Control
TMC Multimodal Coordination

CSP, City, and County EOCs
- Emergency Data Collection
- Emergency Response Management
- Incident Command
- Emergency Call-Taking
- Emergency Dispatch
- Emergency Early Warning System
- Emergency Evacuation Support

Colorado Springs Transit
- Transit Data Collection
- Transit Center Vehicle Tracking
- Transit Center Fixed-Route Operation
- Transit Center Multimodal Coordination
- On-board Transit Signal Priority
- Transit Center Information Services
- Transit Evacuation Support
- Transit Environmental Monitoring

Other Transit Agencies (e.g. Summit Stage, Pueblo)
Each transit agency is somewhat different in the range ITS User Services it plans on deploying.
Many of these services do not require any external coordination. Functional requirements derived
from services requiring external coordination include:
- Transit Data Collection
- Transit Center Vehicle Tracking
- Transit Center Fixed-Route Operation
- Transit Center Multimodal Coordination
- On-board Transit Signal Priority
- Transit Center Information Services
- Transit Evacuation Support
- Transit Environmental Monitoring

G. Recommended ITS Projects
Based on the strategic objectives and the critical issues, a program of ITS strategic projects is
recommended to address these issues, including:

Projects of Statewide Significance
1. Install fiber-optic cable along I-70 from Vail to Frisco including all equipment,
connections with lateral devices and C2C with CSP and local jurisdictions.
2. Install fiber-optic cable along I-25 from Pueblo to the Colorado/New Mexico State line including all equipment, connections with lateral devices and C2C with CSP and local jurisdictions.

3. Develop incident management and traveler information system for I-25 South of Pueblo.

4. Develop incident management and traveler information system for I-70 East of Denver.

5. Complete the I-70 Mountain Corridor Incident Management system improvements from Vail to Clear Creek County, including automated pass maintenance and closure for Loveland Pass and Vail Pass and select freeway management system elements.


7. Implement rural highway management systems on SH 50 east of Pueblo;

8. Implement rural highway management systems on US 287 south of Limon;

9. Provide a secure interface so that participating agencies, such as transit providers or local governments, can access camera images and other data directly;

10. Develop a communications master plan for the rural areas of Southeastern Colorado where existing communication infrastructure is inadequate;

11. Instrument maintenance vehicles to provide road and weather condition data.

Projects of Regional Significance

12. Implement transit management and multi-modal coordination in Summit County;

13. Implementing a transit management system and multi-modal coordination for Colorado Springs Transit;

14. Install automated pass maintenance an closure management system on US 24 over Wilkerson Pass;

15. Implement freeway management and traveler information system on I-25 from Colorado Springs through Pueblo;

16. Implement rural highway management systems on SH 24 east of Colorado Springs;

17. Develop a special event management system for the Air Force Academy;

18. Develop a special event management system in cooperation with Pikes Peak International Raceway;

19. Developing a regional ITS master plan for the Pikes Peak Area Council of Governments region;

20. Developing a military traveler information system in Colorado Springs.
Figure ES-2: Recommended ITS Strategic Projects

**Summit County**
1. Install fiber optic cable & electronics from Vail to Frisco
2. Incident Management System & Vail & Looneland Pass System
3. Implement Transit Management & Multi-Modal Coordination

**SH 24: Wilkerson Pass**
4. Implement Pass Management System

**Other Strategic ITS Initiatives**
5. Provide a secure web interface to camera images
6. Develop a communications master plan
7. Instrument maintenance vehicles for RWIS

**Pikes Peak Area**
8. Implement Transit Management & Multi-Modal Coordination
9. Develop regional ITS Master Plan
10. Develop military Traveler Information System

**Air Force Academy**
11. Event Management System

**I-70: East of Aurora to Kansas state line**
12. Develop Incident Management System

**SH 24: Colorado Springs to Limon**
13. Implement Rural Highway Management System

**I-25: Pueblo to Colorado Springs**
14. Implement Rural Highway Management System

**US 287: Oklahoma to Limon**
15. Implement Rural Highway Management System

**US 50: Pueblo to Kansas**
16. Implement Rural Highway Management System

**I-25: New Mexico state line to Pueblo**
17. Install fiber optic cable and electronics
18. Implement Transit Management Plan
19. Develop Incident Management System for remainder

**I-25: Raton Pass**
20. Implement Pueblo management System
H. Financial Summary

Based on the project priorities identified in the report, a financial summary was prepared to balance project funding through the program time frame. The costs, which are in 2005 dollars, to implement the recommended projects are summarized in the Table below.
### Table ES-1: Financial Summary (Cost are in 2005 dollars)

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Name</th>
<th>Near Term (1 – 3 years)</th>
<th>Mid-Term (4 – 7 years)</th>
<th>Long Term (8 – 10 years)</th>
<th>Project Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Install fiber-optic cable along I-70 from Vail to Frisco (included in Strategic Plan for Western Colorado)</td>
<td>Not Included</td>
<td>Not Included</td>
<td>Not Included</td>
<td>Not Included</td>
</tr>
<tr>
<td>2</td>
<td>Install fiber-optic cable along I-25 from the New Mexico line to Pueblo</td>
<td>546,000</td>
<td>3,500,000</td>
<td>350,000</td>
<td>294,000</td>
</tr>
<tr>
<td>3</td>
<td>Develop Incident Management and Traveler Information System for I-25 south of Pueblo</td>
<td>150,000</td>
<td>1,500,000</td>
<td>225,000</td>
<td>150,000</td>
</tr>
<tr>
<td>4</td>
<td>Develop Incident Management and Traveler Information System for I-70 east of Denver</td>
<td>150,000</td>
<td>1,500,000</td>
<td>225,000</td>
<td>150,000</td>
</tr>
<tr>
<td>5</td>
<td>Complete I-70 Incident Management and Traveler Information System in Summit County</td>
<td>152,000</td>
<td>1,900,000</td>
<td>285,000</td>
<td>152,000</td>
</tr>
<tr>
<td>6</td>
<td>Install pass maintenance and management system on I-25 over Raton Pass</td>
<td>28,000</td>
<td>350,000</td>
<td>52,500</td>
<td>28,000</td>
</tr>
<tr>
<td>7</td>
<td>Implement Rural Highway Management System on SH 50 east of Pueblo</td>
<td>40,000</td>
<td>500,000</td>
<td>75,000</td>
<td>40,000</td>
</tr>
<tr>
<td>8</td>
<td>Implement Rural Highway Management System on US 287 south of Limon</td>
<td>40,000</td>
<td>500,000</td>
<td>75,000</td>
<td>40,000</td>
</tr>
<tr>
<td>9</td>
<td>Provide a secure web interface to camera images</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
</tr>
<tr>
<td>10</td>
<td>Develop a communications master plan</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
</tr>
<tr>
<td>11</td>
<td>Instrument maintenance vehicles for road and weather information</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
<td>Not Quantified</td>
</tr>
<tr>
<td>12</td>
<td>Implement Transit Management and Multi-modal Coordination in Summit County</td>
<td>50,000</td>
<td>500,000</td>
<td>75,000</td>
<td>50,000</td>
</tr>
<tr>
<td>13</td>
<td>Implement transit management system and multi-modal coordination for Colorado Springs Transit</td>
<td>50,000</td>
<td>500,000</td>
<td>75,000</td>
<td>50,000</td>
</tr>
<tr>
<td>14</td>
<td>Install pass maintenance and</td>
<td>28,000</td>
<td>350,000</td>
<td>52,500</td>
<td>28,000</td>
</tr>
</tbody>
</table>
### Executive Summary

**Near Term (1 – 3 years)**

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Name</th>
<th>Design</th>
<th>Construction</th>
<th>Annual Maint. &amp; Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Implement Rural Highway Management System on I-25 between Colorado Springs and Pueblo</td>
<td>50,000</td>
<td>500,000</td>
<td>75,000</td>
</tr>
<tr>
<td>16</td>
<td>Implement Rural Highway Management System on SH 24 east of Colorado Springs</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td>17</td>
<td>Develop a Special Event Management System for the Air Force Academy</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td>18</td>
<td>Develop a Special Event Management System for Pikes Peak International Raceway</td>
<td>Private funding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Develop a regional ITS master plan for Pikes Peak Area Council of Governments</td>
<td>100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Develop a Traveler Information System focused on Military Base related travel</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>578,000</td>
<td>5,350,000</td>
<td>802,500</td>
</tr>
</tbody>
</table>

**Mid-Term (4 – 7 years)**

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Name</th>
<th>Design</th>
<th>Construction</th>
<th>Annual Maint. &amp; Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Implement Rural Highway Management System on I-25 between Colorado Springs and Pueblo</td>
<td>50,000</td>
<td>500,000</td>
<td>75,000</td>
</tr>
<tr>
<td>16</td>
<td>Implement Rural Highway Management System on SH 24 east of Colorado Springs</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td>17</td>
<td>Develop a Special Event Management System for the Air Force Academy</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td>18</td>
<td>Develop a Special Event Management System for Pikes Peak International Raceway</td>
<td>Private funding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Develop a regional ITS master plan for Pikes Peak Area Council of Governments</td>
<td>100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Develop a Traveler Information System focused on Military Base related travel</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>578,000</td>
<td>5,350,000</td>
<td>802,500</td>
</tr>
</tbody>
</table>

**Long Term (8 – 10 years)**

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Name</th>
<th>Design</th>
<th>Construction</th>
<th>Annual Maint. &amp; Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Implement Rural Highway Management System on I-25 between Colorado Springs and Pueblo</td>
<td>50,000</td>
<td>500,000</td>
<td>75,000</td>
</tr>
<tr>
<td>16</td>
<td>Implement Rural Highway Management System on SH 24 east of Colorado Springs</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td>17</td>
<td>Develop a Special Event Management System for the Air Force Academy</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td>18</td>
<td>Develop a Special Event Management System for Pikes Peak International Raceway</td>
<td>Private funding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Develop a regional ITS master plan for Pikes Peak Area Council of Governments</td>
<td>100,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Develop a Traveler Information System focused on Military Base related travel</td>
<td>20,000</td>
<td>250,000</td>
<td>37,500</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>578,000</td>
<td>5,350,000</td>
<td>802,500</td>
</tr>
</tbody>
</table>
I. Introduction

This Architecture for the deployment of Intelligent Transportation Systems (ITS) in Southeastern Colorado is one portion of a larger effort to develop ITS architectures and strategic plans throughout the state. Intelligent transportation systems consist of the application of computers, electronic sensors, communications, and data management used for the purpose of effectively and efficiently managing the transportation system to improve transportation mobility and safety and to provide timely and accurate information to travelers.

CDOT has done considerable work planning, implementing and operating ITS in Colorado beginning with the Colorado Incident Management Coalition, the Denver Early Deployment Study, the Model Deployment Initiative, and the Colorado Transportation Management System. Several regional and project level architectures have been developed and many major corridors now have incident management plans. An architecture is a very formalized description of all the elements of a fully functioning intelligent transportation system, including which entities are responsible for the individual elements and how those entities and elements interface with each other.

In 2002, the CDOT ITS Branch, in consultation with the ITS Steering Group, developed an ITS Strategic Plan setting forth the vision and strategic goals for ITS investments statewide, describing organizational roles and responsibilities, and establishing strategies and implementation actions to achieve the CDOT goals for ITS investment. This plan also incorporated performance measures metrics as part of investment decisions for ITS. While there has been significant progress toward architecture development in Colorado, several actions remain in Region 1 and Region 2. Most of CDOT Region 1 was not included in previous ITS strategic plan/architecture efforts (the portion of CDOT Region 1 in the DRCOG Region was completed), especially the critical segment between the Eisenhower-Johnson Tunnel (EJT) and the town of Vail.

While an ITS architecture was developed for the I-25 corridor through Region 2, large portions of the region were not included and an ITS strategic plan was not developed. Furthermore, a statewide architecture to provide a framework that consolidates the regional architectures together is currently being updated.

This report comprises the Architecture for ITS in CDOT Region 2 and the portion of Region 1 outside the DRCOG Region. This architecture describes the ITS elements, their relationship to each other, the roles and responsibilities of the stakeholders and a systematic approach for implementation of intelligent transportation systems in Southeastern Colorado for the next ten years.

I.A. Purpose of the Regional ITS Architecture

A regional ITS architecture is a powerful tool for planning regional integration and coordination of ITS elements between jurisdictions and across different modes of transportation. The process of creating a regional ITS architecture often enhances regional planning by bringing together a wide array of agencies and stakeholders to discuss future transportation needs and how these needs might be met by ITS.

In January 2001, FHWA and FTA jointly published a rule/policy, to implement section 5206(e) of TEA-21 requiring that all ITS projects funded from the Highway Trust Fund be in conformance with the National ITS Architecture and appropriate standards. The rule/policy
defines “Conformance with the National ITS Architecture” as developing a “regional ITS
architecture” using the National ITS Architecture and tailoring it to the local conditions and
transportation needs. Subsequent project then must adhere to the regional ITS architecture.

Intelligent Transportation Systems (ITS) are interrelated systems of electronics, computers and
communications that must work together to provide transportation services. Integration of these
systems requires a framework to define how each subsystem relates to the other subsystems and
to gain consensus from the stakeholders on the approaches to be taken regarding their particular
systems. An ITS architecture defines the systems and the interconnections and information
exchanges between these systems. A regional ITS architecture is a framework, specific to the
region under consideration, for ensuring institutional agreement and technical integration for the
implementation of ITS projects in a that region.

Typically, a region contains multiple transportation agencies and jurisdictions. These may have
both adjoining and overlapping geographies, but all of the agencies have a need to provide ITS
solutions to transportation problems such as traffic congestion and safety hazards. These solutions
should be provided using public funds in a responsible manner. The purpose of developing a
regional ITS architecture is to foster regional integration so that planning and deployment can
proceed in a coordinated and organized manner.

Regional integration allows for the coordination of activities and sharing of information among
different transportation systems to efficiently and effectively operate. Regional integration also
has a synergistic effect in that information from one system may be used by another system for
another purpose, reducing the need for redundant systems. An example of this would be toll tags
being used by a freeway management center as probe data to obtain speed information on
freeway segments. A regional ITS architecture illustrates this integration and provides the basis
for planning the evolution of existing systems and the definition of future systems that facilitate
the integration over time.

This regional integration can only take place with the participation and cooperation of the
organizations within a region. These stakeholders must work together to establish a regional ITS
architecture that reflects a consensus view of the parties involved.

A regional ITS architecture’s most important goal is institutional integration; providing a
framework within which regional stakeholders can address transportation issues together.
As indicated earlier, a strategic plan is a road map for implementing a system of strategies over a
period of time. It provides a starting point for bringing ITS projects and systems together into an
integrated plan, and identifying transportation related needs that can be addressed by ITS
applications within the context of a systematic approach. Both the Statewide ITS Strategic Plan
and the Regional ITS Strategic Plan have been collaborative efforts involving CDOT, other
federal, state, and local agencies, along with other stakeholders to develop a framework for
deploying ITS. This framework addresses the institutional and operational elements required for
effective, integral statewide and regional transportation systems.

**Goals of ITS**

The goals of ITS are primarily to maximize transportation system management thereby enhancing
mobility and safety for transportation users. More specifically, the Statewide ITS Strategic Plan
identifies the following major goals for ITS.

**Improving mobility through maximizing the productivity of the transportation system** by
using ITS to increase the throughput of passengers and vehicles on the transportation system.
This will effectively increase the capacity of the existing transportation system. CDOT would use
ITS to continuously manage and fine tune the operation of the transportation system in response to travel demand and in the event of incidents that interrupt their normal operations.

**Improving mobility through providing travel choices and increasing travel efficiency** through access to comprehensive, reliable, accurate, and timely traveler information. Travelers will be able to make informed decisions concerning their travel prior to and during travel. ITS will enable travelers and businesses to choose travel time, mode, and route more efficiently based on real time information regarding travel conditions. This will help spread the volume of travelers among modes and over time, reduce the costs of doing business, and enhance the quality of life in Colorado.

**Increasing safety for the traveling public** by enabling faster response to incidents and reducing incidents through active traffic and incident management. In addition, a secondary mobility benefit will be realized where Incident Management Plans have identified alternative routing that is used during incidents. CDOT will use a combination of ITS technologies to enhance the safety of the traveling public, by monitoring system operations, planning and managing transportation affected by special events, and providing travel related weather advisory information.

**Enhancing intermodal connectivity and inter-jurisdictional coordination** by promoting and supporting seamless connectivity between multiple modes of transportation and Colorado’s ITS systems. CDOT envisions information being managed as a resource that will enhance intermodal connectivity between services provided by public and private transportation providers.

Table 1 below highlights the principal benefits and the corresponding performance measure metrics associated with the identified goal areas.

### Table 1: ITS Benefits and Performance Measures

<table>
<thead>
<tr>
<th>Principal Benefits</th>
<th>Performance Measure Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximizing productivity of current transportation system</td>
<td>• Increase in vehicle and passenger throughput.</td>
</tr>
<tr>
<td></td>
<td>• Reduction in total lost productivity due to incidents and congestion.</td>
</tr>
<tr>
<td>Increasing travel efficiency</td>
<td>• Use of travel information to select travel mode and reduce travel time and costs (through use of pre-trip and en-route travel information).</td>
</tr>
<tr>
<td>Increasing safety</td>
<td>• Shorten incident response times.</td>
</tr>
<tr>
<td></td>
<td>• Reduction of secondary accidents due to incidents.</td>
</tr>
</tbody>
</table>

**I.B. Project Process**

The development of the ITS strategic plan and architecture follows a structured process to ensure proper coverage of relevant transportation issues, gather key input from transportation stakeholders within the region, and identify cost-effective and integrated solutions that can evolve as the technology progresses. The planning process moves from an identification of needs and objectives to the development of an implementation plan, which identifies projects for inclusion in the regional transportation plan and the Statewide Transportation Improvement Plan (STIP). Within this process, there are a number of steps (or tasks) to perform to ensure that a thorough, strategic assessment is conducted.
The process began with a series of stakeholder workshops to identify and initial set of ITS Issues and Needs. These were supplemented by transportation issues and needs identified in the various regional transportation plans, as well as ITS strategies that had been selected for inclusion in the RTP’s. Based on this input, and input from the Statewide ITS Strategic Plan, a regional ITS vision and ITS goals were identified. These consist of ITS User Services and ITS Market Packages to address the ITS Issues and Needs. From these, the corridors in the region were prioritized and Strategic ITS Objectives to identified. These lead directly to ITS projects which implement the objectives.

Throughout the process, input was obtained via stakeholder workshops, the review of Transportation Planning Region (TPR) 2030 plans and other resources as indicated below to identify needs and issues that ITS could address.

This process is illustrated in Figure 1: Project Progress Flow Chart.
Figure 1: Project Process Flow Chart

- Stakeholder Workshop
- Regional Transportation Plans
- ITS Issues & Needs
- Statewide ITS Strategic Plan
- Regional ITS Vision & Goals
- Strategic ITS Objectives
- ITS National Architecture
- ITS Strategic Projects
Stakeholder Participation Process

A series of stakeholder workshops was conducted in Silverthorne, Pueblo and Colorado Springs from August 2004 to December 2004. At the first series of workshops an extensive list of ITS issues and needs was developed and subsequently expanded to at follow-up workshops. In addition, draft Regional Transportation Plans for all of the Transportation Planning Regions were reviewed to further identify transportation issues and needs that warranted consideration in the Regional ITS Architecture. The stakeholder participation and a summary of regional transportation plans for the study are provided below.

A public involvement process is part of this plan, and four rounds of ITS workshops were conducted. Generally, each round of workshops included one meeting in CDOT Region 1 and another in CDOT Region 2. The dates and locations were as follows:

CDOT Region 1, August 12, 2004 in Silverthorne
CDOT Region 2, August 13, 2004 in Pueblo
CDOT Region 2, September 30, 2004 in Colorado Springs
CDOT Region 2, November 4, 2004 in Pueblo
CDOT Region 1, November 18, 2004 in Silverthorne
CDOT Region 2, December 10, 2004 in Pueblo
CDOT Region 1, December 15, 2004 in Silverthorne

Some topic areas identified the goals that are desired for the regions and are consistent with the goals highlighted in the 2030 TPR plans (see upcoming section). Other items discussed include technological tools that are desired of the regions, and others are more specific requests for incident management tools or information dissemination mechanisms.

I.C. Related Planning Efforts

- The following reports were referenced as a resource for this report:
- Design Guidelines for Including ITS on Projects, CDOT 2005
- 2030 Statewide Transportation Plan, Moving Colorado – Vision for the Future, CDOT 2004
- Statewide Intelligent Transportation Systems Strategic Plan, CDOT 2002
- Seven 2030 Regional Transportation Plans, CDOT 2004
- Pikes Peak Area TPR 2030 Plan
- Central Front Range TPR 2030 Plan
- Eastern Front Range TPR 2030 Plan
- Pueblo TPR 2030 Plan
- South Central TPR 2030 Plan
- Southeast TPR 2030 Plan
- Intermountain TPR 2030 Plan (for Summit County)
- I-70 Mountain Corridor Incident Management Plan, CDOT 2004
- Ports to Plains Corridor Development and Management Plan, Ports to Plains Steering Committee 2004
As indicated earlier, a number of related planning efforts concern the Project Area. These reports were reviewed as part of the project to determine previously identified transportation problems and to identify ITS initiatives that have been recommended during other planning efforts. The following is a brief summary of the documents reviewed for this study:

**Design Guidelines for Including ITS on Projects**, CDOT 2005 - The purpose of these guidelines is to assist engineers and planners in selecting the appropriate ITS elements so that they may be included in the planning of transportation projects. These guidelines can be accessed at the following web link: www.cotrip.org/ITS/policyguide.htm.

The **2030 Statewide Transportation Plan, Moving Colorado – Vision for the Future**, CDOT 2004 – This plan combined Colorado Transportation Commission policy and direction drawn from the state’s 15 Transportation Planning Regions (TPRs). The statewide plan identifies the following challenges:

- Rapid population growth,
- Growth of the 65 and older population,
- Increasing traffic congestion, and
- Funding shortfalls.

The goals identified in the statewide 2030 plan include the following Transportation Commission (TC) high priorities:

- Preserving, maintaining, and enhancing the existing transportation system.
- Judiciously expanding the system to respond to growth, and recognizing the opportunities provided by the Colorado Tolling Enterprise to incorporate new highways or additional lanes into the system.
- Recognizing the role of all modes of transportation in addressing mobility needs, and working with planning partners to leverage limited financial resources.

To meet these, CDOT focuses on four investment categories:

- System Quality – Maintaining the functionality and aesthetics of the existing transportation infrastructure.
- Mobility – Providing for the efficient movement of people, goods and information.
- Safety – Reducing fatalities, injuries and property damage for all users of the system through services and programs.
- Program Delivery – Providing for the successful delivery of CDOT projects and services.

ITS supports the TC high-priority goals and directly relates to the first three investment categories while this strategic plan and the accompanying architecture support the fourth category.

**2030 Statewide Transportation Plan, Intelligent Transportation System (ITS) Technical Report**, CDOT 2004 – This document provides a technical supplement to the statewide transportation plan regarding the role of ITS in the statewide plan. This document draws heavily on the ITS Strategic Plan, described below. The Technical Report identifies the current state of ITS deployment throughout the Colorado Department of Transportation described in terms of:

Infrastructure, including more than 1200 devices and the network infrastructure to communicate with them,

- Centers, the three main centers as well as other supporting centers,
- Software systems, primarily the Statewide Advanced Traffic Management System and the Advanced Traveler Information System,
- Owners, CDOT ITS Branch as well as CDOT regions, cities, counties, and transit agencies,
- Partners, the various agencies such as the State Patrol and the National Weather Service, that share information and resources with CDOT, and
- Users, including the traveling public as well as commercial vehicle operators and others.

This report also identifies the needs, funding and anticipated revenue for ITS in Colorado. Needs are identified in terms of 1) preventative maintenance and replacement of infrastructure, and 2) statewide enabling infrastructure (communications infrastructure including equipment and lateral connections on statewide corridors and improved and enhanced functionality at major TMCs) and strategic investments (infrastructure to deliver traveler information on statewide corridors). Preventative maintenance and replacement is anticipated to cost $10.3 million per year while needs for enabling infrastructure and strategic investments are estimated to be between $152 to $158 million over the next ten years, split between enabling infrastructure and strategic investments.

The Transportation Commission has allocated $3.5 million per year for preventative maintenance, while CDOT has relied primarily on federal discretionary earmarks, which require state matching funds for new construction. This technical report also illustrates the benefits of several ITS deployments in Colorado, describes the performance monitoring system for ITS investments, and the ITS maintenance management system that is being developed.

**Intelligent Transportation Systems Strategic Plan**, CDOT 2004 – CDOT ITS Branch prepared a statewide strategic plan to provide guidance and direction for current and future ITS investment and implementation across the state. This document also identifies as a key element the need to institutionalize the ITS Core Services into CDOT’s current business areas and functions.

The primary goal of the CDOT ITS Branch is to provide an overall traveler information and traffic management system that effectively utilizes the existing system and seamlessly grows to incorporate future system elements, and one in which information is managed as an asset of value to transportation system users and transportation providers of all types. The elements of the vision adopted to achieve this goal include:

- Improve mobility through maximization of productivity of existing transportation system.
- Improve mobility through travel choice and travel efficiency.
- Increase traveler safety.
- Increase intermodal connectivity and inter-jurisdictional coordination.

In order to provide an integrated statewide traveler information traffic management system, the strategic investment described in the plan focuses on two areas: 1) preventative maintenance and replacement of the existing infrastructure, and 2) statewide expansion of the enabling infrastructure. The maintenance and replacement considers a 15-year life cycle for devices, requiring roughly $19 million. The expansion of the enabling infrastructure includes:

- Completion and update of four traffic management centers (~$28.4 million)
- Completion of a statewide fiber optic network (~$58.5 million)
- Implementations expanding the number of traveler information system related field devices (~$77.5 million).
The deployment timeframe is tied to the availability of funding. The highest priority elements are the traffic management centers and the deployment of the long haul high-speed communication system elements.

Regional Transportation Plans
As noted previously, seven TPRs are contained in CDOT Regions 1 and 2:
- Pikes Peak Area TPR 2030 Plan
- Central Front Range TPR 2030 Plan
- Eastern Front Range TPR 2030 Plan
- Pueblo TPR 2030 Plan
- South Central TPR 2030 Plan
- Southeast TPR 2030 Plan
- Intermountain TPR 2030 Plan (for Summit County)

As part of the needs assessment, the goals identified for each TPR were reviewed. The following summarizes the findings of this review.

- Recurring themes in goals for the study area include:
  - Promote economic growth
  - Provide for multi-modal links
  - Enhance quality of travel (quality of life)
  - Increase and/or maintain safety, mobility and system quality
  - Promote environmental preservation
  - Maximize funds
  - Obtain public support

I-70 Mountain Corridor Incident Management Plan, CDOT 2004 – This document defines the incident management procedures and protocols for I-70 from the Utah border to the west side of the Denver Metro area. Participating agencies and their roles and responsibilities are defined throughout the corridor. A detailed inventory of ITS devices along with proposed locations for future devices is provided. The Plan establishes criteria regarding incident levels, i.e., 1 -3, identifies alternative routes and addresses agency roles and responsibilities and contact personnel.

Ports to Plains Corridor Development and Management Plan, Ports to Plains Coalition, 2004 – The Ports to Plains Corridor is a major highway route planned to run from Laredo, Texas to Denver, Colorado. This corridor is expected to carry significant interstate and international commercial vehicle traffic through the Southeastern plains. In Texas, this route is I-27, while in Colorado the route follows the US 287 alignment. The public outreach conducted during this study posed a series of questions in which the stakeholders were asked to rank the system functions that could be provided along the Ports to Plains Corridor. The questions about functions included the following examples.

- “The system should collect traffic data for monitoring traffic flow in the entire Corridor.”
- “The system should support automated clearance of commercial vehicles at roadside check facilities.”
- “The system should support the computer aided dispatch of emergency vehicles.”
After the stakeholders ranked the functions, requirements for ITS projects in the corridor were developed. The plan recommends that the following categories of functional requirements and user needs should be considered:

- Traffic Management Systems
- Commercial Vehicle Operations
- Emergency Management
- Traveler Information Systems
- Maintenance and Construction Management
- Archived Data Management

I.D. Conformance with the National ITS Architecture

In 1997, the Federal Highway Administration (FHWA) began preparing a National ITS Architecture and Standards in an effort to guide standardized development and deployment of ITS across America. The architecture established a framework to facilitate the regional deployment of ITS projects, while the standards help ensure the compatibility and maintainability of the deployed technologies.

On April 8, 2001, the FHWA established a Final Rule (the Rule) on the National ITS Architecture. The purpose of this rule was to foster integration between existing regional ITS and to ensure that subsequent deployments will be integrated into the existing systems. The Rule established that jurisdictions intending to deploy ITS projects and who wish to seek funding from the Highway Trust Fund must conform to the National ITS Architecture and appropriate standards.

The Rule requires that regions, which are already deploying ITS projects, must prepare a Regional ITS Architecture – a specific framework for ITS deployment tailored to the region from the National ITS Architecture. The Rule has also established April 8, 2005, as the deadline for such regions to have their Regional ITS Architecture prepared.

The purpose of this project is to develop a Regional ITS Architecture and an ITS Strategic Plan to guide the deployment of ITS applications in the study area over the next ten years. These documents will be developed in conformance with the National ITS Architecture Version 5.0.

Regional ITS Architecture

The provisions of the Transportation Equity Act for the 21st Century (TEA-21) requires that ITS projects carried out using funds made available by the Highway Trust Fund be in conformance with the National ITS Architecture and Standards. CDOT, under federal guidelines, is one of the agencies with a responsibility to ensure this conformance for ITS projects within the State of Colorado. The Regional ITS Architecture resulting from this study will address the elements noted in the Federal Highway Administration published rule 23 CFR Part 940, and the Federal Transit Administration’s parallel Policy.

The federal regulations require that a regional ITS architecture includes, at a minimum, the following eight elements:

1. A description of the region;
2. Identification of participating agencies and other stakeholders;
3. An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture;

4. Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture;

5. System functional requirements;

6. Interface requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture);

7. Identification of ITS standards supporting regional and national interoperability; and

8. The sequence of projects required for implementation.

The Regional ITS Architecture provides a framework for ensuring institutional agreement and technical integration for the implementation of the ITS projects as identified in the ITS Strategic Plan. The Regional ITS Architecture will be considered in the development of the Statewide ITS Architecture.

This Architecture also has been incorporated into Turbo Architecture, which is a software tool that will provide users: enhanced functionality in working with the required Architecture elements (identified below), the ability to access physical and logical diagrams at multiple levels, and will facilitate consistency, version control, maintenance and updating of the Regional Architecture.

**ITS Strategic Plan**

The ITS Strategic Plan provides a guide for ITS deployment in the study area over the next 10 years. Although there is currently no regulatory planning requirement to develop an ITS Strategic Plan, federal ITS rules and regulations call for the incorporation of ITS Architecture development and ITS project programming into the existing planning process in the region.

In order to meet the requirements to receive federal funding, an ITS project must demonstrate that a systems engineering analysis was performed during the design of the project. The systems engineering analysis process includes the following seven elements that must to be addressed to ensure a project conforms to the federal ITS requirements:

1. Description of how project fits into the Regional ITS Architecture
2. Roles and responsibilities of participating agencies
3. Requirements definition
4. Analysis of alternative system configurations and technology options
5. Procurement options
6. Applicable ITS standards and testing procedures
7. Procedures and resources necessary for operations and management of the system

The region will need to investigate modifying the TIP/STIP process to incorporate checking for compliance with the federal ITS requirements. The compliance screening would only apply to those projects that have been identified as ITS. A common approach is based upon “self-certification” by project sponsors affirming that they will comply with the ITS requirements. In this way, the project sponsor is taking responsibility for meeting the federal ITS requirements for
their project. An official that could commit the organization to compliance (i.e., Public Works Director, Transportation Director) would be required to authorize the certification. The self-certification would take place at two points in the project development cycle:

**Planning:** At the planning level, the project sponsor would provide a short description of how their ITS project would fit into the Regional ITS Architecture and agree to conduct a systems engineering analysis for the project during the design phase. If the project were not currently addressed in the Regional ITS Architecture, the applicable TPR would work with the project sponsor to modify the Regional ITS Architecture to encompass the project.

**Design (Prior to Construction):** Many of the details about the ITS elements of a project are developed in greater detail during the design phase. Providing in-depth details about the project’s compliance with the new federal ITS requirements is most appropriate during the design phase, prior to construction. The project sponsor would, again, “self-certify” that the systems engineering analysis was completed and provide information on the final project ITS Architecture and its relationship with the Regional ITS Architecture for the purpose of maintaining the Regional ITS Architecture. FHWA or FTA may independently request additional documentation on the systems engineering analysis before funds are released for construction. As with the architecture, the development of the next version of the Statewide ITS Architecture will consider the projects and activities identified in this ITS Architecture.

**I.E. Organization of this Report**

Following this introduction, Section 1, this report consists of six sections as follows:

Section II – Description of the Project Area: This section provides a description of the geography and demographics of the Project Area along with a description of the transportation system and the current state of ITS services and infrastructure.

Section III – Transportation Issues and Needs: This section provides a description of transportation needs and issues related to ITS as they were identified through associated planning studies, particularly the regional transportation plans, through stakeholder input, and through statewide ITS planning efforts.

Section IV – Market Package Plan: Presents the rationale as to which of the user services and market packages in the ITS National Architecture appropriately address the issues and needs of the region.

Section V – Operational Concept: This section provides a scenario-based approach to identifying the roles and responsibilities of major stakeholders as well as key interconnections and information flows.

Section VI – Implementation Plan: This section identifies the projects needed to implement the ITS goals, agreements and standards needed, provides the sequence for funding and implementation, and provides a Financial Summary.

Section VII – Next Steps: This section describes the steps that will be established to ensure that there is an adequate process in place to continue a forum to discuss, monitor, evaluate and amend elements within the Plan.
II. Description of the Region

The Project Area is comprised of CDOT Regions 1 and 2 covering the central and southern portions of the Front Range and Eastern Plains, including Summit County. The DRCOG portion of Region 1, which is not included, contains the nine counties surrounding Denver.

![Figure 2: Project Area](image)

II.A. Geography of the Region

Southeastern Colorado is comprised of CDOT Regions 1 and 2 covering the Southeastern portion of the state along with the Central Front Range and Summit County. Colorado is divided into 15 Transportation Planning Regions (TPRs) that are responsible for producing transportation plans within their particular area. These TPRs are defined and identified by geographic location (e.g., Eastern), and do not correspond exactly to CDOT’s Region boundaries. Southeastern Colorado includes the TPRs of: the Central Front Range, Pikes Peak Area, Pueblo, South Central and Southeast, plus Summit County (Intermountain TPR), along with Elbert, Lincoln, Kit Carson, and Cheyenne Counties located in the Eastern TPR.

The region is urbanized along the I-25 corridor from Pueblo to Colorado Springs, but the rest of it is predominantly rural, with mountains to the west and plains to the east. Colorado Springs and Pueblo are major urbanized areas. Other small urban areas in the region include: Limon, La Junta,
Lamar, Canon City, and Trinidad. Fountain is also considered a small urban area, but is rapidly being engulfed by the Colorado Springs urbanized area.

The counties in this Project Area that experienced the most growth from 1990 to 2000 represent Colorado’s primary urbanized centers, such as Pueblo and Colorado Springs. Summit County, which includes several of the state’s major ski destinations, including Breckenridge, Keystone, Copper Mountain, and Arapahoe Basin, contains the most accessible ski destinations from the Denver Metropolitan area, and experienced the most growth (172%) from 1990 to 2000.

Travel Destinations

This Project Area includes many of the major ski areas in Colorado, several National Parks and Monuments, and two Native American Tribal Lands — the Southern Ute and the Ute Mountain reservations. Tourism is an important economic element for most of the communities in Southeastern Colorado and presents several challenges. The seasonality of many attractions can make it difficult for businesses to remain viable and for their employees to maintain a consistent lifestyle. Local governments can likewise find it difficult to sustain the necessary infrastructure to accommodate large peaks in visitation during short seasons. Tourism-related service jobs have historically paid relatively low wages, which makes it difficult for service workers to afford living near their jobs. As a result many workers commute from outside the areas they work and turnover is often high.

Southeastern Colorado includes popular ski resorts most accessible to the Denver Metropolitan area including Breckenridge, Keystone, Copper Mountain, and Arapahoe Basin.

Southeastern Colorado also includes three sites under jurisdiction of the National Park Service, including Bent’s Old Fort, Sand Creek Massacre National Historic Sites, and Florissant Fossil Beds National Monument.

I-70 provides access to several tourist destinations, as well as numerous state highways that provide access to other attractions. In addition to the ski towns and resorts serviced by I-70, the highway also provides access to Glenwood Springs, which is a popular tourist destination year-round and is bisected by this interstate.

Several historic mountain towns now offer gambling, which has increased traffic on highways leading to Cripple Creek (west of Colorado Springs in Teller County), along with Black Hawk and Central City (west of Denver in Gilpin County). The Royal Gorge is another tourist destination, and is located on US 50 west of Pueblo. The Arkansas River, which parallels this highway, is popular with rafters, and several tourism companies provide boat trips along this section of the river. All major roadways heading west of I-25 provide access to popular mountain destinations in the western part of the state.

Military Installations

The Colorado Springs area contains the majority of Colorado’s military installations, including Peterson Air Force Base (AFB), Schriever AFB, the Air Force Academy, Fort Carson (US Army), and Cheyenne Mountain Air Station.

Peterson AFB is located adjacent to the city’s municipal airport, which is east of downtown Colorado Springs. During the 1970s and 1980s, the role of Peterson Air Force Base grew with the activation of the Strategic Air Command, U.S. Space Command and Air Force Space Command. The primary access route is US 24. The base is flanked by South Powers Road to the west and Marksheffel Road to the east.
Schriever Air Force Base, located approximately 10 miles east of Peterson AFB, is home to the Air Force's 50th Space Wing providing command and control for Department of Defense warning, navigational and communications satellites. The Space Warfare Center and the Ballistic Missile Defense Organization are also housed at Schriever AFB, and support strategic space systems and missile defense programs. The primary access route is SH 94.

The Air Force Academy is located off I-25 at Exit 156B, 14 miles north of Colorado Springs and comprises over 18,000 acres of land. Just over 4,200 cadets attend the Academy.

Fort Carson is a large Army base comprising 137,000 acres and lies between I-25 and SH 115 directly south and slightly west of Colorado Springs. Several Army units are assigned to this base, and it is home to the 3rd BCT, 43rd ASG, 3rd ACR, 5th Armored Brigade, 13th Air Support Operations Squadron, and the 10th Special Forces Group. Its western border parallels SH 115 almost in its entirety. The Pueblo Army Depot is a significant military installation on the east side of Pueblo.

II.B. Transportation

Highways

Principal highways in this Project Area include I-25 from Denver south to New Mexico, and I-70 from Kansas to Vail Pass. The Area also includes US 287 from Denver to Oklahoma, which has been designated as the Ports-to-Plains corridor, providing a major connection to I-27 in West Texas. US 350 traverses north to south across the Project Area joining with US 287 in Lamar. US 50 and US 160 are major east-west corridors to the Kansas state line. SH 94 and US 24 are major connectors from Colorado Springs to the east. US 285 is a major highway heading west and then south of Denver. For more specifics on highway locations see Figure 3.

Traffic counts across the Project Area are in highlighted in the Table 2 and Table 3 below:

<table>
<thead>
<tr>
<th>E-W Corridors</th>
<th>Area of Traffic Count</th>
<th>Average Vehicles-Per-Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-70</td>
<td>Project Area</td>
<td>8,300 – 11,500</td>
</tr>
<tr>
<td>SH 24</td>
<td>Project Area</td>
<td>2,200 – 7,200</td>
</tr>
<tr>
<td>US 50</td>
<td>Project Area</td>
<td>2,940 (East) – 11,000 (West of I-25)</td>
</tr>
<tr>
<td>US 160</td>
<td>Project Area</td>
<td>3,300 (West of I-25); 200 (East of I-25)</td>
</tr>
<tr>
<td>US 40</td>
<td>Project Area</td>
<td>500 – 2,300</td>
</tr>
<tr>
<td>SH 94</td>
<td>Arroya to Colorado Springs</td>
<td>390 – 4,400</td>
</tr>
<tr>
<td>SH 86</td>
<td>US 287 – I25</td>
<td>470 – 2,500</td>
</tr>
<tr>
<td>SH 10</td>
<td>Walsenburg to La Junta</td>
<td>400</td>
</tr>
<tr>
<td>SH 96</td>
<td>Westcliffe to Kansas</td>
<td>400 – 2,300</td>
</tr>
<tr>
<td>SH 165</td>
<td>SH 96 to (I-25) Colorado City</td>
<td>250 – 3,500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N-S Corridors</th>
<th>Area of Traffic Count</th>
<th>Average Vehicles-Per-Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-25</td>
<td>Project Area</td>
<td>8,300 – 28,000</td>
</tr>
<tr>
<td>US 385</td>
<td>Project Area</td>
<td>590 – 2,900 (North of US 50)</td>
</tr>
<tr>
<td>US 287</td>
<td>Project Area</td>
<td>1,700</td>
</tr>
<tr>
<td>SH 9</td>
<td>Henney to US 24</td>
<td>600 – 1,400</td>
</tr>
<tr>
<td>SH 69</td>
<td>Texas Creek to I-25</td>
<td>500 - 900</td>
</tr>
<tr>
<td>SH 12</td>
<td>US160 to Trinidad</td>
<td>670 – 3,400</td>
</tr>
<tr>
<td>SH 78</td>
<td>SH165 to Pueblo</td>
<td>400 – 1,600</td>
</tr>
<tr>
<td>SH 109</td>
<td>US160 to La Junta</td>
<td>300</td>
</tr>
<tr>
<td>SH 101</td>
<td>Las Animas to Springfield</td>
<td>300 - 500</td>
</tr>
<tr>
<td>SH 71</td>
<td>Lincoln County to Timpas (US 350)</td>
<td>480 - 670</td>
</tr>
</tbody>
</table>
It should be noted that the two major highways in the Project Area, I-25 and I-70 are substantially different in character depending on the area. I-70 is significantly different west of the Denver Metro Area. I-70 traffic west of Denver is approximately 15,000 Average Daily Traffic (ADT), which is the average vehicles-per-day, and to the east is approximately 8,000 to 11,000 ADT within the Project Area. For I-25, within the Project Area the character changes substantially south of Pueblo. North of Pueblo the ADT is approximately 28,000 and south of Pueblo the counts range from 8,000 to 14,000 ADT. The tables above provide information on the approximate range of ADT for each highway.

As the population has grown, so has traffic. Not only have traffic volumes increased, but trip lengths have increased as well, due in part to increased commuting between communities. As a result many of the communities experience severe traffic congestion, especially the resort communities.
Figure 3: Project Area Roadway Systems

ROADWAY SYSTEM MAP
FUNCTIONALLY CLASSIFIED ROADS (FC)

STATE HIGHWAYS
- Red: Other Principal Arterials
- Collectors and Minor Arterials
- Blue: Interstate

Legend: 10 miles

Map showing the project area roadway systems in Southeastern Colorado, including state highways.
Transit

The major urban centers in the Project Area are Colorado Springs and Pueblo. Existing public transportation services both publicly and privately owned and operated for Southeastern Colorado urban areas are described below.

The primary provider of transit within the Colorado Springs area is Springs Transit. Springs Transit is operated by a private contract firm. Springs Transit is ADA compliant (provides on demand service to the disabled) and provides service to Colorado Springs proper, Fountain, Security, Widefield, and some unincorporated areas of El Paso County. There are 23 daily routes and a fleet of 65 busses. The daily routes operate six days a week from approximately 6 am to 7 pm, with eight night routes operating until 10 pm. Springs Transit charges a basic rider fare of $1.25 and offers a variety of pre-pay options. The City of Colorado Springs is providing a new regional bus service by FREX (the Front Range Express) that stops 12 times daily in Fountain, Colorado Springs (2 stops), Monument, Castle Rock and Denver (3 stops). The cost for a one-way ticket ranges between $2.00 to $6.00 depending upon the length of the trip provided and offers a variety of pre-pay options. Colorado Springs just completed a rapid transit study in September 2004 to determine the feasibility of a rapid transit system for their city. Other services provided in the Colorado Springs area include Ambicab that provides transportation for the disabled with curb-to-curb and/or door to/through door service as needed. Other options for the disabled or elderly include Springs Mobility and Teller Senior Coalition that are similar to Ambicab. Fountain Valley Senior Services, Silver Key, and the Resource Center provide transportation services to senior citizens. Another branch of the Colorado Springs Transit Services Division is RideFinders that coordinates vans and car pool rides for people who need transportation and who desire an alternative to driving alone. Express Taxi and Yellow Cab also provide taxicab service in Colorado Springs. Various charter busses and airport shuttles/limousines provide service to the city as well.

The City of Pueblo is served by Pueblo Transit, which provides 12 bus routes throughout the city. The fare is $1.00 per ride. Bus frequencies range between headways of a half-hour to an hour. Other forms of public transportation offered in Pueblo include Citi-lift; an on demand service to qualified users, and SRDA a non-profit on-demand service for seniors including meal delivery. Pueblo County Social Services coordinates and subsidizes transportation services. City Cab provides taxi service in Pueblo. Colorado BlueSky Enterprises is a non-profit company that provides home-to-work tips to riders. Two other private transportation providers that serve the Pueblo area are Shuttle of Southern Colorado (airport service) and Ramblin’ Express (charter bus service).

Public transportation in Summit County is provided for free by the Summit Stage. Scheduled bus service is available to most ski areas, shopping centers, medical centers, and some residential areas in Summit County. It provides three types of bus routes: town-to-town, residential, and shuttle. The town-to-town routes are Breckenridge-Frisco, Copper Mountain – Frisco, Keystone-Frisco, and Silverthorne-Frisco. All town-to-town routes meet at Frisco Station. Residential routes to Boreas Pass and Warrior’s Mark depart from Breckenridge Station. The Wilderness route departs from Silverthorne Station. During the Ski Season the Stage contracts with Keystone Transportation to provide Arapahoe Basin Shuttle service between Keystone and Arapahoe Basin ski area. Bus service is available 365 days a year. Busses serve stops every hour.

The other non-urban/rural areas of Southeast Colorado have similar limited transportation services for the disabled and elderly that are provided in Colorado Springs and Pueblo, but do not
provide fixed route service for their communities, except for Summit County’s Summit Stage, due to limited financial resources and the comparatively lower ridership demands.

**Aviation**

Airports contribute to an area’s mobility and provide access to services, as well as help support economic activity. General Aviation services include fixed base operators, flight instruction, fueling, aircraft repair and maintenance, air taxi/charter, corporate flight departments, airport maintenance and administration, etc. Several General Aviation service facilities (14) and two commercial service facilities exist within this Project Area. The two commercial facilities are located in the vicinities of Colorado Springs and Pueblo. In addition, three military aviation facilities are located in the Project Area in close proximity to Colorado Springs.

**Rail**

Numerous rail facilities exist throughout the Project Area. The most represented railroad in the Area is the Burlington-Northern/Santa Fe Railroad primarily in the southern portion of the area along highway routes, such as I-25, SH 101, US 350, US 287 and US 50, US 385 and SH 96. Other major lines are in ownership of the Union Pacific railroad that owns lines primarily along I-25, US 50 and US 40/US 287. The South San Luis Valley railroad is concentrated in the urbanized areas of Colorado Springs and Pueblo and in the vicinity of Canon City.

### II.C. Existing ITS Services and Infrastructure

**ITS Services**

The following section describes the ITS services and infrastructure that currently exist in the Project Area. The service areas identified are grouped by what is referred to in the ITS National Architecture as ITS User Service Areas.

**Traffic and Travel Management**

- **Freeway Management** - The City of Colorado Springs operates a freeway management system on I-25 through the city. Currently this system is focused on information collection and dissemination, although the city and CDOT are considering ramp metering to regulate congestion on I-25. While high-occupancy vehicle (HOV) lanes have been discussed, the current plans are for continuous access HOV lanes; hence no additional ITS services are expected. This system is managed from the Colorado Springs Transportation Management Center (CSTMC). CDOT Region 2 also operates a freeway management system on I-25 through Pueblo. This system is also focused on information collection and dissemination and is managed primarily from the Region’s node building with backup support from the CTMC. CDOT Region 1 is implementing a freeway management system for I-70 through Summit and Clear Creek Counties, including ramp metering and service patrols. This system will be managed from the EJT TMC.

- **Incident Management** - An extensive incident management plan was developed for I-70 from the west side of the Denver region to the Utah border. This system uses the network of closed circuit TV (CCTV) cameras, variable message signs, call boxes, and advisory radio to respond to incidents in the corridor. The system identifies alternative routes, procedures and protocols and contact personnel and involves coordination between CDOT, the Colorado State Patrol, and local public works, police, fire and sheriffs departments. This has proven to be a very effective system. The Plan was currently updated as part of a biannual review process. The Plan also recommends additional
infrastructure/devices to be deployed in order to more effectively facilitate incident management strategies in the corridor.

Incident management plans have also been developed for I-25 through the Colorado Springs area and through the Trinidad area, although the Trinidad system has not been fully implemented. At the same time, large segments of interstate highway and other major highways are without comprehensive incident management plans.

- **Tunnel Management** - Tunnels present a unique set of issues for traffic management. Due to their constrained nature, it is important to manage the environment inside the tunnel with ventilation fans and pumps. It is also important to quickly identify and respond to incidents inside the tunnels. The EJT system is actively managed from a control center located in the tunnel complex. These tunnels have continuous surveillance along with lane use control signals, message boards, and traffic detectors. The tunnel control center also manages the devices on both approaches to the tunnels.

- **Rural Highways** - Rural highways present a unique challenge for ITS. Typically, these facilities extend for long distances with relatively low traffic volumes compared to urban highways. Furthermore, there is frequently a scarcity of infrastructure including communications and power. This is certainly the case in Southeastern Colorado. Despite these challenges CDOT has deployed arterial scale variable message signs at many critical decision points and installed remote weather stations in key segments of major roadways.

- **Arterial Management** - CDOT Region 2 operates and maintains approximately 100 traffic signals on State Highways primarily in and around Pueblo and Colorado Springs. The City of Colorado Springs maintains another 200 intersections while Pueblo maintains about 50. Region 1 operates and maintains about a dozen signals in this Project Area, although they maintain several more outside this area. The signals in Colorado Springs are operated by the City’s Advanced Traffic Management System. In Pueblo, CDOT and the city have jointly installed a traffic signal control system. The CDOT signals are all controlled by this system; however, the city’s signals have not been placed under system control due to communications issues. Region 1 controls the signals in Summit County on closed-loop systems.

**Traveler Information**

- In addition to the statewide traveler information system operated by CDOT from the CTMC, the City of Colorado Springs operates a local traveler information system for the Colorado Springs/Pikes Peak region. There are also several other small-scale information systems operating in Southeastern Colorado. Many of the communities provide information for local travelers via a City website. Some of the transit agencies also provide information to their passengers as well as the public. Colorado Springs Transit is actively pursuing a real-time transit traveler information system.

**Public Transportation Management**

- There are several transit agencies throughout Southeastern Colorado with varying degrees of sophistication and resources. Many of these agencies have deployed elements of transit management. Colorado Springs Transit is actively pursuing a number of transit management strategies including: automatic vehicle location (AVL), route scheduling, information kiosks, vehicle maintenance monitoring and transit signal priority. Summit Stage, the transit agency for Summit County is also planning to implement several transit management strategies and has programmed funding in their long-range plan. Other
transit agencies in the region are also exploring various levels of transit management systems.

**Vehicle Safety Systems**
- Vehicle safety systems are largely considered a private sector initiative in Colorado. These will be addressed in the Statewide Architecture instead of this effort since they have a much wider scope of application.

**Emergency Management**
- Colorado has recently completed an extensive statewide emergency management planning effort in response to several Homeland Security initiatives. Many of the local emergency management groups have already or are in the process of developing joint operations centers. Many of these agencies are also migrating, along with CDOT, to a statewide digital trunk radio (DTR) system to facilitate on-site coordination of emergencies and incidents.

**Data Management**
- Data Management -- Currently CDOT compiles databases of much of the information collected, especially that collected by the CTMC. However, there is also considerable data that is not compiled by CTMC either because the communication links do not exist, or because the data is being managed locally, such as traffic signal data. As a result, there are several islands of data throughout the Project Area.

- Communications -- Communications is a major weakness in Southeastern Colorado. With the exception of the I-70 corridor and I-25 south to Pueblo, CDOT has very little high-speed data communications. As a result, CDOT frequently has to rely on leased communications. Even then, there are major areas where high-speed communication is simply not available. Wireless communication can even be problematic. Large dead-zones in cell coverage exist throughout Southeastern Colorado. Deployment of the digital trunk radio system is hampered due to lack of towers and limited range in the mountainous areas.

The City of Colorado Springs is deploying an extensive fiber-optic system throughout town in support of the Advanced Transportation Management System (ATMS) and Digital Trunk Radio (DTR) to coordinate between maintenance, law enforcement, and emergency services.

**Maintenance and Construction Management**
CDOT is currently in the process of implementing a statewide program for maintenance of ITS infrastructure. In addition, CDOT uses ITS extensively to predict winter maintenance needs and to determine avalanche control measures. CDOT is participating in a FHWA sponsored project, Maintenance Decision Support System, and has outfitted several maintenance vehicles with AVL and other detectors. CDOT is requiring large construction projects to include project incident management systems during construction.
ITS Infrastructure

Several ITS elements are either currently deployed in this Project Area, or are in the process of being implemented. This includes the Colorado Springs ATMS, an advanced traffic signal system in Pueblo, closed-loop signal systems in Summit County, a freeway management system in Pueblo, and various degrees of transit management. There are also a number of dynamic message signs, closed-circuit television (CCTV) camera sites, call boxes, highway advisory radios, and remote weather stations. All of the major ports of entry (POE) have Pre-Pass systems installed, which provides the capability for commercial vehicles to bypass the POE providing their credentials and vehicle weights are in compliance. Incident management plans have been developed for I-70 west of the Denver metro area and for I-25 from Pueblo north. These systems are described in more detail below.

Since 1990, CDOT has invested more than $100 million into ITS infrastructure. While much of this has been in the Front Range, CDOT has made significant investments in Southeastern Colorado as well. More than 350 devices have been installed in Southeastern Colorado, as shown below, and several more are being installed.

### Table 4: Existing CDOT ITS Infrastructure

<table>
<thead>
<tr>
<th>ITS Device</th>
<th>Region 1</th>
<th>Region 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATR</td>
<td>15</td>
<td>26</td>
<td>41</td>
</tr>
<tr>
<td>ATR Piezo</td>
<td>6</td>
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<td>Callbox</td>
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<tr>
<td>CCTV</td>
<td>30</td>
<td>0</td>
<td>30</td>
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<td>Flood Warning System</td>
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<td>HAR</td>
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<tr>
<td>Lane Control Sign</td>
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<td>Over Height Detection</td>
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</tr>
<tr>
<td>Portable VMS</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>RTMS</td>
<td>11</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Static HAR Beacon Sign</td>
<td>10</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Tunnel**</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>VMS</td>
<td>39</td>
<td>27</td>
<td>66</td>
</tr>
<tr>
<td>Weather Station</td>
<td>12</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Weigh In Motion</td>
<td>7</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>287</td>
<td>64</td>
<td>351</td>
</tr>
</tbody>
</table>

*Includes all devices in CDOT Region 1, not just those in the Project Area.

**The following ITS devices are used for operations at the EJT tunnel: air velocity sensors, carbon monoxide sensors (14), CCTV-fixed (33), and CCTV-PTZ (57).

While many of these devices are concentrated along the I-25 and I-70 corridors, they are also distributed throughout Southeastern Colorado as shown on Figure 4.
Figure 4: Project Area ITS Infrastructure
(Southeastern Colorado)
In addition to these ITS devices, CDOT Regions 1 and 2 combined operate close to 115 traffic signals spread throughout the region. The City of Colorado Springs also manages close to 200 signals including managing CDOT and El Paso County traffic signals. Pueblo manages and operates another 50 signals.

**Traffic Management Centers**

Statewide ITS operations are managed through four major centers including the Colorado Springs Transportation Management Center (CS TMC). The EJT Transportation Management Center (EJT TMC) also manages all the ITS devices on both approaches to the tunnels as well as those inside the tunnels. The CDOT Regions, as well as other agencies, support and assist the centers with maintenance, coordination and other support services. The Colorado Transportation Management Center (CTMC) in the Denver area is also important to ITS in Southeastern Colorado.

The CTMC is responsible for coordinating and providing traveler information throughout the state, especially information dissemination. In Southeastern Colorado, information collection requires a coordinated effort between CS TMC and CTMC since CS TMC actually controls the devices on I-25 in the greater Colorado Springs area. Weather data is gathered from the National Weather Service as well as CDOT weather stations. The Colorado State Patrol and CDOT maintenance crews collect information on road conditions. CS TMC monitors traffic sensors, CCTV images, radar detectors, and other devices inside the Pikes Peak area, and by CTMC for the rest of the region. CS TMC data is forwarded to CTMC for dissemination. The CTMC aggregates and processes data before disseminating it through a variety of media. The primary sources for Pre-trip traveler information are the CDOT ITS website (www.cotrip.org), an automated telephone system and 511 service, broadcast fax, media reports, and wireless access to personal digital assistants (PDA’s)/palm pilots and cell phones. En-route information is disseminated via dynamic message signs and highway advisory radios.

The CS TMC primarily performs traffic management, incident management, and event management for the Pikes Peak Area. The EJT TMC performs the same functions for the tunnel approaches. Region 2 performs traffic management and freeway management for the portions of the region outside the Pikes Peak area from the Pueblo node building. CS TMC also is designed to function as a backup to the CTMC.
III. Transportation Issues and Needs

The architecture process followed both a top-down approach and a bottom-up approach at the same time. The top-down portion is described in the Strategic Goals section. This portion describes the bottom-up approach. Before ITS services could be identified and prioritized, it was necessary to identify the transportation problems in the region and the needs of the users, operators, and other stakeholders. This effort involved review of regional transportation plans, discussion with stakeholders, and examination of other transportation studies and projects in the region. This process identified the following critical issues.

- Weather and crash related incidents on I-70 and I-25;
- Weather related closures on mountain passes and eastern plains;
- Congestion in Colorado Springs and Pueblo;
- Congestion in mountain communities, especially Summit County, Woodland Park, and Cripple Creek/Victor;
- Special event impacts;
- Wildlife crashes;
- Natural or manmade emergencies;
- Lack of electrical power and communications infrastructure;
- Homeland security;
- Maintenance of ITS.

The process of identifying these issues and discussion of the needs follows.

III.A. TPR Goals

There are seven Transportation Planning Regions represented in CDOT Regions 1 and 2. They are:

- Central Front Range TPR
- Southeast TPR
- Pueblo Area TPR
- Pikes Peak Area TPR
- South Central TPR
- Portions of Eastern TPR
- Summit County (Intermountain TPR)

Each TPR was in the latter stages of developing their regional transportation plans during this project process. These regional transportation plans each contain an analysis of the transportation needs and goals in each TPR. Most all (six of seven) TPRs indicated they desired to promote economic development. The Eastern TPR specifically indicated improving transportation for farm to market movement of goods. The Pueblo Area TPR had the smallest list of goals related to mobility, livability, inter-modalism and implementation, while the Eastern TPR stood out for desiring the preservation of rail service. Community support and/or projects that address community needs were desired by most TPRs as well. Improving/enhancing air service was indicated for the Eastern, South Central and Central Front Range TPRs. Improving safety was identified for four out of seven TPRs. Preservation of natural/environmental resources was a goal
for most TPRs, with the Eastern TPR concerned with cost effective means for addressing environmental concerns. The Pueblo Area TPR makes mention of livability that alludes to preservation of existing resources. The Southeast TPR alludes to resource protection by preserving the agricultural economic base of the region and promoting improved air quality, bicycle facilities and enhancing transit opportunities.

Overall, the TPR’s in CDOT Regions 1 and 2 appear to be similar in terms of what they desire for their transportation system. Recurring themes in goals for TPRs in the study area include:

- Promote economic growth
- Provide for multi-modal links
- Enhance quality of travel (quality of life)
- Increase and/or maintain safety, mobility and system quality
- Promote environmental preservation
- Maximize funds
- Obtain public support

In addition, several TPRs specifically identified Traveler Information and other ITS applications as goals.

III.B. Stakeholder Needs and Issues Identified

A broad overview of needs and issues identified by research and results of the stakeholder workshops is provided below.

Communication Coordination and Connectivity

Communication coordination and connectivity is the foundation of ITS. Without the links and interfaces much of the value of ITS is lost. In general throughout Southeastern Colorado, except for the I-25 urban corridor, there is very little high-speed data communication, especially fiber optics. In many cases the high-speed data communication that does exist is not in the areas where it is needed. Cellular telephone coverage in Southeastern Colorado is also patchy outside the urban areas; some areas have very good coverage while others have no coverage at all. The coverage also varies dramatically between different cellular telephone carriers. In the mountainous areas, terrain disrupts wireless communications in general. In addition, there are many locations where telephone and electricity are not available for several miles. These communication limitations restrict the types of ITS elements that can be deployed and where they can be effectively deployed.

Where communication and information does exist it is often not shared because the connections between different entities are not present. For example, there is extensive, CCTV coverage throughout the Colorado Springs area and through Pueblo, but emergency dispatch personnel do not have direct access to this. Many jurisdictions have information that will be valuable to other jurisdictions but that information is not used due to lack of awareness, formatting, and other issues. For example, many rural dispatchers use latitude and longitude to dispatch emergency services. But, emergency calls frequently, are based on state highway number and milepost. At the same time, CDOT has a database referencing all the state highways and mile markers to latitude and longitude. This information exists, but it was not readily available to the 911-dispatch center. Because of this project, the database is being made available to dispatch centers that request it.
**Communication, Coordination, and Connectivity**

- Coordination of implementation
- Communications between states
- Communications between regions
- Citizen buy-in (congestion not bad enough yet)
- Social/cultural acceptance
- Internal/external education/awareness
- Streamlined communications and closures
- Limits on messages
- Streamlined communications between agencies
- Information feedback to improve accuracy
- Execution if incident management is breaking down due to complexity of communications
- Communication backbone
- Fast-paced technology
- Standardized implementation
- Better systems integration
- Link El Paso coordinated signals to Colorado Springs TMC
- Back-up operations
- Integration with Port to Plains project
- Improved information collection/dissemination
- Standardized ITS deployment
- Date retrieval for planning purposes
- Regional ITS Implementation Plan
- Storage of data in consistent database
- Coordinated ITS planning/design/implementation
- Comprehensive inventory
- Conduit should be included at beginning of projects
- Performance monitoring
- Tunnel communications (digital radio)
- Cell phone coverage
- Traffic signals/Traffic adaptive signal control (TASC)/Traffic response control (TRC)
- Coordination with KDOT
- Coordination with E-470
- Interface with DTR

**Traffic Congestion**

Congestion is becoming a major problem in Colorado Springs and, to a lesser degree, in Pueblo. Most rural routes, between communities, are not highly congested. However, many of the mountain communities, especially the resort towns, experience severe congestion on a recurring basis. This congestion is due to tourism and recreational travel as well as commuter travel. The cost of living in many Southeastern communities, especially the resort towns, forces much of the work force to live in other towns and commute. These communities are frequently located in narrow steep sided valleys making widening of roads or construction of parallel routes
problematic. The result is extreme congestion on narrow roads with few alternate routes. Secondary accidents as a result of congestion lead to further problems. Furthermore, the congestion leads to increased emissions in air pollutants, which degrade many of the environmental qualities these communities, rely on to attract visitors. In many of these communities, construction of additional capacity is cost prohibitive or has excessive negative impacts.

<table>
<thead>
<tr>
<th>Traffic Congestion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestion in urban areas</td>
</tr>
<tr>
<td>Military related congestion</td>
</tr>
<tr>
<td>Ramp metering for congestion</td>
</tr>
<tr>
<td>Unusual traffic peak volumes</td>
</tr>
</tbody>
</table>

**Trip and Mode Options**
Except for the cities of Colorado Springs and Pueblo, southeastern Colorado is characterized by a sparse roadway network where there are limited options for travel when traffic incidents occur. This is only exacerbated for travelers unfamiliar with the area, who don’t know even the limited alternate routes available. There's very little information on alternative routes in the event of closures. In addition, for many trips, few options to the automobile exist. Where options to the automobile are available, such as regional bus service, it is not always obvious to travelers where and when to take those options.

In Colorado Springs and Pueblo, growth continues to lead to increased levels of congestion. Providing alternative to single occupant vehicle travel is one approach to addressing congestion. In addition, alternatives are needed for those member of society who lack access to automobile travel. The security of passengers on transit systems is also an issue, both the security of passengers themselves as well as the transit operators.

<table>
<thead>
<tr>
<th>Trip and Mode Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit service expansion</td>
</tr>
<tr>
<td>Lack of alternative routes</td>
</tr>
<tr>
<td>Local access</td>
</tr>
<tr>
<td>Inter-modal facility</td>
</tr>
<tr>
<td>Alternate route for I-25</td>
</tr>
</tbody>
</table>

**Incidents and Special Events**
Many of the communities in southeastern Colorado hold special events that attract large number of visitors from throughout the state. Examples of this are the Air Force Academy Football Games, the Colorado State Fair other sporting event in Colorado Springs and races at the Pikes peak International Raceway. In addition, special events in the mountain communities, such as, World Cup Skiing, and the X-Games, affect Summit County as well as other mountain communities in the region. Also, there are many cycling races and other athletic events that attract competitors as well as spectators. These events frequently require road closures and detours that further complicate travel for visitors unfamiliar with the area as well as creating unwanted impacts within residential areas in the vicinity of the events.

Crashes, weather and other natural events can severely impact the transportation system throughout the Western Slope. These may require complete or partial closures of the road system several times throughout the year, adding considerable delay either due to congestion from the
incident, or the need to detour many miles around a closure. An example of this is Vail Pass, which is closed or restricted 20 to 30 times a year due to weather conditions. Each time it closes travelers must either wait for the road to reopen, or detour several miles out of the way.

A special class of special events, unique to the Colorado Springs area, is the various security measures taken around the military bases around the city. Due to differing security levels these measures can range from windshield checks to full-stop and search procedures. When the latter occurs it can create significant backups that disrupt the roadway network around the military bases.

<table>
<thead>
<tr>
<th>Incidents and Special Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rear-end crashes on I-25 north of Colorado Springs</td>
</tr>
<tr>
<td>Military incident management</td>
</tr>
<tr>
<td>Animal/wildlife crashes</td>
</tr>
<tr>
<td>Incident Management Plan</td>
</tr>
<tr>
<td>Updates of Incident Management Plan</td>
</tr>
<tr>
<td>Overly complex Incident Management Plan</td>
</tr>
<tr>
<td>De-icing</td>
</tr>
<tr>
<td>Weather impacts on roads</td>
</tr>
<tr>
<td>Incidents/avalanches/rockslides</td>
</tr>
<tr>
<td>Casinos</td>
</tr>
<tr>
<td>Rock falls</td>
</tr>
<tr>
<td>Truck spills</td>
</tr>
</tbody>
</table>

### Safety and Security

Safety and security have become increasingly important element of transportation in general and ITS specifically. There is a need to provide security for the overall transportation system, protecting the vehicles and infrastructure from damage either intentional or unintentional. In addition, there's a significant investment in ITS elements, the computers electronics and sensors, mandating a need to provide security for these assets as well. In addition, the significant military presence in Colorado Springs adds another dimension. Changes in alert status can lead to sudden changes in the security levels at military facilities leading to congestion that spills off site.

<table>
<thead>
<tr>
<th>Safety and Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Military related security</td>
</tr>
<tr>
<td>Public safety messages</td>
</tr>
<tr>
<td>Safety education</td>
</tr>
<tr>
<td>Enforcement platforms</td>
</tr>
<tr>
<td>Enforcement safety</td>
</tr>
<tr>
<td>Weather impacts on roads</td>
</tr>
<tr>
<td>Accidents on Monument Hill</td>
</tr>
<tr>
<td>Violations of road closures</td>
</tr>
<tr>
<td>Red light violators</td>
</tr>
</tbody>
</table>
Traveler Information

The nature of road closures, the resulting congestion, and other issues makes the provision of timely and accurate information to travelers especially important. Advising travelers well before they encounter congestion or closures allows them to avoid the incident altogether. It's also important to provide information to travelers before they depart so they can adjust their travel plans. Finally, there's a need to provide information to travelers traversing a detour route so that they know they are following the correct route.

<table>
<thead>
<tr>
<th>Traveler Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faster update of traveler information</td>
</tr>
<tr>
<td>Military base traveler information</td>
</tr>
<tr>
<td>Traffic enforcement messages</td>
</tr>
<tr>
<td>High wind-weather information</td>
</tr>
<tr>
<td>Setting up public expectations</td>
</tr>
<tr>
<td>Alternate route/detour information</td>
</tr>
<tr>
<td>Notify travelers of information further ahead</td>
</tr>
<tr>
<td>Tourism information more readily available</td>
</tr>
<tr>
<td>Weather impacts on roads</td>
</tr>
<tr>
<td>Drunk driving</td>
</tr>
</tbody>
</table>

Emergency Response

The timeliness of emergency response is a critical issue. Emergency response planners often speak of a “golden hour”. If emergency responders can treat injuries within the first hour of a crash, the severity of the injuries declines dramatically. Due to the long distances between some communities and a sparse roadway network, long response times are often a given. This makes it all the more important for timely and accurate identification of emergencies and determining the appropriate response.

<table>
<thead>
<tr>
<th>Emergency Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incident detection and response</td>
</tr>
<tr>
<td>Remote emergency response deployment</td>
</tr>
<tr>
<td>Reduced emergency response time</td>
</tr>
</tbody>
</table>

Maintenance and Construction

Managing maintenance and construction zones is also an increasingly important need. ITS can be a key tool for enhancing the safety of travelers as well as maintenance and construction workers. Maintenance of the ITS infrastructure is also a critical issue. These assets represent a considerable investment and must be maintained on an ongoing basis in order to sustain their effectiveness. In addition, more effective and timely use of deicing applications, particularly in mountain areas along with other routine maintenance activities, such as road-kill removal and weed control, would be made safer if real-time messaging is used to inform motorists of activities occurring along the roadway.
### Maintenance and Construction

- Traffic management in construction zones
- Accuracy of information in work zones
- Project specific work zone information (I-25)
- Funding/staffing for maintenance
- Training/awareness
- Dollars for operation and maintenance
- Reliability of hardware and system
- Trinidad Overland Pass construction
- Non-state highway rural arterials
- Ramp metering feasibility
- Work zone safety
- Coordination is needed to know elements required as construction projects are undertaken
- Reliability/maintenance

### Commercial and Freight Mobility

Commercial deliveries and freight are both important elements of transportation. This is especially true in the rural areas of Southeastern Colorado where these represent a higher percentage of traffic than they would in a more urban setting. Also, because they are more isolated, many of the mountain communities in Southeastern Colorado are highly dependent on commercial traffic to keep these towns supplied. However, trucks often have more difficulty on mountain roadways than vehicular traffic. As a result, it is important to provide timely information on road and weather conditions to commercial traffic. Another critical issue is the safety aspect of truck traffic. Trucks are more likely to lose their braking ability on steep hills, resulting in crashes. Furthermore, truck crashes tend to be more disruptive to the roadway. Hence, commercial and freight traffic is important enough to specifically address with ITS.

### Commercial and Freight Mobility

- Commercial vehicle traffic
- Truck speed/safety
- Overweight truck diversions
- Truck traffic- gravel pits
IV. Market Package Plan

Market packages are the building blocks of the National ITS Architecture. The process of identifying local issues, needs, and plans, and correlating them to ITS market packages provides the systems engineering perspective that is crucial to ITS planning (and required by the FHWA and FTA). Market packages provide an accessible, deployment-oriented perspective to the National Architecture and are tailored to fit - separately or in combination - real world transportation problems and needs. Market packages identify physical ITS elements that are required to implement a particular transportation service.

Market packages for the study area were selected to address the issues and needs as identified through the stakeholder process.

Market packages are grouped in the National ITS Architecture based upon the type of transportation service provided, as follows:

- **Advanced Traffic Management Systems (ATMS):** Manage operation of the roadway network.
- **Advanced Traveler Information Systems (ATIS):** Provide real-time information to travelers.
- **Advanced Public Transportation Systems (APTS):** Manage transit operations and make transit use more convenient and safe.
- **Emergency Management (EM):** Manage emergency response operations.
- **Maintenance and Construction Management (MCM):** Manage maintenance and construction activities and operations.
- **Archived Data Management (AD):** Store and retrieve transportation system information for future analysis.

IV.A. Advanced Traffic Management Systems

Several ATMS market packages are already in operation in various portions of the region, either by CDOT, the City of Colorado Springs, the City of Pueblo, or other stakeholders. There are several automatic traffic recorders along I-70, I-25 and other major highways (Network Surveillance), CDOT, Colorado Springs and Pueblo operate traffic signal systems (Surface Street Traffic Control), which include signalized railroad grade crossings (Standard Railroad Grade Crossing). Lane use control signs, variable message signs and cameras (Freeway Control) are controlled on I-70, especially through the Eisenhower-Johnson Tunnels and along I-25 through Colorado Springs. Variable message signs and highway advisory radio are used to provide traveler information (Traffic Information Dissemination) and to advise drivers of unsafe speeds (Speed Monitoring). CDOT and local jurisdictions provide incident management along I-25 and I-70 through the regions (Incident Management System) Additional services are needed to close mountain passes (Roadway Closure Management). CDOT has discussed coordinating traffic signals between jurisdictions in both Colorado Springs and Pueblo and sharing real-time data (Regional Traffic Control). Finally, while there are no specific plans, HOV lanes have been considered for I-25 through Colorado Springs so they may need special control in the future (HOV Lane Management). Table 5 lists the selected ATMS market packages for the study area.
### Table 5: Selected ATMS Market Packages

<table>
<thead>
<tr>
<th>Market Package Name</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Surveillance (exist.)</td>
<td>Collects information from field devices (detectors, CCTV, etc.) for monitoring or roadway conditions.</td>
</tr>
<tr>
<td>Surface Street Control (exist.)</td>
<td>Provide traffic signal control.</td>
</tr>
<tr>
<td>Freeway Control (exist.)</td>
<td>Control of devices installed along freeways, including control of cameras and dynamic message signs.</td>
</tr>
<tr>
<td>HOV Lane Management (prop.)</td>
<td>Manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals.</td>
</tr>
<tr>
<td>Traffic Information Dissemination (exist.)</td>
<td>Supports Dynamic Message Signs and Highway Advisory Radio</td>
</tr>
<tr>
<td>Regional Traffic Control (prop.)</td>
<td>Provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy.</td>
</tr>
<tr>
<td>Incident Management System (exist.)</td>
<td>Detects incidents and provides links between transportation and emergency management centers to exchange information.</td>
</tr>
<tr>
<td>Standard Railroad Grade Crossing (exist.)</td>
<td>Manages highway traffic at highway-rail intersections where rail operational speeds are less than 80 miles per hour.</td>
</tr>
<tr>
<td>Reversible Lane Management (exist.)</td>
<td>Monitors and controls reversible lanes through an interface to reversible lane field equipment.</td>
</tr>
<tr>
<td>Speed Monitoring (exist.)</td>
<td>Monitors speeds of vehicles on roadways. DMS can then be used to post a safe seed reminder.</td>
</tr>
<tr>
<td>Roadway Closure Management (prop.)</td>
<td>Support for remotely controlled gates or barriers that close off roads in unsafe conditions, plus camera surveillance and traveler information.</td>
</tr>
</tbody>
</table>

### IV.B. Advanced Traveler Information Systems

The two primary market packages for providing traveler information are Broadcast Traveler Information, which relies on existing, low-cost broadcast communications to “push” information out to travelers (such as via fax or public television), and Interactive Traveler Information, which provides customized information in response to a request, such as via a web site or through an Interactive Voice Response (IVR) phone system. There are several existing broadcast and interactive traveler information systems existing and planned, including city and CDOT web sites, HAR, CDOT road conditions faxes, and future CDOT 511 phone system.

Table 6 lists the selected ATIS market packages for the study area.

### Table 6: Selected ATIS Market Packages

<table>
<thead>
<tr>
<th>Market Package Name</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broadcast Traveler Information (exist.)</td>
<td>Dissemination of information over a wide area through existing infrastructures and low cost user equipment.</td>
</tr>
<tr>
<td>Interactive Traveler Information (exist.)</td>
<td>Provides tailored information in response to a traveler request. Includes dynamic web pages and 511-telephone information.</td>
</tr>
</tbody>
</table>

### IV.C. Advanced Public Transportation Systems

The three primary regional transit agencies in the study are have deployed various degrees of fixed-route operations demand response (Para-transit) and traveler information. All have
expressed the need for Automatic Vehicle Location (AVL), Computer Aided Dispatch (CAD), electronic fare collection, and improved transit traveler information. In addition, transit security and automated maintenance are needed to improve rider and operator safety and reduce operating costs. Colorado Springs Transit is moving ahead with deployment on a Transit management system including transit signal priority (Multi-modal Coordination).

Table 7 lists the selected APTS market packages for the study area.

### Table 7: Selected APTS Market Packages

<table>
<thead>
<tr>
<th>Market Package Name</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transit Vehicle Tracking (prop.)</td>
<td>Provide automatic vehicle location (AVL) to track transit vehicles.</td>
</tr>
<tr>
<td>Transit Fixed-Route Operations (exist.)</td>
<td>Performs automatic driver assignment and monitoring, as well as vehicle routing and scheduling for fixed-route services.</td>
</tr>
<tr>
<td>Demand Response Transit Operations (exist.)</td>
<td>Performs automatic driver assignment and monitoring as well as vehicle routing and scheduling for demand response transit services.</td>
</tr>
<tr>
<td>Transit Passenger and Fare Management (prop.)</td>
<td>Allows for the management of passenger loading and fare payments on-board vehicles using electronic means.</td>
</tr>
<tr>
<td>Transit Security (prop.)</td>
<td>Provides for the physical security of transit passengers.</td>
</tr>
<tr>
<td>Transit Maintenance (prop.)</td>
<td>Supports automatic maintenance scheduling and monitoring.</td>
</tr>
<tr>
<td>Multi-modal Coordination (prop.)</td>
<td>Establishes two-way communications between multiple transit and traffic agencies and transit signal priority.</td>
</tr>
<tr>
<td>Transit Traveler Information (exist.)</td>
<td>Provides customized or real-time transit information.</td>
</tr>
</tbody>
</table>

### IV.D. Emergency Management

The Emergency Management market packages include the dispatch and routing of emergency vehicles, support for roadway service patrols, and response to major disasters such as floods, earthquakes and terrorist attacks. Several of the Emergency Management market packages include functionality to access existing traveler information systems to disseminate emergency information. An example would be the use of CDOT DMS to post “Amber Alert” messages on behalf of emergency management agencies. All the emergency management market packages exist to varying degrees. The major challenge is integrating the emergency management centers with the traffic management centers where many of the devices are monitored and controlled.

Table 8 lists the selected EM market packages for the study area.

### Table 8: Selected EM Market Packages

<table>
<thead>
<tr>
<th>Market Package Name</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Response (exist.)</td>
<td>Provides computer-aided dispatch systems.</td>
</tr>
<tr>
<td>Mayday Support (exist.)</td>
<td>Supports response to requests for help from in-vehicle or call-box type systems.</td>
</tr>
<tr>
<td>Transportation</td>
<td>Uses surveillance cameras and sensors to monitor critical</td>
</tr>
</tbody>
</table>
### Market Package Name

<table>
<thead>
<tr>
<th>Infrastructure Protection (prop.)</th>
<th>infrastructures such as bridges, tunnels, etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wide-Area Alert (exist.)</td>
<td>Facilitates the use of ITS driver information devices (such as DMS and HAR) to spread emergency alert messages – example would be Amber Alerts.</td>
</tr>
<tr>
<td>Early Warning System (exist.)</td>
<td>Uses various types of sensors and monitors to facilitate early detection and warning of emergencies, including weather emergencies and terrorist attacks.</td>
</tr>
<tr>
<td>Disaster Response and Recovery (exist.)</td>
<td>Supports the overall coordinated response to emergencies by transportation, emergency response, and maintenance personnel.</td>
</tr>
<tr>
<td>Evacuation and Re-entry Management (exist.)</td>
<td>Supports coordination of evacuation plans by transportation and safety agencies as well as the subsequent return to the evacuation area.</td>
</tr>
<tr>
<td>Disaster Traveler Information (exist.)</td>
<td>Augments existing traveler information systems to provide emergency traveler information, such as evacuation routes, etc., in the event of a disaster.</td>
</tr>
</tbody>
</table>

### IV.E. Maintenance and Construction Management

Market packages in this service area may be linked to problems concerning maintenance vehicles, work zones, and collecting/distributing weather and road conditions data. Currently, both CDOT regions have deployed weather stations that are interconnected and can share data. Additionally, CDOT has deployed a statewide network of weather stations, the data from which are available on the Co-Trip web site as well as more detailed information available separately for CDOT maintenance. CDOT is further exploring instrumenting maintenance vehicles to collect more real-time road condition data and dispatch maintenance vehicles even sooner. CDOT is also trying to expand the locations where automatic deicing systems are employed.

Table 9 lists the selected MCM market packages for the study area.

#### Table 9: Selected MCM Market Packages

<table>
<thead>
<tr>
<th>Market Package Name</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance and Construction Vehicle and Equipment Tracking (prop.)</td>
<td>Tracks the location of maintenance and construction vehicles and other equipment.</td>
</tr>
<tr>
<td>Maintenance and Construction Vehicle Maintenance (prop.)</td>
<td>On-board diagnostics that provide maintenance and repair information for snowplows, trucks, etc.</td>
</tr>
<tr>
<td>Road Weather Data Collection (exist.)</td>
<td>Collection of weather and road conditions data using sensors installed near the roadway.</td>
</tr>
<tr>
<td>Weather Information Processing and Distribution (exist.)</td>
<td>Processing and dissemination of road/weather conditions information to travelers, maintenance workers, etc.</td>
</tr>
<tr>
<td>Roadway Automated Treatment (exist.)</td>
<td>Automated anti-icing systems for bridges and roadways.</td>
</tr>
<tr>
<td>Winter Maintenance (exist.)</td>
<td>Supports winter road maintenance including snowplow operations, roadway treatments (i.e., salt spraying, etc.)</td>
</tr>
<tr>
<td>Roadway Maintenance and Construction (exist.)</td>
<td>Supports scheduled and unscheduled maintenance and construction of ITS and non-ITS equipment.</td>
</tr>
</tbody>
</table>
### IV.F. Archived Data Management

Most ITS applications (i.e., traffic signal control systems) automatically generate information on transportation network performance and use. The implication is that each ITS application should include the ability to gather information to help develop improved operational plans and responses. The ITS Data Mart market package provides the basic data quality, data privacy, and data management common to all ITS archives and provides general query and report access to archive data users. This market package establishes a common framework to collect and archive data for each entity. In the study area, existing ITS Data Marts include the CDOT ITS DMS logs and weather station data, as well as local traffic volume and speed monitoring data.

The ITS Virtual Data Warehouse enables a network arrangement where multiple agencies can access multiple data archives directly without data actually being uploaded to a central location.

Table 10 lists the Archived Data market packages.

**Table 10: Selected Archived Data Market Packages**

<table>
<thead>
<tr>
<th>Market Package Name</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITS Data Mart (prop.)</td>
<td>Collect data for future analysis for one agency only.</td>
</tr>
<tr>
<td>ITS Virtual Data Warehouse (prop.)</td>
<td>Supports networked access to data archives for multiple agencies.</td>
</tr>
</tbody>
</table>
V. Operational Concept

The previous section identified the ITS market packages that address the most critical transportation issues in Southeastern Colorado. The Operational Concept identifies the stakeholders that will be responsible for implementing those services and their roles and responsibilities for those services. A detailed list of the stakeholders and their roles and responsibilities was developed using Turbo Architecture. Due to the large geographic area, the number of stakeholders, and the extensive list of roles and responsibilities, this list is not particularly insightful. In order to better illustrate the complex relationships of the stakeholders, a scenario-based approach is provided to illustrate the roles and responsibilities. This section provides an overview of these roles and responsibilities in the context of four specific operational scenarios. These operational scenarios are based on the strategic ITS objectives identified for Southeastern Colorado.

V.A. Strategic Goals

The analysis of ITS Needs and Services identified seven core services as well as necessary enabling infrastructure (communications and connectivity) to focus on in Southeastern Colorado. These are:

- Incident Management
- Traveler Information
- Freeway Traffic Management
- Arterial Traffic Management
- Transit Management and Multi-modal Coordination
- Safety Management
- Maintenance and Construction Management

In order to further clarify ITS Goals the region was divided into major sub-areas based on the unique characteristics of each sub-area. Key objectives for implementation were then identified in each sub-area for implementing the core ITS services. The sub-areas are:

- Summit County,
- Foothills and Mountains West of I-25,
- Pikes Peak/Colorado Springs Urbanized Area,
- Pueblo Urbanized Area,
- I-25 Corridor South of Pueblo,
- Eastern Plains.

Each sub-area and the strategic objectives are described below.

Summit County

This is a major destination for tourism and recreation travel as well as a significant urbanized area. Summit County 2003 estimated population is over 27,000 spread between Keystone, Dillon, Silverthorne, Frisco, Breckenridge, and Copper Mountain. This area experiences frequent congestion, especially during ski season. However, the busiest days on I-70 through the county are on the holiday weekends in the summer. The strategic objectives are:
• Install a high-speed fiber-optic telecommunications connection between the Hanging Lake Tunnels Transportation Management Center (HLT TMC) and the Eisenhower-Johnson Tunnel Transportation Management Center (EJT TMC);
• Complete the I-70 Mountain Corridor Incident Management System Improvements;
• Implement a freeway management system on I-70;
• Implement a pass management system for Loveland Pass and Vail Pass;
• Implement a transit management system with multi-modal coordination.

Foothills and Mountains West of I-25
This sub-area is predominately rural with a few small towns. Some of these towns are significant tourism or recreation destinations. The road network is sparse and few alternate routes exist. The strategic objectives are:
• Provide timely, accurate, and relevant traveler information;
• Develop incident management plans;
• Improve emergency response;
• Deploy automated pass maintenance and closure management systems.

Pikes Peak/Colorado Springs Urbanized Area
This is the largest urbanized area outside the Denver Metro area. Colorado Springs has already deployed freeway and surface street management systems which are managed and operated by the Colorado Springs Transportation Management Center (CS TMC). Colorado Springs Transit is developing an advanced transit management system as well. Congestion is a significant issue. The strategic objectives are:
• Expand the city’s Regional Arterial Traffic Management System and coordinate with adjacent signal operators;
• Develop a military traveler information system in the Colorado Springs area;
• Develop a regional ITS master plan for the Pikes Peak Area Council of Governments region;
• Provide communication links between emergency operations centers and the Colorado Springs Transportation Management Center (CS TMC);
• Expand the existing freeway management system;
• Develop regional incident and event management plans for the major highways off the interstate highway system and major event venues including the Air Force Academy;
• Develop a transit management system with multi-modal coordination.

Pueblo Urbanized Area
This is another major urbanized area in Southeastern Colorado. CDOT and Pueblo have jointly purchased a regional traffic signal system, but the inter-jurisdictional capabilities have not yet been fully realized. Congestion is a growing problem, but is not severe yet. Strategic objectives are:
• Provide arterial traffic management on state highways and other arterials through town;
• Implement freeway management strategies as congestion increases;
• Develop incident management plans and systems, especially on I-25 and US 50.
I-25 Corridor South of Pueblo

This is the rural portion of the I-25 corridor south of Pueblo. The roadway has long distances between towns with few services. Many stretches of highway lack telephone or electrical utility lines. Strategic objectives are:

- Install a high-speed fiber-optic telecommunications connection between Pueblo and the Colorado/New Mexico State line;
- Implement automated pass maintenance and closure management systems on I-25 at Raton Pass;
- Provide rural traveler information;
- Develop coordinated incident management plans and systems with county emergency management groups;
- Coordinate with emergency service providers to reduce emergency response time.

Eastern Plains

This is the rural portion of the region east of the I-25 urban corridor. It is characterized by long distances between towns, open spaces, limited services and high truck traffic. Strategic objectives are:

- Provide rural traveler information;
- Develop coordinated incident management systems with county emergency management groups.
- Coordinate with emergency service providers to reduce emergency response time.

Other Strategic Objectives

In addition to the sub-area objectives identified above, the following are recommended in the Project Area:

- Develop automated systems to detect wildlife for critical roadway sections;
- Provide customized access to CDOT traveler information for other stakeholders;
- Develop a communication master plan for rural areas of the Project Area.

V.B. Operational Scenarios

Four operational scenarios have been identified to illustrate the roles and responsibilities of the numerous stakeholders in Southeastern Colorado. These four scenarios are:

- Freeway and Incident Management on I-70 West of Denver
- Regional Traffic and Transit Management in Colorado Springs
- Freeway and Incident Management in Pueblo
- Rural Freeway Management on US 287 (Ports to Plains)

These four scenarios were chosen as representative of the range of roles and responsibilities covered by the regional architecture. Each scenario represents key aspects of the overall ITS implementation in Southeastern Colorado, highlighting key interfaces and information flows as well.
V.C. Freeway and Incident Management on I-70 West of Denver

I-70 is the most important east-west transportation corridor in Colorado. It carries more than half of all east-west travel and the majority of the travel destinations in the mountains are along or adjacent to the corridor. Furthermore, many of the important tourism destinations west of Denver are served by I-70. Due to the mountainous terrain and high elevations, weather related incidents occur often. Crashes are also more frequent due to the terrain and the geometry it imposes in the form of steep grades and sharp curves. In addition, for most of the corridor, there are few alternate routes and these require detours of up to 100 miles. Incidents occur regularly and they create major impacts due to the importance of the corridor for travel. Furthermore, increased traffic volumes have lead to significant congestion most weekends of the year. For these reasons, stakeholders identified freeway and incident management on I-70 west of Denver as one the most critical needs in the region.

Market Packages Included

Freeway and incident management on I-70 is based on the Freeway Control and the Incident Management System Market Packages, but also includes elements of the following Market Packages as well:

- **Network Surveillance** – this package includes the control of traffic sensors and surveillance cameras along the corridor as well as the collection of data from those.
- **Traffic Information Dissemination** – this package provides the posting of messages on dynamic message signs and highway-advisory radios along the corridor.
- **Roadway Closure Management** – provides control of automatic roadway closure gates on the corridor.
- **Broadcast Traveler Information** – while the Traffic Information Dissemination package provides HAR and DMS control, this package provides for dissemination of information to travelers outside the corridor through broadcast media such as radio and television.
- **Interactive Traveler Information** – this package supports corridor specific information to travelers through media such as the Internet and 511 service.
- **Emergency Response** – the package provides the support to receive emergency calls, identify the location, and initiate the proper response.
- **Mayday Support** – the package provides the support to automatic emergency notification services such as On Star.
- **Roadway Service Patrols** – supports service patrols that offer rapid response to minor incidents such as flat tires and stalls.
- **Reversible Lane Management** - monitors and controls reversible lanes through an interface to reversible lane field equipment.
- **Wide-Area Alert** – this package supports the dissemination of information throughout the statewide traveler information system where the magnitude of an incident warrants.
- **Road Weather Data Collection** – provides the management and control of environmental sensors both on the road and in instrumented maintenance vehicles.
- **Roadway Automated Treatment** – provides for automatic deicing of critical features such as bridges that tend to freeze early.
- **Work Zone Traffic Management** – coordinate work plans with maintenance systems so that work zones are established that have minimum traffic impact. Trafic controlstrategies are implemented to further mitigate trafic impacts associated with work zones that are established, providing work zone information on driver information systems such as dynamic message signs.
• **Work Zone Management** - directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, traffic management, other maintenance and construction centers) for better coordination management. Work zone speeds and delays are provided to the motorist prior to the work zone.

• **Archived Data Packages** – various elements of archived data management provide support for selecting detour routes, coordinating between agencies, converting between coordinate systems, and identifying resources for response.

**Roles and Responsibilities**

While there are numerous stakeholders, the critical ones for freeway and incident management on I-70 are the EJT TOC, the CTMC in Golden, Colorado, the county Emergency Operations Centers (EOCs), local emergency response agencies, the CSP, and the CDOT Region 1 traffic and maintenance offices. These critical stakeholders are described below along with their roles and responsibilities.

The CDOT EJT TOC controls all the ITS devices in and around the Eisenhower-Johnson Tunnel complex. This includes collecting information from sensors and cameras along the tunnels, controlling lane use signs, and posting messages on DMS and HAR. EJT TOC also functions as a point of contact for CDOT for incident management purposes. This streamlines coordination between emergency response forces and CDOT resources.

The CTMC manages the statewide traveler information system as well as functioning as a surrogate for Information Service providers. In the latter role, public information offices at CTMC provide all coordination with media. CTMC staff also update the CoTrip website, disseminate broadcast fax and email, update the 511 and telephone advisory system, and place messages on DMS and HAR as needed. CTMC also will provide secure video images to the EOC to support real-time decision-making at the EOC or incident command post. The current vision is that these images would be available over a secure Internet link, but this detail requires further study.

The county EOC functions as the Emergency Management Center as described in the architecture. The EOC is also considered to include the 911-Dispatch from a logical perspective. While this may not be physical accurate, from a functional perspective, it is generally true and the difference has little effect on the architecture. The EOC is responsible for receiving reports of an incident and dispatching the appropriate response. The EOC is also responsible for incident command and coordination of needed resources.

Emergency responders and CSP are primarily concerned with response to and clearing of the incident. They provide an initial assessment of the incident, take control of the scene, and initiate the appropriate incident management plans. They also determine any necessary lanes closures and when to reopen lanes to traffic. This includes determining the need to establish detours and alternate routes.

CDOT Region 1 Traffic Operations is responsible for control of ramp meters along the corridor and traffic signals on the adjacent street system. In the event of an incident, traffic operations staff would make any needed adjustments to signal timing or meter operation. After hours or on weekends, the CTMC will operate the signals and ramps.

CDOT Region 1 Maintenance forces provide resource such as signs, cones and barricades, and heavy equipment as may be needed to clear incident or control traffic during an incident. This may also include signing and control for detours and alternate routes. In this effort, they may call
upon county and local maintenance forces for additional resources. CDOT Maintenance is also responsible for clearing debris and restoring the roadway to operating conditions after the incident has been cleared.

V.D. Regional Traffic and Transit Management in Colorado Springs

Colorado Springs is the second largest metropolitan area in Colorado and the most populated region in southeastern Colorado. Under an agreement with CDOT, Colorado Springs manages all the ITS devices in the city including the freeway control devices and traffic signals on state highways. Colorado Springs Transit is also deploying an advanced transit management system, which will coordinate with traffic signal control in the city. This scenario focuses on the inter-jurisdictional and inter-modal coordination aspects.

Market Packages Included

This scenario focuses on the shared management and control of traffic management as well as the multi-modal coordination. The market packages include:

- **Surface Street Control** – this package provides the control and monitoring of the traffic signals in the corridor.
- **Freeway Control** – this package provides the communication and control for ramp control, especially wrong way entrance, and for freeway monitoring and surveillance, especially related to incident management.
- **Regional Traffic Control** – this package provides for the sharing of information and control among the city’s traffic control center, CDOT Region 3 traffic, and the HLT TMC.
- **Transit Vehicle Tracking** – this package provides the hardware and data management to determine the real-time location of transit vehicles.
- **Transit Fixed-Route Operations** – this package performs the vehicle routing and scheduling functions.
- **Multi-modal Coordination** – this market package provides the interface between RFTA and CDOT to improve services, especially through transit signal priority.
- **Transit Traveler Information** – this package provides users at stops and on-board transit vehicles with access to transit arrival and departure times.
- **Traffic Information Dissemination** – this package provides the posting of messages on dynamic message signs and highway-advisory radios along the corridor.
- **Roadway Closure Management** – provides control of automatic roadway closure gates on the corridor.
- **Broadcast Traveler Information** – while the Traffic Information Dissemination package provides HAR and DMS control, this package provides for dissemination of information to travelers outside the corridor through broadcast media such as radio and television.
- **Interactive Traveler Information** – this package supports corridor specific information to travelers through media such as the Internet and 511 service.
- **Emergency Response** – the package provides the support to receive emergency calls, identify the location, and initiate the proper response.
- **Mayday Support** – the package provides the support to automatic emergency notification services such as On Star.
- **Wide-Area Alert** – this package supports the dissemination of information throughout the statewide traveler information system where the magnitude of an incident warrants.
• **Archived Data Packages** – various elements of archived data management provide support for selecting detour routes, coordinating between agencies, converting between coordinate systems, and identifying resources for response.

**Roles and Responsibilities**

The key stakeholders in this scenario and the CS TMC, Colorado Springs Transit. The CTMC and CDOT Region 2 Traffic. These critical stakeholders are described below along with their roles and responsibilities.

The CS TMC manages all the devices on both the freeway and the surface street system in Colorado Springs. CS TMC gathers local road conditions from sensors and forwards them to the statewide traveler information system as well as using them for more localized management. CS TMC manages signal priority at signalized intersections.

The CTMC manages the statewide traveler information system as well as functioning as a surrogate for Information Service providers. In the latter role, public information offices at CTMC provide all coordination with media. CTMC staff also update the CoTrip website, disseminate broadcast fax and email, update the 511 and telephone advisory system, and place messages on DMS and HAR outside the area, as needed. CTMC also provides weekend and after-hours backup to the CS TMC.

Colorado Springs Transit manages the transit system in the service area. CS Transit provides transit traveler information via a website and telephone. The vision for the region also includes transit traveler information at stops and on vehicles, which would be operated by CS Transit. RFTA will also be responsible for communicating transit vehicle location to the transit signal priority system. They also acquire camera images and real-time travel information from CS TMC to use for estimating transit arrival times. In addition, transit vehicles may be used as probes to provide travel data to CS TMC.

CDOT Region 2 Traffic is responsible for operation and maintenance of the traffic signals and other devices on state highways outside city limits. Region 2 will coordinate operation of key signals with the City. Region 2 also shares camera images and traffic data with the City where communication facilities facilitate this sharing.

**V.E. Freeway and Incident Management in Pueblo**

Pueblo is an important crossroads for travel in southeastern Colorado. North-south traffic on I-25 intersects with east-west travel on US 50. Both highways serve regional, interregional, and interstate travel. I-25 connects the Colorado Springs and Denver regions with south-central Colorado as well as New Mexico. US 50 runs east from Pueblo to Kansas, connecting Pueblo with southeastern communities such as Lamar and La Junta. US 50 also extends to the west into the mountains to communities such as Canon City, Salida, Gunnison, and Montrose, extending all the way to Grand Junction where it ties into I-70. Incidents on either roadway can disrupt traffic in all directions as well as disrupting local traffic in Pueblo. In 2000 and 2001 CDOT, CSP and the city developed an incident management plan and began deploying CCTV and message signs along the I-25 corridor. This system facilitates rapid identification of and response to incidents along I-25 and timely dissemination of traveler information to the public.
Market Packages Included

Freeway and incident management in Pueblo is based on the Freeway Control and the Incident Management System Market Packages, but also includes elements of the following Market Packages as well:

- **Network Surveillance** – this package includes the control of traffic sensors and surveillance cameras along the corridor as well as the collection of data from those.
- **Traffic Information Dissemination** – this package provides the posting of messages on dynamic message signs and highway-advisory radios along the corridor.
- **Roadway Closure Management** – provides control of automatic roadway closure gates on the corridor.
- **Surface Street Control** – provides control of traffic signals along US 50 as well as interchanges on I-25 and adjacent signalized intersections.
- **Broadcast Traveler Information** – while the Traffic Information Dissemination package provides HAR and DMS control, this package provides for dissemination of information to travelers outside the corridor through broadcast media such as radio and television.
- **Interactive Traveler Information** – this package supports corridor specific information to travelers through media such as the Internet and 511 service.
- **Emergency Response** – the package provides the support to receive emergency calls, identify the location, and initiate the proper response.
- **Mayday Support** – the package provides the support to automatic emergency notification services such as On Star.
- **Wide-Area Alert** – this package supports the dissemination of information throughout the statewide traveler information system where the magnitude of an incident warrants.
- **Archived Data Packages** – various elements of archived data management provide support for selecting detour routes, coordinating between agencies, converting between coordinate systems, and identifying resources for response.

Roles and Responsibilities

While there are numerous stakeholders, the critical ones for freeway and incident management in Pueblo are the CTMC in Golden, Colorado, the city and county Emergency Operations Centers (EOCs), city and county emergency responders, Pueblo Police Department, the CSP, and CDOT Region 2 traffic operations and maintenance staff. These critical stakeholders are described below along with their roles and responsibilities.

The CTMC manages the statewide traveler information system, including monitoring of CCTV cameras and control message signs and advisory radio. CTMS also functions as a surrogate for Information Service providers. In the latter role, public information offices at CTMC provide all coordination with media. CTMC staff also update the CoTrip website, disseminate broadcast fax and email, update the 511 and telephone advisory system, and place messages on DMS and HAR as needed. CTMC also will provide secure video images to the EOC to support real-time decision-making at the EOC or incident command post. The current vision is that these images would be available over a secure Internet link, but this detail requires further study.

**CDOT Region 2** controls traffic signals on the state highways and freeway ramps, coordinates with Pueblo traffic engineering regarding adjacent traffic signals, and maintains devices along the corridors.

The **County EOC** functions as the Emergency Management Center as described in the architecture. The EOC is also considered to include the 911-Dispatch from a logical perspective.
While this may not be physical accurate, from a functional perspective, it is generally true and the difference has little effect on the architecture. The EOC is responsible for receiving reports of an incident and dispatching the appropriate response. The EOC is also responsible for incident command and coordination of needed resources.

**Pueblo Police Department and CSP** are responsible for traffic enforcement and accident investigation. They are also usually the first response on site and therefore usually provide incident command for short duration events. They provide an initial assessment of the incident, take control of the scene, and initiate the appropriate incident management plans. They also determine any necessary lanes closures and when to reopen lanes to traffic. This includes determining the need to establish detours and alternate routes.

**Emergency responders** are concerned with response to and clearing of the incident, medical assistance when needed, clearing hazardous materials and other emergency responses. They may provide a detailed assessment of complex incidents and take control of the scene in some circumstances including determining necessary lanes closures and when to reopen lanes to traffic when special conditions are involved.

**CDOT Region 2 Maintenance** forces also provide resource such as signs, cones and barricades, and heavy equipment as may be needed to clear incident or control traffic during an incident. This may also include signing and control for detours and alternate routes. In this effort, they may call upon county and local maintenance forces for additional resources. CDOT Maintenance is also responsible for clearing debris and restoring the roadway to operating conditions after the incident has been cleared.

**V.F. Rural Highway Management on US 287 (Ports to Plains)**

US 287 has been designated as the Ports to Plains corridor through Colorado. As such it is part of a highly important commercial vehicle route from the Mexico border to Denver. This route crosses through a rural, sparsely populated, portion of eastern and southeastern Colorado. Traveler services are minimal and separated by large distances due to the distances between population centers. Likewise, emergency and medical services are minimal. Winter driving conditions can be treacherous due to blowing snow and dust. This scenario defines the traveler information, incident management, and emergency response aspects of ITS in the corridor. While commercial vehicle travel is significant in the corridor, the commercial vehicle aspects of ITS are defined in the statewide architecture instead of this architecture since they are managed by the state Ports of Entry.

**Market Packages Included**

Rural highway management is based on the incident management and traffic information dissemination market packages, but includes elements of the following as well:

- **Network Surveillance** – this package includes the control of traffic sensors and surveillance cameras along the corridor as well as the collection of data from those.
- **Roadway Closure Management** – provides control of automatic roadway closure gates on the corridor.
- **Surface Street Control** – provides control of traffic signals along US 287 as well as adjacent signalized intersections.
- **Broadcast Traveler Information** – while the Traffic Information Dissemination package provides HAR and DMS control, this package provides for dissemination of information to travelers outside the corridor through broadcast media such as radio and television.
• **Interactive Traveler Information** – this package supports corridor specific information to travelers through media such as the Internet and 511 service.

• **Emergency Response** – the package provides the support to receive emergency calls, identify the location, and initiate the proper response.

• **Mayday Support** – the package provides the support to automatic emergency notification services such as On Star.

• **Wide-Area Alert** – this package supports the dissemination of information throughout the statewide traveler information system where the magnitude of an incident warrants.

• **Road Weather Data Collection** – provides monitoring and control of roadside devices for collecting environmental data and for distributing the information to the necessary stakeholders. This package also includes data collection from instrumented maintenance vehicles.

• **Archived Data Packages** – various elements of archived data management provide support for selecting detour routes, coordinating between agencies, converting between coordinate systems, and identifying resources for response.

### Roles and Responsibilities

While there are numerous stakeholders, the critical ones for rural highway management on US 287 are the CTMC in Golden, Colorado, the county Emergency Operations Centers (EOCs), county emergency responders, the CSP and county sheriffs, and both CDOT Region 2 and Region 1 traffic operations and maintenance staff. These critical stakeholders are described below along with their roles and responsibilities.

The CTMC manages the statewide traveler information system, including monitoring of CCTV cameras and control message signs and advisory radio. CTMS also functions as a surrogate for Information Service providers. In the latter role, public information offices at CTMC provide all coordination with media. CTMC staff also update the CoTrip website, disseminate broadcast fax and email, update the 511 and telephone advisory system, and place messages on DMS and HAR as needed. CTMC also will provide secure video images to the EOC to support real-time decision-making at the EOC or incident command post. The current vision is that these images would be available over a secure Internet link, but this detail requires further study.

CDOT Region 1 and Region 2 traffic controls traffic signals on US 287 and adjacent traffic signals, and maintains devices along the corridors.

The County EOC functions as the Emergency Management Center as described in the architecture. The EOC is also considered to include the 911-Dispatch from a logical perspective. While this may not be physical accurate, from a functional perspective, it is generally true and the difference has little effect on the architecture. The EOC is responsible for receiving reports of an incident and dispatching the appropriate response. The EOC is also responsible for incident command and coordination of needed resources.

County sheriffs and CSP are responsible for traffic enforcement and accident investigation. They are also usually the first response on site and therefore usually provide incident command for short duration events. They provide an initial assessment of the incident, take control of the scene, and initiate the appropriate incident management plans. They also determine any necessary lane closures and when to reopen lanes to traffic. This includes determining the need to establish detours and alternate routes.

Emergency responders are concerned with response to and clearing of the incident, medical assistance when needed, clearing hazardous materials and other emergency responses. They may
provide a detailed assessment of complex incidents and take control of the scene in some circumstances including determining necessary lanes closures and when to reopen lanes to traffic when special conditions are involved.

CDOT Region 1 and Region 2 Maintenance forces also provide resource such as signs, cones and barricades, and heavy equipment as may be needed to clear incident or control traffic during an incident. This may also include signing and control for detours and alternate routes. In this effort, they may call upon county and local maintenance forces for additional resources. CDOT Maintenance is also responsible for clearing debris and restoring the roadway to operating conditions after the incident has been cleared.

V.G. Functional Requirements

Functional requirements are one of the mandatory components of a regional ITS architecture as identified in the FHWA/FTA rules and policies. Functional requirements identify the tasks or activities that are, or will be, performed by each system or subsystem in the region. Detailed functional requirements are generally best left to project architectures or design. At the regional architecture level these are high-level descriptions of the tasks derived from the operational concept. In the context of the National ITS Architecture functional requirements can be stated in terms of Equipment Packages, implementable groupings of processes within a given subsystem.

The major physical entities in the regional architecture, the equipment packages and high-level functional requirements are described below.

**CDOT ITS Branch**

**Government Reporting Systems Support** - select and format data residing in an ITS archive to facilitate local, state, and federal government data reporting requirements.

**ITS Data Repository** - collect data and data catalogs from one or more data sources and stores the data in a focused repository that is suited to a particular set of ITS data users.

**Traffic and Roadside Data Archival** - collect and archive traffic, roadway, and environmental information for use in off-line planning, research, and analysis. The equipment package controls and collects information directly from equipment at the roadside, reflecting the deployment of traffic detectors that are used primarily for traffic monitoring and planning purposes rather than for traffic management.

**Virtual Data Warehouse Services** - provide capabilities to access "in-place" data from geographically dispersed archives and coordinate information exchange with a local data warehouse. While many of the functions performed by this equipment package are similar to the functions inherent in other archived data management subsystem equipment packages (e.g. data management, fusion, analysis) this equipment package also provides the specialized publishing, directory services, and transaction management functions associated with coordinating remote archives.

**Colorado Transportation Management Center**

The CTMC functions as a traffic management center and as an ISP in addition to functioning as a backup to the Colorado Springs TMC.

**Traffic Data Collection** - collect and stores traffic information that is collected in the course of traffic operations performed by the Traffic Management Subsystem. This data can be
used directly by operations personnel or it can be made available to other data users and archives in the region.

**Collect Traffic Surveillance** - remotely monitor and controls traffic sensors and surveillance (e.g., CCTV) equipment, and collects, processes and stores the collected traffic data. The collected information is provided to traffic operations personnel and made available to other centers.

**Traffic Maintenance** - monitor the operational status of field equipment and detect failures. Field equipment status is presented to Traffic Operations Personnel and failures are reported to the Maintenance and Construction Management Subsystem.

**TMC Freeway Management** - provide center monitoring and control of freeway traffic control systems including overhead lane control signals, freeway mainline metering, and variable speed control systems.

**TMC HOV Lane Management** - this market package manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals. Preferential treatment is given to HOV lanes using special bypasses, reserved lanes, and exclusive rights-of-way that may vary by time of day. Vehicle occupancy detectors may be installed to verify HOV compliance and to notify enforcement agencies of violations.

**TMC Traffic Information Dissemination** - disseminate traffic and road conditions, closure and detour information, incident information, driver advisories, and other traffic-related data to other centers, the media, and driver information systems and monitor and control driver information system field equipment including dynamic message signs and highway advisory radio, managing dissemination of driver information through these systems.

**TMC Incident Detection** - identify and report incidents to Traffic Operations Personnel by remotely monitoring and controlling traffic sensor and surveillance systems that support incident detection and verification.

**TMC Incident Dispatch Coordination/Communication** - formulate and manage an incident response taking into account the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.

**TMC Speed Monitoring** - remotely monitor and control speed monitoring and speed warning systems. This equipment package can also notify an enforcement agency if excessive speeds are identified.

**Barrier System Management** - remotely monitor and control barrier systems for transportation facilities and infrastructure under control of center personnel. Barrier systems include automatic or remotely controlled gates, barriers and other access control systems.

**TMC Evacuation Support** - support development, coordination, and execution of special traffic management strategies during evacuation and subsequent reentry of a population in the vicinity of a disaster or major emergency.

**TMC Environmental Monitoring** - assimilate current and forecast road conditions and surface weather information using a combination of weather service provider information,
information collected by other centers such as the Maintenance and Construction Management Subsystem, and data collected from environmental sensors deployed on and about the roadway.

**ISP Data Collection** - collect and store traveler information that is collected in the course of operation of the ISP subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.

**Basic Information Broadcast** - collect, process, store, and disseminate traveler information including traffic and road conditions, incident information, maintenance and construction information, event information, transit information, parking information, and weather information. The same information is broadcast to all equipped traveler interface systems and vehicles.

**ISP Traveler Data Collection** - collect traveler-related data from other centers, consolidate, verify, and refine the collected data, and make this data available in a consistent format to applications that deliver traveler information.

**Traveler Telephone Information** - service voice-based traveler requests for information that supports traveler telephone information systems such as 511. In addition to servicing requests for traveler information, this equipment package also collects and forwards alerts and advisories to traveler telephone information systems.

**ISP Emergency Traveler Information** - collect and provide emergency information to the public, including wide-area alerts and evacuation information; provide emergency alerts, information on evacuation zones and evacuation requirements, evacuation destinations and shelter information, available transportation modes, and traffic and road conditions at the origin, destination, and along the evacuation routes.

**Eisenhower-Johnson Tunnel TOC**

**Traffic Data Collection** - collect and stores traffic information that is collected in the course of traffic operations performed by the Traffic Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.

**Collect Traffic Surveillance** - remotely monitor and controls traffic sensors and surveillance (e.g., CCTV) equipment, and collects, processes and stores the collected traffic data. The collected information is provided to traffic operations personnel and made available to other centers.

**Traffic Maintenance** - monitor the operational status of field equipment and detect failures. Field equipment status is presented to Traffic Operations Personnel and failures are reported to the Maintenance and Construction Management Subsystem.

**TMC Freeway Management** - provide center monitoring and control of freeway traffic control systems including overhead lane control signals, freeway mainline metering, and variable speed control systems.

**TMC Traffic Information Dissemination** - disseminate traffic and road conditions, closure and detour information, incident information, driver advisories, and other traffic-related data to other centers, the media, and driver information systems and monitor and control
ITS Architecture for Southeastern Colorado

driver information system field equipment including dynamic message signs and highway advisory radio, managing dissemination of driver information through these systems.

**TMC Incident Detection** - identify and report incidents to Traffic Operations Personnel by remotely monitoring and controlling traffic sensor and surveillance systems that support incident detection and verification.

**TMC Incident Dispatch Coordination/Communication** - formulate and manage an incident response taking into account the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.

**TMC Reversible Lane Management** - remotely monitor and control reversible lanes through an interface to reversible lane field equipment (traffic sensors, surveillance equipment, lane control signals, physical lane access controls, etc.) and to traffic operations personnel to support central monitoring and control of these facilities.

**TMC Speed Monitoring** - remotely monitor and control speed monitoring and speed warning systems. This equipment package can also notify an enforcement agency if excessive speeds are identified.

**Barrier System Management** - remotely monitor and control barrier systems for transportation facilities and infrastructure under control of center personnel. Barrier systems include automatic or remotely controlled gates, barriers and other access control systems.

**Safeguard System Management** - remotely monitor and control safeguard systems for transportation facilities and infrastructure. Safeguard systems include blast shielding, exhaust systems and other automatic or remotely controlled systems intended to mitigate the impact of an incident.

**TMC Evacuation Support** - support development, coordination, and execution of special traffic management strategies during evacuation and subsequent reentry of a population in the vicinity of a disaster or major emergency.

**TMC Environmental Monitoring** - assimilate current and forecast road conditions and surface weather information using a combination of weather service provider information, information collected by other centers such as the Maintenance and Construction Management Subsystem, and data collected from environmental sensors deployed on and about the roadway.

**CDOT Region 1 and Region 2 Traffic**

**Traffic Maintenance** - monitor the operational status of field equipment (esp. traffic signals) and detect failures.

**TMC Signal Control** - provide the capability for traffic managers to monitor and manage the traffic flow at signalized intersections including analyzing and reducing the collected data from traffic surveillance equipment and developing and implementing control plans for signalized intersections.

**TMC Regional Traffic Control** - support coordination between traffic management centers in order to share traffic information between centers as well as control of traffic
management field equipment. This coordination supports wide area optimization and regional coordination that spans jurisdictional boundaries; for example, coordinated signal control in a metropolitan area or coordination between freeway operations and arterial signal control within a corridor.

**TMC Multimodal Coordination** - support center-to-center coordination between the Traffic Management and Transit Management Subsystems, monitor transit operations, and provides traffic signal priority for transit vehicles on request from the Transit Management Subsystem.

**TMC Work Zone Traffic Management** - coordinate work plans with maintenance systems so that work zones are established that have minimum traffic impact. Traffic control strategies are implemented to further mitigate traffic impacts associated with work zones that are established, providing work zone information on driver information systems such as dynamic message signs.

**CDOT Region 1 and Region 2 Maintenance**

**MCM Data Collection** - collect and store maintenance and construction information that is collected in the course of operations by the Maintenance and Construction Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.

**MCM Incident Management** - support maintenance and construction participation in coordinated incident response. Incident notifications are shared, incident response resources are managed, and the overall incident situation and incident response status is coordinated among allied response organizations.

**MCM Vehicle Tracking** - tracks the location of maintenance and construction vehicles and other equipment. Vehicle location and associated information is presented to the operator.

**MCM Vehicle and Equipment Maintenance Management** - monitors vehicle and equipment condition, tracks maintenance history, and schedules routine and corrective maintenance based on vehicle utilization and availability schedules.

**MCM Environmental Information Collection** - collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. In addition to fixed sensor stations at the roadside, this equipment package also collects environmental information from sensor systems located on Maintenance and Construction Vehicles. It also collects current and forecast environmental conditions information that is made available by other systems.

**MCM Environmental Information Processing** - processes current and forecast weather data, road condition information, local environmental data, and uses internal models to develop specialized detailed forecasts of local weather and surface conditions. The processed environmental information products are presented to center personnel and disseminated to other centers.

**MCM Automated Treatment System Control** - remotely monitors and controls automated road treatment systems that disperse anti-icing chemicals or otherwise treat a road segment. The automated treatment system may be remotely activated by this equipment package or it may include environmental sensors that activate the system automatically based on
sensed environmental conditions. This equipment package monitors treatment system operation, sets operating parameters, and directly controls system activation if necessary.

**MCM Work Zone Management** - remotely monitors and supports work zone activities, controlling traffic through dynamic message signs (DMS), Highway Advisory Radio (HAR), gates and barriers, and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds, and delays, and closures are provided to the motorist prior to the work zones. This equipment package provides control of field equipment in all maintenance areas, including fixed and portable field equipment supporting both stationary and mobile work zones.

**MCM Work Activity Coordination** - disseminates work activity schedules and current asset restrictions to other agencies. Work schedules are coordinated with operating agencies, factoring in the needs and activities of other agencies and adjacent jurisdictions. Work schedules are also distributed to Information Service Providers for dissemination to the traveling public.

**CDOT Maintenance Vehicles**

**MCV Vehicle Location Tracking** - This on-board equipment package tracks vehicle location and reports the position and timestamp information to a dispatch center.

**MCV Environmental Monitoring** - This on-board equipment package collects current road and surface weather conditions from sensors on-board the maintenance and construction vehicle or by querying fixed sensors on or near the roadway. Environmental information including road surface temperature, air temperature, and wind speed is measured and spatially located and time stamped, and reported back to a center.

**CDOT Roadside Devices**

**Roadway Data Collection** - collects traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications where data quality and completeness take precedence over real-time performance. This equipment package includes the sensors, supporting roadside infrastructure, and communications equipment that collects and transfers information to a center for archival.

**Roadway Signal Priority** - includes the field elements that receive signal priority and/or signal preemption requests from vehicles approaching a signalized intersection and controls traffic signals accordingly. Depending on the type of request and implementation, this equipment package may override (preempt) current signal timing or delay phase transition. In signal priority systems, the request for priority may or may not be granted, based on the overall traffic situation at the intersection.

**Roadway Basic Surveillance** - monitor traffic conditions using fixed equipment such as loop detectors and CCTV cameras.

**Roadway Equipment Coordination** - support direct communications between field equipment. It includes field elements that control and send data to other field elements. This includes coordination between remote sensors and field devices (e.g., Dynamic Message Signs) and coordination between the field devices themselves (e.g., direct coordination between traffic controllers that are controlling adjacent intersections).
**Roadway Signal Controls** - includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, signal heads, detectors, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. Represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems.

**Roadway Freeway Control** - includes the field equipment used to control traffic on freeways including ramp meters, interchange connector meters, mainline meters, and lane control signals.

**Roadway Traffic Information Dissemination** - includes field elements that provide information to drivers, including dynamic message signs and highway advisory radio.

**Roadway Speed Monitoring** - includes the field elements that monitor vehicle speeds. If the speed is determined to be excessive, then roadside equipment can suggest a safe driving speed. Environmental conditions may be monitored and factored into the safe speed advisories that are provided to the motorist. The operational status (state of the device, configuration, and fault data) is provided to the center. This equipment package can also provide an enforcement function, reporting speed violations to an enforcement agency.

**Field Barrier System Control** - includes the field equipment that controls barrier systems used to control access to transportation facilities and infrastructure. Barrier systems include automatic or remotely controlled gates, barriers and other access control systems.

**Colorado Springs TMC**

**Traffic Data Collection** - collect and stores traffic information that is collected in the course of traffic operations performed by the Traffic Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.

**Collect Traffic Surveillance** - remotely monitor and controls traffic sensors and surveillance (e.g., CCTV) equipment, and collects, processes and stores the collected traffic data. The collected information is provided to traffic operations personnel and made available to other centers.

**Traffic Maintenance** - monitor the operational status of field equipment and detect failures. Field equipment status is presented to Traffic Operations Personnel and failures are reported to the Maintenance and Construction Management Subsystem.

**TMC Freeway Management** - provide center monitoring and control of freeway traffic control systems including overhead lane control signals, freeway mainline metering, and variable speed control systems.

**TMC Traffic Information Dissemination** - disseminate traffic and road conditions, closure and detour information, incident information, driver advisories, and other traffic-related data to other centers, the media, and driver information systems and monitor and control driver information system field equipment including dynamic message signs and highway advisory radio, managing dissemination of driver information through these systems.
TMC Incident Detection - identify and report incidents to Traffic Operations Personnel by remotely monitoring and controlling traffic sensor and surveillance systems that support incident detection and verification.

TMC Incident Dispatch Coordination/Communication - formulate and manage an incident response taking into account the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.

TMC Speed Monitoring - remotely monitor and control speed monitoring and speed warning systems. This equipment package can also notify an enforcement agency if excessive speeds are identified.

Barrier System Management - remotely monitor and control barrier systems for transportation facilities and infrastructure under control of center personnel. Barrier systems include automatic or remotely controlled gates, barriers and other access control systems.

Safeguard System Management - remotely monitor and control safeguard systems for transportation facilities and infrastructure. Safeguard systems include blast shielding, exhaust systems and other automatic or remotely controlled systems intended to mitigate the impact of an incident.

TMC Evacuation Support - support development, coordination, and execution of special traffic management strategies during evacuation and subsequent reentry of a population in the vicinity of a disaster or major emergency.

TMC Environmental Monitoring - assimilate current and forecast road conditions and surface weather information using a combination of weather service provider information, information collected by other centers such as the Maintenance and Construction Management Subsystem, and data collected from environmental sensors deployed on and about the roadway.

Traffic Maintenance - monitor the operational status of field equipment (esp. traffic signals) and detect failures.

TMC Signal Control - provide the capability for traffic managers to monitor and manage the traffic flow at signalized intersections including analyzing and reducing the collected data from traffic surveillance equipment and developing and implementing control plans for signalized intersections.

TMC Regional Traffic Control - support coordination between traffic management centers in order to share traffic information between centers as well as control of traffic management field equipment. This coordination supports wide area optimization and regional coordination that spans jurisdictional boundaries; for example, coordinated signal control in a metropolitan area or coordination between freeway operations and arterial signal control within a corridor.

TMC Multimodal Coordination - support center-to-center coordination between the Traffic Management and Transit Management Subsystems, monitor transit operations, and provides traffic signal priority for transit vehicles on request from the Transit Management Subsystem.
CSP, City, and County EOCs

**Emergency Data Collection** - collect and store emergency information that is collected in the course of operations by the Emergency Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.

**Emergency Response Management** - provide the strategic emergency response capabilities and broad inter-agency interfaces that are implemented for extraordinary incidents and disasters that require response from outside the local community. It provides the functional capabilities and interfaces commonly associated with Emergency Operations Centers.

**Incident Command** - provide tactical decision support, resource coordination, and communications integration for Incident Commands that are established by first responders at or near the incident scene to support local management of an incident. Information is shared with agency centers including resource deployment status, hazardous material information, traffic, road, and weather conditions, evacuation advice, and other information that enables emergency or maintenance personnel in the field to implement an effective, safe incident response.

**Emergency Call-Taking** - support the emergency call-taker, collecting available information about the caller and the reported emergency, and forwarding this information to other equipment packages that formulate and manage the emergency response. This equipment package receives 911, 7-digit local access, and motorist call-box calls and interfaces to other agencies to assist in the verification and assessment of the emergency and to forward the emergency information to the appropriate response agency.

**Emergency Dispatch** - track the location and status of emergency vehicles and dispatch these vehicles to incidents. Pertinent incident information is gathered from the public and other public safety agencies (see the Emergency Call-Taking equipment package) and relayed to the responding units. Incident status and the status of the responding units is tracked so that additional units can be dispatched and/or unit status can be returned to available when the incident is cleared and closed.

**Emergency Early Warning System** - monitor alerting and advisory systems, information collected by ITS surveillance and sensors, and reports from other agencies and uses this information to identify potential, imminent, or in-progress major incidents or disasters. Notification is provided to other equipment packages that provide the emergency response, including public notification using ITS traveler information systems, where appropriate.

**Emergency Evacuation Support** - coordinate evacuation plans among allied agencies and manage evacuation and reentry of a population in the vicinity of a disaster or other emergency that poses a risk to public safety. Where appropriate, the affected population is evacuated in shifts, using more than one evacuation route, and including several evacuation destinations to spread demand and thereby expedite the evacuation.

**Colorado Springs Transit**

**Transit Data Collection** - collect and store transit information that is collected in the course of transit operations performed by the Transit Management Subsystem. This data can be
used directly by operations personnel or it can be made available to other data users and archives in the region.

**Transit Center Vehicle Tracking** - monitor transit vehicle location. The location information is collected via a data communication link between the transit vehicles and the transit center. The location information is presented to the transit operator on a digitized map of the transit service area.

**Transit Center Fixed-Route Operations** - manage fixed route transit operations supporting planning and scheduling of fixed and flexible route transit services. The package allows fixed-route and flexible-route transit services to develop and disseminate schedules and automatically updates customer service operator systems with the most current schedule information.

**Transit Center Multi-Modal Coordination** - determine the need for transit priority on routes and at certain intersections and request transit vehicle priority at these locations.

**On-board Transit Signal Priority** - provide the capability for transit vehicles to request signal priority at signalized intersections through short-range communication directly with traffic control equipment at the roadside.

**Transit Center Information Services** - collect the latest available information for a transit service and make it available to transit customers and to Information Service Providers for further distribution. Customers are provided information at transit stops and other public transportation areas before they embark and on-board the transit vehicle once they are en-route.

**Transit Evacuation Support** - manage transit resources to support evacuation and subsequent reentry of a population in the vicinity of a disaster or other emergency. It supports coordination of regional evacuation plans, identifying the transit role in a regional evacuation and identifying transit resources that would be used. During an evacuation, this equipment package coordinates the use of transit and school bus fleets, supporting evacuation of those with special needs and the general population.

**Transit Environmental Monitoring** - assimilate current and forecast road conditions and surface weather information from a variety of sources, including both weather service providers and vehicle probes.

**Other Transit Agencies (e.g. Summit Stage, Pueblo)**

Each transit agency is somewhat different in the range ITS User Services it plans on deploying. Many of these services do not require any external coordination. Functional requirements derived from services requiring external coordination include:

**Transit Data Collection** - collect and store transit information that is collected in the course of transit operations performed by the Transit Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.

**Transit Center Vehicle Tracking** - monitor transit vehicle location. The location information is collected via a data communication link between the transit vehicles and the transit
center. The location information is presented to the transit operator on a digitized map of the transit service area.

**Transit Center Fixed-Route Operations** - manage fixed route transit operations supporting planning and scheduling of fixed and flexible route transit services. The package allows fixed-route and flexible-route transit services to develop and disseminate schedules and automatically updates customer service operator systems with the most current schedule information.

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**Transit Center Information Services** - collect the latest available information for a transit service and make it available to transit customers and to Information Service Providers for further distribution. Customers are provided information at transit stops and other public transportation areas before they embark and on-board the transit vehicle once they are en-route.

**Transit Evacuation Support** - manage transit resources to support evacuation and subsequent reentry of a population in the vicinity of a disaster or other emergency. It supports coordination of regional evacuation plans, identifying the transit role in a regional evacuation and identifying transit resources that would be used. During an evacuation, this equipment package coordinates the use of transit and school bus fleets, supporting evacuation of those with special needs and the general population.

**Transit Environmental Monitoring** - assimilate current and forecast road conditions and surface weather information from a variety of sources, including both weather service providers and vehicle probes.
VI. Implementation Plan

Ultimately, the realization of the strategic objectives for intelligent transportation systems in Southeastern Colorado will be dependent on developing projects that deploy the enabling infrastructure and create the connections and interfaces that do not exist today. While all implementations that lead to the strategic objectives are important, some are more critical than others are. This may be because they implement critical supporting infrastructure, like fiber-optic backbone, because they fill an essential role such as managing pass closures, or because they require extensive cooperation and coordination between agencies such as a transit signal priority system.

Furthermore, a project can be significant on different levels, just as transportation facilities can have different levels of significance. Some projects are significant on a state or national level, such as incident management on a heavily traveled interstate highway. Other projects are significant on a regional level because they implement strategic objectives across a large portion of the region. Finally, some projects implement strategic objectives, but on a more localized basis.

VI.A. Recommended ITS Projects

Based on the strategic objectives and the critical issues, a program of strategic ITS projects is proposed to address these issues (Figure 5), including:

Projects of Statewide Significance

1. Install fiber-optic cable along I-70 from Vail to Frisco including all equipment, connections with lateral devices and C2C with CSP and local jurisdictions.
2. Install fiber-optic cable along I-25 from Pueblo to the Colorado/New Mexico State line including all equipment, connections with lateral devices and C2C with CSP and local jurisdictions.
3. Develop incident management and traveler information system for I-25 South of Pueblo.
4. Develop incident management and traveler information system for I-70 East of Denver.
5. Complete the I-70 Mountain Corridor Incident Management system improvements from Vail to Clear Creek County, including automated pass maintenance and closure for Loveland Pass and Vail Pass and select freeway management system elements.
7. Implement rural highway management systems on SH 50 east of Pueblo;
8. Implement rural highway management systems on US 287 south of Limon;
9. Provide a secure interface so that participating agencies, such as transit providers or local governments, can access camera images and other data directly;
10. Develop a communications master plan for the rural areas of Southeastern Colorado where existing communication infrastructure is inadequate;
11. Instrument maintenance vehicles to provide road and weather condition data.

Projects of Regional Significance

12. Implement transit management and multi-modal coordination in Summit County;
13. Implementing a transit management system and multi-modal coordination for Colorado Springs Transit;
14. Install automated pass maintenance and closure management system on US 24 over Wilkerson Pass;
15. Implement freeway management and traveler information system on I-25 from Colorado Springs through Pueblo;
16. Implement rural highway management systems on SH 24 east of Colorado Springs;
17. Develop a special event management system for the Air Force Academy;
18. Develop a special event management system in cooperation with Pikes Peak International Raceway;
19. Developing a regional ITS master plan for the Pikes Peak Area Council of Governments region;
20. Developing a military traveler information system in Colorado Springs.
Figure 5: Recommended ITS Strategic Projects

**Summit County**
1. Install fiber optic cable & electronics from Vail to Frisco
2. Incident Management System & Vail & Loveland Pass Systems
3. Implement Transit Management & Multi-Modal Coordination

**SH 24: Wilkerson Pass**
4. Implement Pedestrian System

**Other Strategic ITS Initiatives**
5. Provide a secure web interface to camera images
6. Develop a communications master plan
7. Instrument maintenance vehicles for RWIS

**Pikes Peak Area**
8. Implement Transit Management & Multi-Modal Coordination
9. Develop regional ITS Master Plan
10. Develop military traveler Information System

**Air Force Academy**
11. Event Management System

**SH 24: Colorado Springs to Limon**
12. Implement Rural Highway Management System

**I-70: East of Aurora to Kansas state line**
13. Develop Incident Management System

**I-25: Pueblo to Colorado Springs**
14. Implement Rural Highway Management System

**US 287: Oklahoma to Limon**
15. Implement Rural Highway Management System

**US 50: Pueblo to Kansas**
16. Implement Rural Highway Management System

**I-25: New Mexico state line to Pueblo**
17. Install fiber optic cable and electronics
18. Implement Trinidad Incident Management Plan
19. Develop Incident Management System for remainder

**I-25: Raton Pass**
20. Install Pass Management System
VI.B. Projects of Statewide Significance

As discussed above, some projects are important to the achievement of state and national strategic objectives as well as regional strategic objectives. This is particularly the case for projects focused along the I-70 and I-25 corridors as well as other major state highways. These corridors are critical parts of the interstate transportation system connecting Colorado with adjacent states in all directions. This level of significance also implies that statewide ITS funding could be made available for these projects. Three projects are critical to achieving the strategic objectives are:

Fiber-optic cable installation

While numerous ITS devices have been deployed along the I-70 and I-25 corridors and incident management plans have been in place for several years, there is still a pressing need to gather greater real-time information along the corridor. In particular, there is a growing demand for real-time video images both for incident and emergency responders and for the traveling public at large. However, further deployment of surveillance cameras and other devices is constrained by the lack of supporting communications infrastructure to transmit the video images and control data between the field and the control center at the CTMC in Golden or the CS TMC in Colorado Springs. Recently, fiber-optic cable was installed from the CTMC to Frisco. Fiber optic cable also extends south to Pueblo, but that leaves almost 100 miles of interstate south of Pueblo without fiber optic connections. Given the importance of I-70 over Vail Pass and of the southern end of I-25, fiber optic communications is a critical piece of supporting infrastructure for other strategic goals, therefore these two fiber-optic projects are significant to the goals in the Project Area.

1. **Fiber-optic cable installation: I-70 Frisco to Vail (and on to Glenwood Canyon)**

   CDOT has designated a fiber-optic backbone system connecting the major regional Transportation Management Centers as a critical piece of enabling infrastructure. Recently, CDOT installed fiber-optic cable from the CTMC to the town of Frisco in Summit County. Fiber-optic cable also runs from HLT TMC, east to the end of the Glenwood Canyon near the town of Dotsero. This project will extend the fiber-optic line from Frisco to Glenwood Canyon, a distance of about 70 miles. It also provides the network communication equipment, lateral connections, and center-to-center communications with CSP and local jurisdictions. This project cost is itemized in the Regional ITS Strategic Plan for Western Colorado; it is shown here for the sake of completeness.

2. **Fiber-optic cable installation along I-25 from Pueblo to state line**

   Fiber-optic cable has been installed from the CTMC to the south side of Pueblo, however there is no high-speed communication available to CDOT between Pueblo and the New Mexico state line. This is a distance of about 95 miles. This project also provides the network communication equipment, lateral connections, and center-to-center communications with CSP and local jurisdictions.

   Estimated Construction Cost: $10,500,000  
   Design Costs (8%): $840,000  
   Annual Maintenance and Repair (10%): $1,050,000
Interstate Incident Management and Traveler Information Systems

Due to the volume of traffic it carries and the inter-regional and interstate nature of trips along it, I-25 and I-70 have a unique strategic importance in the project area. For this reason, incident management and traveler information along these two highways is strategically important to the region, and to the state as a whole. CDOT Regions 1 and 3 have jointly developed an Incident Management Plan for I-70 from the Utah State Line to the Denver Metro Region. From an operational standpoint, this management plan has been highly successful. At the same time, the plan recommended several additional devices, particularly variable message signs, surveillance cameras, and highway advisory radios, some of which have not yet been installed. Furthermore, the Incident Management Plan does not identify automated pass management applications for Vail Pass on I-70 or Loveland Pass US 6. Vail pass is the highest pass on the interstate highway system and as such frequently experiences severe weather requiring closure or restrictions. These have to be manually implemented by stationing a state patrol or sheriff’s vehicle at the closure point. Loveland pass is the designated hazardous material route around the EJT. Closures on this pass require altering operation at the tunnel.

While there is fiber-optic cable running along I-70 to the Kansas border, a comprehensive incident management plan and traveler information system has not been developed for this section of interstate highway. In addition, there is no incident management plan for I-25 south of Pueblo. While this section of highway is not as heavily traveled as the section to the north, it still carries more than 10,000 vehicles-per-day. Furthermore, the general lack of services or alternate routes makes incident management and traveler information all the more critical for those travelers. In addition, this section of interstate highway crosses over Raton Pass. While not as high as some of the other passes in Colorado, this pass does occasionally close. Because it is on the border with New Mexico, coordination between the states is required.

3. I-25 Incident Management and Traveler Information: New Mexico to Pueblo

CDOT currently has several variable message signs and RWIS along this section of highway. However, these are only accessible through dial up telephone. Furthermore, due to the lack of communication bandwidth, there is no camera surveillance in this stretch of highway. This project will install surveillance cameras, highway advisory radios, at locations to be determined and hardware to automatically manage closure of Raton Pass. CDOT is currently updating the Incident Management plan for I-70. This project will develop an incident management plan and determine locations for signs, CCTV, and other devices. For estimating purposes I-70 is assumed to need the following: 2 VMS, 10 CCTV, 20 Call Boxes, 2 Automatic Gates, HAR and ATR.

Estimated Construction Cost: $1,500,000
Design Costs (10%): $150,000
Annual Maintenance and Repair (15%): $225,000

4. I-70 Incident Management and Traveler Information System: Denver to Kansas

CDOT has variable message signs both eastbound and westbound around the Junction with US 287 in Limon and a westbound sign at Burlington, but the rest of this highway stretch has little in the way of infrastructure for incident management or traveler information. This project will develop an incident management plan and determine locations for signs, CCTV, and other devices. For estimating purposes I-70 is assumed to need the following: 4 VMS, 6 CCTV, 20 Call Boxes, ATR and HAR.
Estimated Construction Cost: $1,500,000
Design Costs (10%): $150,000
Annual Maintenance and Repair (15%): $225,000

5. **I-70 Mountain Corridor Incident Management and Traveler Information System: Summit and Clear Creek Counties**

This project will provide automated pass closures for Vail Pass and for Loveland Pass as well as completing the recommendation of the Incident Management Plan. Based on the incident management plan and the recommendation for pass closures the following are assumed for estimating purposes: 4 VMS, 10 CCTV, 12 Call Boxes, ATR, HAR, and automatic gates.

Estimated Construction Cost: $1,900,000
Design Costs (8%): $152,000
Annual Maintenance and Repair (15%): $285,000

6. **Automated pass maintenance and closure management system on I-25 over Raton Pass**

Pass maintenance and closure on Raton Pass is a major issue on I-25. This project will provide the sensors to monitor road and weather conditions, the devices to automatically close roadways and post warning signs, and the devices to disseminate condition information to travelers. They consist of automatic gates, advanced warning signs, arterial scale variable message signs, highway advisory radio, and road and weather information systems. A fully automated system is estimated to cost approximately $250,000, exclusive of communications. Communication costs could vary widely, but are expected to average $100,000 for this location due to the general lack of communications infrastructure in the area.

Estimated Construction Cost: $350,000
Design Costs (8%): $28,000
Annual Maintenance and Repair (15%): $52,500

**Rural Highway Management Systems**

Southeast Colorado contains several important state highways in addition to the interstate highways. Specifically US 50 and US 24 are important east-west corridors while US 287 is an important north-south corridor. With the exception of a few scattered call boxes, traffic recorders, weather stations, and a few message signs on US 287 there is little infrastructure on these important highways. While they probably do not warrant as extensive a treatment as the interstate system, they warrant more than currently exists. Rural highway management systems, consisting of message signs and advisory radios at key junctions, weather stations at various locations and call boxes distributed every few miles, are recommended for these corridors.

7. **US 50 Rural Highway Management System: Pueblo to State Line**

This system will help CDOT to manage this critical east-west corridor in the southeast corner of the state. For estimating purposes the following were assumed: 6 arterial scale message signs, 6 HAR, call boxes every 5 miles (30), ATR and 4 RWIS.
Estimated Construction Cost: $500,000
Design Costs (8%): $40,000
Annual Maintenance and Repair (15%): $75,000

8. **US 287 Rural Highway Management System: Limon to State Line**

This system will serve as an interim until the Ports to Plains corridor is built with its associated ITS improvements. For estimating purposes the following were assumed: 6 arterial scale message signs, 6 HAR, call boxes every 5 miles (35), ATR and 4 RWIS.

Estimated Construction Cost: $500,000
Design Costs (8%): $40,000
Annual Maintenance and Repair (15%): $75,000

9. **Provide a secure interface so that participating agencies, such as transit providers or local governments, can access camera images and other data directly**

While CDOT has several cameras and other sensors along the highway system many other agencies do not have direct access to these devices. Direct access to camera images and other sensors would greatly benefit many other stakeholders such as emergency management centers and transit agencies. A secure access would provide resource sharing similar to that which some Front Range communities have, albeit at slower speeds. This work would most likely be completed by CTMC hence no cost is associated with it.

10. **Develop a communications master plan for rural areas**

Several areas of Southeastern Colorado have limited or no communications infrastructure. Long distances make fiber optics not cost effective and the mountains and rugged terrain interfere with many wireless communications methods. Many areas have no, or very limited, cellular telephone coverage. Since ITS is dependent on communications this condition limits the ability to deploy ITS in the more remote areas, which are some of the most critical areas as well. A communications master plan will identify public and private options for communications as well as exploring numerous wireless communications options throughout the regions.

   Estimated Cost: $150,000

11. **Instrumenting maintenance vehicles to provide road and weather condition data**

CDOT maintenance vehicles are constantly on the road network and drivers frequently call in reports of road conditions, accidents, and other data. However, at times the drivers are too busy driving to provide complete information and the information they do provide is generally qualitative. Instrumented vehicles would significantly increase the amount of weather and road condition data available. These systems could also be combined with vehicle safety systems such as edge of pavement detection to greatly improve road maintenance.

   Cost Estimate: Not quantified.

**VI.C. Projects of Regional Significance**

Regional, in this context, refers to Southeastern Colorado, the entire Project Area of this report. There are several other regions defined in this area, the transportation planning regions and the
CDOT Regions. Projects of regional significance affect a larger area than the specific area of implementation. There are several other projects that may be significant within these smaller regions, planning or CDOT, but whose significance does not extend beyond that area. These projects are discussed in the section following this.

12. **Summit County Transit Management and Multi-modal Coordination**

Summit County is a destination for travelers from all over the state, and even the nation. Congestion in Summit County effects mobility along the I-70 corridor, affecting many other regions. Strategies to improve the attractiveness of transit provide benefits to the I-70 corridor and other state highways that cross this county (US 6, SH 9, and SH 91). Specific strategies will be determined by the transit provider; however, transit signal priority is probably the most promising.

- Estimated Construction Cost: $500,000
- Design Costs (12%): $60,000
- Annual Maintenance and Repair (15%): $75,000

13. **Transit management system and multi-modal coordination for Colorado Springs Transit.**

Colorado Springs is the second largest metropolitan area in Colorado. As it continues to grow, so does congestion. Congestion in Summit County effects mobility along the I-25 corridor, affecting other regions as well. Improved transit services are one of the strategies being employed to address congestion. The transit provider has identified several candidate strategies for improving the attractiveness of transit.

- Estimated Construction Cost: $500,000
- Design Costs (12%): $60,000
- Annual Maintenance and Repair (15%): $75,000

14. **Automated Pass Management on SH 24 (Wilkerson Pass)**

One of the major issues in Southeastern Colorado, from both a traveler information perspective and from a maintenance management perspective, is the closure of mountain passes on major highways. These passes may be closed, either fully or partially, due to rockslides, avalanche control, excessive snowfall, or maintenance needs. Due to the sparse roadway network, pass closures can entail long delays or detours of up to 100 miles. Wilkerson Pass on State Highway 24 is a critical pass for this region. These systems provide the sensors to monitor road and weather conditions, the devices to automatically close roadways and post warning signs, and the devices to disseminate condition information to travelers. They consist of automatic gates, advanced warning signs, arterial scale variable message signs, highway advisory radio, and road and weather information systems. A fully automated system is estimated to cost approximately $250,000, exclusive of communications. Communication costs could vary widely, but are estimated at $50,000 for this location. An incremental deployment could consist of manual gates and warning signs and would cost about $150,000.

- Estimated Construction Cost (full system): $300,000
- Design Costs (8%): $24,000
- Annual Maintenance and Repair (15%): $45,000

* Estimated Construction Cost for Manual System = $250,000
15. I-25 freeway management and traveler information system, Colorado Springs through Pueblo

CDOT currently has several ITS devices deployed in Pueblo and there are also several devices deployed in Colorado Springs. There are also incident management plans for both towns however; the area in between has not been addressed. This project will develop an incident management plan for the area between cities and deployed the required devices as well as enhancing the freeway management system through Pueblo.

Estimated Construction Cost (full system): $500,000
Design Costs (8%): $40,000
Annual Maintenance and Repair (15%): $75,000


This is a key corridor connecting Colorado springs to I-70. For estimating purposes the following were assumed: 3 arterial scale message signs, 2 HAR, ATR and 1 RWIS.

Estimated Construction Cost: $250,000
Design Costs (8%): $20,000
Annual Maintenance and Repair (15%): $37,500

17. Air Force Academy Event Management System

Special Events at the Air force Academy, such as football games and graduation, lead to severe congestion on I-25, especially when the events are over. Managing this congestion is an essential strategy for preserving mobility on I-25 between Denver and Colorado Springs. This is similar to incident management except that the location and times of the incidents are known.

Estimated Construction Cost: $250,000
Design Costs (8%): $20,000
Annual Maintenance and Repair (15%): $37,500

18. Pikes Peak International Raceway Event Management System

Special Events at Pikes Peak International Raceway lead to severe congestion on I-25, especially when the events are over. Managing this congestion is an essential strategy for preserving mobility on I-25 between Pueblo and Colorado Springs. This is similar to incident management except that the location and times of the incidents are known. Because this is a private sector responsibility it is identified here, but the cost is not defined.


While the Colorado Springs area has made significant investments in ITS, there is no regional plan to identify and prioritize future investments. This project would identify ITS projects needed to address the needs and goals of the MPO, prioritize those actions, and developed a structured plan for funding and implementation.
Estimated Cost: $100,000

20. Developing a military traveler information system in Colorado Springs.

Military base related travel has significant impacts on travel in the Colorado Springs area due to the size and number of military installations in the area. This project will install the network surveillance (sensors and CCTV) so that the CS TMC can monitor traffic conditions around the bases and the information dissemination equipment (message signs and HAR) so that military base travelers can be advised of conditions and other travelers can choose alternate routes.

Estimated Construction Cost: $250,000
Design Costs (8%): $20,000
Annual Maintenance and Repair (15%): $37,500

VI.D. Relating Projects to Goals

Table 4 shows the Strategic Goals for each of the sub areas and identifies the projects that implement each goal. As can be seen from this table, one project may implement more than one of the Strategic Goals.
## Table 11: Strategic Goals to Projects

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Strategic ITS Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Install fiber-optic cable along I-70 from Vail to Frisco (included in Strategic Plan for Western Colorado)</td>
</tr>
<tr>
<td>2</td>
<td>Install fiber-optic cable along I-25 from the New Mexico line to Pueblo</td>
</tr>
<tr>
<td>3</td>
<td>Develop Incident Management and Traveler Information System for I-70 south of Pueblo</td>
</tr>
<tr>
<td>4</td>
<td>Develop Incident Management and Traveler Information System for I-70 east of Denver</td>
</tr>
<tr>
<td>5</td>
<td>Complete I-70 Incident Management and Traveler Information System in Summit County</td>
</tr>
<tr>
<td>6</td>
<td>Install and manage maintenance system on I-25 over Raton Pass</td>
</tr>
<tr>
<td>7</td>
<td>Implement Rural Highway Management System on SH 30 east of Pueblo</td>
</tr>
<tr>
<td>8</td>
<td>Implement Rural Highway Management System on US 24 south of Limon</td>
</tr>
<tr>
<td>9</td>
<td>Provide a secure web interface to camera images</td>
</tr>
<tr>
<td>10</td>
<td>Develop a communications master plan for rural areas</td>
</tr>
<tr>
<td>11</td>
<td>Implement maintenance vehicles for road and weather information</td>
</tr>
<tr>
<td>12</td>
<td>Implement Transit Management and Multi-modal Coordination in Summit County</td>
</tr>
<tr>
<td>13</td>
<td>Implement transit management system and multi-modal coordination for Colorado Springs Transit</td>
</tr>
<tr>
<td>14</td>
<td>Install and manage maintenance system on SH 24 over Wilkerson Pass</td>
</tr>
<tr>
<td>15</td>
<td>Implement Freeway Management System on I-25 from Colorado Springs through Pueblo</td>
</tr>
<tr>
<td>16</td>
<td>Implement Rural Highway Management System on SH 24 east of Colorado Springs</td>
</tr>
<tr>
<td>17</td>
<td>Develop a Special Event Management System for the Air Force Academy</td>
</tr>
<tr>
<td>18</td>
<td>Develop a Special Event Management System for Pikes Peak International Racetrack</td>
</tr>
<tr>
<td>19</td>
<td>Develop a regional ITS master plan for Pikes Peak Area Council of Governments</td>
</tr>
<tr>
<td>20</td>
<td>Develop a Traveler Information System focused on Military Base related travel</td>
</tr>
</tbody>
</table>
VI.E. Agreements

The operational concepts presented previously define the overall relationships between stakeholders in the region. In order to fully implement the operational concept, additional agreements may be necessary to define the roles and responsibilities of the agencies involved. These agreements may have technological and operational impacts on the development of some of the systems. This section discusses existing, planned and potential agreements.

The following are projects and implementations that require establishment of formal agreements:

- **Regional Traffic Control**: there are some informal agreements currently in place. For example, CDOT Region 2 maintenance currently coordinates with the CS TMC to have DMS
messages posted on the freeway in Colorado Springs. As the network of ITS implementations grow along each of the corridors and regionally, many agencies will be responsible for operation and maintenance of ITS devices such as traffic signals, vehicle detectors, CCTV cameras, DMS and RWIS stations. Agreements that detail the authority, priorities for shared operation, and liability will be necessary to share the current and future ITS implementations. This is especially important for devices with which agencies have sensitivities regarding shared control (i.e. traffic signals). Interim agreements to support interagency signal coordination control and to use existing ITS systems to their full effectiveness should be the primary set of agreements.

- **Incident Management**: There are existing incident management plans for the I-70 Mountain Corridor and I-25 in Pueblo. These plans define the roles of key agencies in responding to incidents along the freeway based on the incident location and severity. There is interest in expanding the coverage of incident management plans to consider other major highways within the study area. In addition, there is a desire to develop responses that include the use of existing and future ITS deployments (i.e. signal timing plans and DMS messaging). The sharing of ITS devices becomes critical as maintenance and device reliability will be an issue for all agencies involved. These agreements must be sure to address device availability as well as the means by which control conflicts (i.e. competing messages on a DMS) can be resolved.

- **Communications**: As the communication networks in the study area grow, there will be opportunities for sharing of communications infrastructure. In fact, it is expected that the communications planning will embody that concept in order to leverage a communications network that best serves the needs of the agencies within the study area. The purpose of the agreement is to define the ownership and subsequently responsibilities for maintenance and repair of the network. Provision in these agreements should accommodate new participants as the infrastructure network grows.

### VI.F. ITS Standards


*The U.S.DOT ITS Standards Program is working toward the widespread use of standards to encourage the interoperability of ITS systems. Through cooperative agreements with five standards development organizations (SDOs), the Standards Program is accelerating development of about 100 non-proprietary, industry-based, consensus ITS standards, and is encouraging public-sector participation in the development process.*

*The Standards Program is maturing from a primarily standards development program to a standards deployment program by rapidly moving into standards deployment support. Such support includes helping to build credibility in the standards through testing and case studies, providing standards resource information, supporting training and technical assistance to deployers, developing deployment experience-based guidance such as “lessons learned”, and assessing the readiness of standards for deployment.”*

The ITS standards govern communications between the following interfaces between various ITS subsystems as defined in the National ITS Architecture:

- Center to Center (Example: Traffic Management Center (TMC) to Emergency Dispatch Center)
- Center to Roadside (Field) (Example: TMC to DMS)
- Center to Vehicle/Traveler (Example – Information service provider to kiosk, Emergency Dispatch Center to emergency response vehicle)
- Roadside to Roadside (Example – traffic signal controller to railroad crossing equipment)
- Roadside to Vehicle (Example – transit signal priority or electronic toll collection)

The physical architecture flows between these subsystems from the National ITS Architecture are linked to appropriate ITS standards. For example, the DMS sign controller software developed for CDOT is compliant with the standard “National Transportation Communications for ITS Protocol (NTCIP) 1203 – Object Definitions for Dynamic Message Signs”. This use of the standard enables one software driver to communicate with NTCIP-compliant DMS signs from different vendors.

There are a series of standards that define terms, data elements and message sets, and foundation standards that cut across many market packages. These standards form the basis for interoperability among systems by defining a common set of terms and information elements. The server standards that should be adopted and used by regional jurisdictions in the development of ITS applications include:

- **Data Dictionary for Advanced Traveler Information System (ATIS):** A minimum set of media-independent data elements needed by potential information service providers to deploy ATIS services and provide the basis for future interoperability of ATIS devices.

- **Message Set for Advanced Traveler Information System (ATIS):** A basic message set using the data elements from the ATIS data dictionary needed by potential information service providers to deploy ATIS services and to provide the basis for future interoperability of ATIS devices.

- **Message Sets for External TMC Communication (MS/ETMCC):** A message set standard for communication between transportation system management centers and other ITS centers, including traffic and transit management systems, information service providers, emergency management systems, and emissions management systems.

- **National Location Referencing Information Report:** A basis for location referencing standardization activities by various application communities and SDOs.

- **Standard for Common Incident Management Message Sets (IMMS) for use by Emergency Management Centers (EMC):** Standards describing the form and content of the incident management message sets for emergency management systems to traffic management systems and from emergency management systems to the emergency telephone system E911.

- **Standard for Data Dictionaries for Intelligent Transportation Systems:** A set of meta-entities and meta-attributes for ITS data dictionaries, as well as associated conventions and schemes, that enable describing, standardizing, and managing all ITS data.

- **Standard for Functional Level Traffic Management Data dictionary (TMDD):** This document includes data elements for traffic control, ramp metering, traffic modeling, video camera control traffic, parking management and weather forecasting, as well as data elements related to detectors, actuated signal controllers, vehicle probes, and dynamic message signs. It also contains data elements for roadway links, for incidents and traffic-disruptive roadway events.

- **Standard for Traffic Incident Management Message Sets for Use by EMCs:** Enables consistent standardized communications among incident management centers, fleet and freight management centers, information service providers, emergency management centers, planning subsystems, traffic management centers and transit management centers.
The National Transportation Communications for ITS Protocol Family (NTCIP): the National Transportation Communications for ITS Protocol (NTCIP) standards committee is a specialized SDO focus group comprised of AASHTO, ITE and national Electrical Manufacturers Association (NEMA) delegates. This joint committee provides for the development of a family of ITS standards that apply to the majority of interfaces between traffic and transit management systems and devices. These standards are referred to in shorthand as the NTCIP for traffic systems, and the Transit Communications Interface Protocols (TCIP) for transit systems.

These key baseline standards are critical for the deployment of a wide range of market packages because they establish the common vocabulary of data elements and message structures that allow regional ITS applications to exchange data and information with each other. The adoption of this common vocabulary is of particular importance for the exchange of information between CDOT CTMC, EJT TOC, CS TMC and the various transit and traffic signal systems deployed or planned in the region.

VI.G. Financial Summary

Based on the project priorities identified in the previous section, a financial summary was prepared to balance project funding through the program time frame. The costs, which are in 2005 dollars, to implement the recommended projects are summarized in Table 12 below. Pass maintenance and management systems are assumed to be implemented in two stages, with a manual system implemented initially followed by an upgrade to a fully automated system.
### Table 12: Financial Summary (Cost are in 2005 dollars)

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Name</th>
<th>Near Term (1 – 3 years)</th>
<th>Mid-Term (4 – 7 years)</th>
<th>Long Term (8 – 10 years)</th>
<th>Project Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Design</td>
<td>Construction</td>
<td>Annual Maint. &amp; Repair</td>
<td>Design</td>
</tr>
<tr>
<td>1</td>
<td>Install fiber-optic cable along I-70 from Vail to Frisco</td>
<td>Not Included</td>
<td></td>
<td></td>
<td>Not Included</td>
</tr>
<tr>
<td>2</td>
<td>Install fiber-optic cable along I-25 from the New Mexico line to Pueblo</td>
<td>546,000</td>
<td>3,500,000</td>
<td>350,000</td>
<td>840,000</td>
</tr>
<tr>
<td>3</td>
<td>Develop Incident Management and Traveler Information System for I-25 south</td>
<td>150,000</td>
<td>1,500,000</td>
<td>225,000</td>
<td>150,000</td>
</tr>
<tr>
<td></td>
<td>of Pueblo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Develop Incident Management and Traveler Information System for I-70 east</td>
<td>150,000</td>
<td>1,500,000</td>
<td>225,000</td>
<td>150,000</td>
</tr>
<tr>
<td></td>
<td>of Denver</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Complete I-70 Incident Management and Traveler Information System in Summit</td>
<td>152,000</td>
<td>1,900,000</td>
<td>285,000</td>
<td>152,000</td>
</tr>
<tr>
<td></td>
<td>County</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Install pass maintenance and management system on I-25 over Raton Pass</td>
<td>28,000</td>
<td>350,000</td>
<td>52,500</td>
<td>28,000</td>
</tr>
<tr>
<td>7</td>
<td>Implement Rural Highway Management System on SH 50 east of Pueblo</td>
<td>40,000</td>
<td>500,000</td>
<td>75,000</td>
<td>40,000</td>
</tr>
<tr>
<td>8</td>
<td>Implement Rural Highway Management System on US 287 south of Limon</td>
<td>40,000</td>
<td>500,000</td>
<td>75,000</td>
<td>40,000</td>
</tr>
<tr>
<td>9</td>
<td>Provide a secure web interface to camera images</td>
<td>Not Quantified</td>
<td></td>
<td></td>
<td>Not Quantified</td>
</tr>
<tr>
<td>10</td>
<td>Develop a communications master plan.</td>
<td>Not Quantified</td>
<td></td>
<td></td>
<td>Not Quantified</td>
</tr>
<tr>
<td>11</td>
<td>Instrument maintenance vehicles for road and weather information</td>
<td>Not Quantified</td>
<td></td>
<td></td>
<td>Not Quantified</td>
</tr>
<tr>
<td>12</td>
<td>Implement Transit Management and Multi-modal Coordination in Summit County</td>
<td>50,000</td>
<td>500,000</td>
<td>75,000</td>
<td>50,000</td>
</tr>
<tr>
<td>13</td>
<td>Implement transit management system and multi-modal coordination for</td>
<td>50,000</td>
<td>500,000</td>
<td>75,000</td>
<td>50,000</td>
</tr>
<tr>
<td></td>
<td>Colorado Springs Transit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Install pass maintenance and</td>
<td>28,000</td>
<td>350,000</td>
<td>52,500</td>
<td>28,000</td>
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<tr>
<td>----------------</td>
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</tr>
<tr>
<td>15</td>
<td>Implement Rural Highway Management System on SH 24 over Wilkerson Pass</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Implement Rural Highway Management System on SH 24 east of Colorado Springs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Develop a Special Event Management System for the Air Force Academy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Develop a Special Event Management System for Pikes Peak International Raceway</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Develop a regional ITS master plan for Pikes Peak Area Council of Governments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Develop a Traveler Information System focused on Military Base related travel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>578,000</td>
<td>5,350,000</td>
<td>802,500</td>
<td>866,000</td>
</tr>
</tbody>
</table>

Note: Private funding was used for the project.
VII. Next Steps

The ITS Architecture is intended to guide the deployment of ITS elements within the study area. It is intended that this document be maintained as an input to the formal planning process in the study area.

1. The ITS Branch will continue to actively work with the regions utilizing the ITS Architecture Steering Committee, and involve other interested stakeholders, to promote the projects and ensure that they remain visible and receive support at all necessary levels in order to secure implementation. The ITS Committee should meet at least every six months to evaluate and discuss plan status and determine whether updates to the ITS Architecture are necessary.

2. Sponsoring agencies should develop high priority projects further for inclusion in the upcoming cycle of updates to the Statewide Transportation Improvement Program. Projects identified in this ITS Strategic Plan should be submitted by sponsoring agencies for inclusion in that document as part of mainstreaming ITS.

3. Incident management planning should continue for other major corridors, such as I-70, I-25, US 287, and also for the rural areas. These require coordination with local sheriffs and rural emergency responders as well as the regional emergency management forums.

4. The CTMC should continue with developing secure interfaces for agencies outside CDOT, which do not have direct communications lines with CDOT.

5. The ITS Branch should proceed with communication master planning for Southeastern Colorado since this forms the foundation for management and control of ITS devices throughout the region.