STRATEGIC PLAN FOR WESTERN COLORADO INTELLIGENT TRANSPORTATION SYSTEM
Colorado Department of Transportation
Regional ITS Strategic Plan for Western Colorado

November 2006
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<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>AD ................................................................. Archived Data Management</td>
</tr>
<tr>
<td>APTS .............................................................. Advanced Public Transportation Systems</td>
</tr>
<tr>
<td>ATIS ............................................................... Advanced Traveler Transportation Systems</td>
</tr>
<tr>
<td>ATMS ............................................................... Advanced Traffic Management Systems</td>
</tr>
<tr>
<td>AVL ................................................................. Automated Vehicle Location</td>
</tr>
<tr>
<td>AVSS ............................................................... Advanced Vehicle Safety Systems</td>
</tr>
<tr>
<td>CCTV ............................................................... Closed Circuit Television</td>
</tr>
<tr>
<td>CDOT ............................................................... Colorado Department of Transportation</td>
</tr>
<tr>
<td>COGJ ............................................................... City of Grand Junction</td>
</tr>
<tr>
<td>CSP ................................................................. Colorado State Patrol</td>
</tr>
<tr>
<td>CSTMC ............................................................ Colorado Springs Transportation Management Center</td>
</tr>
<tr>
<td>CTMC ............................................................... Colorado Transportation Management Center</td>
</tr>
<tr>
<td>CV ................................................................. Commercial Vehicles Operations</td>
</tr>
<tr>
<td>DOIT ............................................................... Department of Information Technology</td>
</tr>
<tr>
<td>DRCOG ............................................................. Denver Regional Council of Governments</td>
</tr>
<tr>
<td>DTR ................................................................. Digital Truck Radio</td>
</tr>
<tr>
<td>DVR ................................................................. Digital Video Recorders</td>
</tr>
<tr>
<td>ECO ................................................................. Eagle County Regional Transportation Authority</td>
</tr>
<tr>
<td>EJT ................................................................. Eisenhower-Johnson Tunnel</td>
</tr>
<tr>
<td>EM ................................................................. Emergency Management</td>
</tr>
<tr>
<td>EOC ................................................................. Emergency Operations Center</td>
</tr>
<tr>
<td>ES ................................................................. Executive Summary</td>
</tr>
<tr>
<td>FHWA .............................................................. Federal Highway Administration</td>
</tr>
<tr>
<td>FTA ................................................................. Federal Transit Authority</td>
</tr>
<tr>
<td>GIS ................................................................. Geographical Information System</td>
</tr>
<tr>
<td>GPS ................................................................. Global Positioning System</td>
</tr>
<tr>
<td>GVT ................................................................. Grand Valley Transit</td>
</tr>
<tr>
<td>HAR ................................................................. Highway Advisory Radio</td>
</tr>
<tr>
<td>HLT ................................................................. Hanging Lake Tunnel</td>
</tr>
<tr>
<td>HLTTMC .......................................................... Hanging Lake Tunnel Traffic Management Center</td>
</tr>
<tr>
<td>HQ ................................................................. Headquarters</td>
</tr>
<tr>
<td>ITS ................................................................. Intelligent Transportation Systems</td>
</tr>
<tr>
<td>MCM ............................................................... Maintenance and Construction Management</td>
</tr>
<tr>
<td>MP ................................................................. Market Package</td>
</tr>
<tr>
<td>MPO ............................................................... Metropolitan Planning Organization</td>
</tr>
<tr>
<td>NRF ................................................................. North Front Range</td>
</tr>
<tr>
<td>O&amp;M ............................................................... Operations and Management</td>
</tr>
<tr>
<td>PDA ................................................................. Personal Digital Assistant</td>
</tr>
<tr>
<td>POE ................................................................. Port of Entry</td>
</tr>
<tr>
<td>RFTA ............................................................... Roaring Fork Transit Authority</td>
</tr>
<tr>
<td>RWIS ............................................................... Road and Weather Information Systems</td>
</tr>
<tr>
<td>STIP ............................................................... Statewide Transportation Improvement Plan</td>
</tr>
<tr>
<td>SWTPR ............................................................ Southwest Transportation Planning Region</td>
</tr>
<tr>
<td>TPR ................................................................. Transportation Planning Region</td>
</tr>
<tr>
<td>UP ................................................................. Union Pacific</td>
</tr>
<tr>
<td>VMS ............................................................... Variable Message Sign</td>
</tr>
<tr>
<td>WIM ............................................................... Weigh-In-Motion</td>
</tr>
</tbody>
</table>
Executive Summary

This strategic plan for intelligent transportation systems (ITS) in Western Colorado describes the vision, goals, overall strategic direction and systematic approach for implementation of intelligent transportation systems in CDOT Region 3 and Region 5 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 following vision for ITS in Western Colorado was developed based on discussions with stakeholders during the strategic plan process. The regional vision is to:

*Improve the mobility, safety, and comfort of the multi-modal transportation system and support economic development in the Project Area 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 CDOT Region 3 and Region 5 (Figure ES-1), and includes all of the counties on the Western Slope within these two Regions. It also includes the areas of North Park, the San Luis Valley, and the Upper Arkansas River Valley. Region 3 and Region 5 have been combined for this plan since all the ITS devices that CDOT manages and operates are controlled from the Hanging Lake Tunnel Transportation Management Center (HLT TMC). Furthermore, due to the geography, Region 3 and Region 5 have similar issues and needs with respect to ITS. Combining the two CDOT Regions creates a number of synergies for ITS planning purposes.

Western Colorado is a mix of rural, small urban areas and one urbanized area characterized by the following:

- The Project Area is predominantly mountainous and rural, with a sparse roadway network and lack of extensive power and communications infrastructure;
- Western Colorado is known for its scenic and natural resources, drawing visitors from around the world;
- The tourism and recreation industries provide significant economic benefits to the Project Area, as well as generate significant travel demands;
- A large array of wildlife abounds, including several large animal species such as moose, elk, deer, bear and mountain lion, which has resulted in significant numbers of animal/vehicle collisions;
- Due to the geography of the area, characteristics such as steep grades, sharp curves, and narrow roads with minimal or no shoulders are common;
- Every major corridor crosses one or more mountain passes, which are subject to sudden unexpected closures due to weather and other natural events, such as rockslides or avalanches;
- There is a wide mix of users including: rural-based travel, urban-based travel, through travel, and commercial travel;
- I-70 is the dominant east-west corridor, carrying almost half of all east-west vehicular travel, while major state highways carry the overwhelming majority of the remaining east-west travel;
There are no continuous north-south corridors, which impacts and sometimes limits travel options;

Grand Junction is the only major urbanized area. The small urban population centers, of which Durango is the major hub in the southwestern part of the State, are mostly isolated mountain communities with few transportation links between population centers;

Long distances separate many destinations with varying levels of services in between;

There are few alternate or detour routes available;

Long-haul trucking represents a large percentage of travel on many routes;

Periodic congestion occurs in the built up areas, especially associated with holidays and weekends.
Figure ES-1. Project Area
(CDOT Regions 3 and 5)
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 local 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-70 cause major disruption to travel in the Project Area 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;
- Traffic congestion in Grand Junction is growing and will become a major issue if not proactively addressed;
- Traffic congestion is becoming a major issue in mountain communities—especially Durango, Steamboat Springs, Vail/Avon, and the State Highway 82 corridor from Glenwood Springs to Aspen – leading to delay, safety concerns and increased pollution emissions, and disruption to the economy;
- Transportation impacts due to special events, such as festivals, outdoor sporting events, and bicycle rides, affect participants in the events, local residents, and travelers passing through the area;
- 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 transportation system. On some sections of road, such collisions represent as much as 50% of all accidents;
- Natural or manmade emergencies, such a 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.
- Transit in the area is limited and does not allow for free access without private motor vehicles for many of the mountain communities;
- There exists a lack of power and communications infrastructure that would support timely notice of events through ITS technology and adds to traffic delays.
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, six 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 to clear 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 Western Colorado will be focused on I-70, major mountain passes, 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 an 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.

**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.

**Transit Management and Multi-modal Coordination** – Transit agencies in Western Colorado vary greatly in the size, sophistication, and resources. Some agencies will employ 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 a priority in heavy transit corridors such as SH-82 and possibly SH-6 through Eagle County.

**Safety Management** – Refers to the several strategies used to reduce the number and severity of crashes. In Western 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 Western 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 and 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. Strategic Objectives

As part of identifying Strategic Objectives for ITS, the Project Area was divided into five major sub-areas based on their unique characteristics. In each sub-area, key objectives were identified for implementing the core ITS services in that sub-area. In addition to the five sub-areas, objectives that have applicability to more than one sub-area were also identified. The sub-areas are:

- I-70 Corridor,
- Grand Junction Urbanized Area,
- Mountain Communities,
- Rural Northwest,
- Rural Southwest,
- Other Strategic Objectives.

Each sub-area is described below and the strategic objectives for each are given.

I-70 Corridor

This is the major transportation corridor through Western Colorado, running from the Utah state line to the west side of Vail Pass. It is a significant truck and tourism route as well as a major commuting route for workers in the resort towns along the corridor. The strategic objectives are:

- Install a high-speed fiber-optic telecommunications connection between the HLT TMC and the Eisenhower-Johnson Tunnel Transportation Management Center (EJT TMC) and between HLT TMC and Grand Junction, including all equipment, connections with lateral devices and C2C connectivity with CSP and local jurisdictions (fiber is currently installed from Denver to Frisco);
- Complete the I-70 Mountain Corridor Incident Management Plan Improvements;
- Install an Automated Road Closure System for Glenwood Canyon;
- Provide reliable, timely, accurate, and complete traveler information along the corridor; among CDOT departments and with other transportation agencies, such as Eagle County Transit, Roaring Fork Transportation Authority and Grand Valley Transit.
- Facilitate faster emergency response in the corridor.

Grand Junction Urbanized Area

This is the only major urbanized center in Western Colorado. Traffic congestion is a growing problem. The strategic objectives are:

- Expand the city’s traffic signal system into a Regional Arterial Traffic Management System;
- Develop regional incident management plans and implement improvements on the major roadways off the interstate highway system;
- Enhance the existing transit management system and provide multi-modal coordination.
Mountain Communities

This sub-area refers to the numerous small urban areas including: Alamosa, Durango, Cortez, Montrose, Glenwood Springs, Aspen, Craig and Steamboat Springs, throughout the Project Area. Many of these are significant tourism and recreation destinations, experience recurring traffic congestion, and are home to major special events. Strategic objectives are:

- Provide arterial traffic management on major state highways through towns;
- Implement congestion management strategies such as ride sharing, vanpools, and transit enhancements;
- Develop special event management plans and systems;
- Deploy transit management systems and multi-modal coordination.

Rural Northwest

This is the rural portion of the Project Area north of I-70. It is characterized by long distances between towns with limited services. Strategic objectives are:

- Implement pass closure systems on major state highways, especially US 40.
- Provide rural traveler information and travel information specific to destinations in the northwest such as Steamboat Springs and Winter Park.
- Develop coordinated incident management plans with county emergency management groups.
- Coordinate with emergency service providers to reduce emergency response time.

Rural Southwest

This is the rural portion of the Project Area south of I-70. It is characterized by long distances between towns, high mountain passes, and limited services. Strategic objectives are:

- Provide rural traveler information and travel information specific to destinations in the southwest.
- Develop coordinated incident management systems with county emergency management groups.
- Coordinate with emergency service providers to reduce emergency response times.

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 certain stakeholders;
- Develop a communication master plan for rural areas of the Project Area;
- Provide communications links between Emergency Operations Centers and the Hanging Lake Tunnel Management TMC;
- Implement mobile road and weather information systems (RWIS)/automated vehicle location (AVL) on maintenance vehicles.
E. 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 Frisco to Glenwood Canyon including all equipment, connections with lateral devices and C2C connectively with CSP and local jurisdictions (the segment from Frisco to Vail is physically in Region 1, but is included here to provide connectivity between the HLT TMC and the EJT TMC).

2. Install fiber-optic cable along I-70 from Glenwood Springs to Grand Junction including all equipment, connections with lateral devices and C2C connectively with CSP and local jurisdictions.

3. Completion of the I-70 Incident Management Plan improvements from Vail to Grand Junction, including automated road closure for Glenwood Canyon.

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

5. Develop a communications master plan for the rural areas of Western Colorado where existing communication infrastructure is inadequate.

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

**Projects of Regional Significance**

7. Installation of Automated Pass Management Systems and automated shoulder delineation systems on the major highway routes, including:
   
   7.1. US 550 between Durango and Ouray (Coal Bank Pass, Molas Divide, Red Mountain Pass),
   
   7.2. US 160 over Wolf Creek Pass,
   
   7.3. US 40 between Kremmling and Steamboat Springs (Muddy Pass and Rabbit Ears Pass),
   
   7.4. US 50 over Monarch Pass,
   
   7.5. SH 145 over Lizard Head Pass,
   
   7.6. US 24 over Tennessee Pass,
   
   7.7. US 50 over Cerro Summit,
   
   7.8. SH 91 over Fremont Pass,
   
   7.9. US 160 over La Veta Pass, and
   
   7.10. US 50 in the Blue Mesa Reservoir area.

8. Implementation of a Transit Signal Priority System on State Highway 82 from Glenwood Springs to Aspen (this is separate from the arterial management system for SH 82).


10. Implementation of arterial management systems on:
   
   10.1. SH 82 from Glenwood Springs to Aspen,
10.2. US 40 through Steamboat Springs,
10.3. US 40 through Winter Park,
10.4. US 550 and US 160 through Durango,
10.5. US 160/US 285 through Alamosa,
10.6. US 550 and US 50 through Montrose, and
10.7. US 50 through Gunnison.


12. Develop communication links between the HLT TMC and major Emergency Operations Centers and other transportation providers.

13. Enhance transit management systems for local transit operators, to include automatic vehicle location, automatic fare collection, and real-time transit passenger information.

F. 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 Table ES-1, 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.
Figure ES-2. Recommended ITS Strategic Projects

Other Strategic ITS Initiatives

4: Provide a secure web interface to camera images
5: Develop a communications master plan
6: Instrument maintenance vehicles for RWS
11: Automated Wildlife Crossing Systems
12: Communication links between the Hanging Lake TMC and EOCs
13: Transit management systems for local transit operators

US 50: East of Steamboat Springs
7.3: Install pass management system on Rabbit Ears and Muddy Passes

I-70: Glenwood Springs to Grand Junction
2: Install fiber optic cable and electronics
3: Complete Incident Management and Traveler Information System

Winter Park
10.3: Install Arterial Management System on US 40

I-70: Glenwood Canyon to Vail
1: Install fiber optic cable and electronics

US 40: East of Steamboat Springs
10.2: Install Arterial Management System on US 40

Winter Park
10.3: Install Arterial Management System on US 40

US 24 and SH 91
7.8: Install pass management & system on Fremont and Tennessee Passes

I-70: Vail to Grand Junction
7.3: Install pass management system on Rabbit Ears and Muddy Passes

Grand Junction
9: Complete Regional Traffic Management System

Montrose
10.6: Install Arterial Management System on US 50 and US 550

US 50: Gunnison to Montrose
7.7: Install pass management system on Cerro Summit

US 50: Gunnison to Montrose
7.10: Install pass management system in the area of Blue Mesa Reservoir

SH 82: Aspen to Glenwood Springs
8: Transit Signal Priority
10.1: Arterial Traffic Management System

US 50: Poncha Springs to Gunnison
7.4: Install Pass Management System on Monarch Pass
10.7: Install Arterial Management System in Gunnison

US 550: Durango to Ouray
1: Install pass management System on Colbark, Molas, and Red Mountain Passes

Durango
10.4: Install Arterial Management System on US 550 and US 160

US 160: South Fork to Pagosa Springs
7.2: Install Pass Management System on Wolf Creek Pass

Alamosa
10.5: Install Arterial Management System on US 160 and US 285

US 160: Alamosa to Walsenburg
7.9: Install Pass Management System on La Veta Pass

Regional ITS Strategic Plan for Western Colorado CDOT Region 3 & Region 5
Executive Summary
### 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>Design</th>
<th>Construction</th>
<th>Annual Maint. &amp; Repair</th>
<th>Mid-Term (4 - 7 years)</th>
<th>Design</th>
<th>Construction</th>
<th>Annual Maint. &amp; Repair</th>
<th>Long Term (8 – 10 years)</th>
<th>Design</th>
<th>Construction</th>
<th>Annual Maint. &amp; Repair</th>
<th>Project Total</th>
<th>Design</th>
<th>Construction</th>
<th>Annual Maint. &amp; Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fiber-optic cable along I-70 from Glenwood to Frisco</td>
<td>840,000</td>
<td>5,000,000</td>
<td>500,000</td>
<td>550,000</td>
<td>840,000</td>
<td>5,000,000</td>
<td>550,000</td>
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<td>840,000</td>
<td>10,500,000</td>
<td>1,050,000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fiber-optic cable along I-70 from Grand Junction to Glenwood Springs</td>
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<td>2,900,000</td>
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<td></td>
<td>232,000</td>
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<tr>
<td>3</td>
<td>Arterial traffic management system</td>
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<td></td>
<td>150,000</td>
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<tr>
<td>4</td>
<td>Instrument maintenance vehicle for road and weather information</td>
<td>20,000</td>
<td>150,000</td>
<td>22,500</td>
<td>8,000</td>
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<tr>
<td>5</td>
<td>Pass maintenance and management system on Molas Divide, Red Mountain and Coal Bank passes on Wolf Creek Pass</td>
<td>16,000</td>
<td>150,000</td>
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<td>150,000</td>
<td>22,500</td>
<td>6,000</td>
<td>150,000</td>
<td>22,500</td>
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<td>7</td>
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<td>16,000</td>
<td>150,000</td>
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<td>8</td>
<td>Pass maintenance and management system on Lizard Head Pass</td>
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<td>150,000</td>
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<tr>
<td>12</td>
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<td>Regional Traffic Management System in Grand Junction</td>
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<td>Arterial traffic management system on US 550 and US 160 in Durango</td>
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<td>200,000</td>
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<td>Automated Wildlife Detection Systems on critical roadways sections</td>
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<td>160,000</td>
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<td>400,000</td>
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*Note: Costs are in 2005 dollars.*
## Executive Summary

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I. Introduction

This strategic plan for the deployment of Intelligent Transportation Systems (ITS) Western 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. 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. The strategic plan is a road map for implementing the proposed system.

In 2002, CDOT ITS Branch, in consultation with the ITS Steering Group, developed a Statewide 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, CDOT Regions 3 and 5 do not have Strategic Plans or Architectures. In addition, the Statewide Architecture to provide a framework that consolidates the regional architectures together is currently being updated.

This report comprises the Strategic Plan for ITS in CDOT Region 3 and Region 5. This strategic plan describes the vision, goals and overall strategic direction for implementation of ITS in Region 3 and Region 5 for the next ten years.

I.A. Purpose of the Regional ITS Strategic Plan

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. The strategic plan identifies a package of ITS applications to be implemented and integrated over time. It also addresses specific transportation goals and needs in coordination with regional and statewide planning activities. This strategic plan will be the framework to assure that all the pieces will ultimately fit together, not only with each other, but also with other potential transportation improvements.

The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) have adopted rules and regulations, which have detailed requirements regarding ITS architectures. Although there are no specific requirements to develop strategic plans in the ITS rules and regulations (http://ops.fhwa.dot.gov/its_arch_imp/policy.htm) there is the requirement to incorporate ITS Architecture and ITS project programming into the existing planning process in the Region. Since there are no formal requirements for Strategic Plans, there are variations in
their content, but in general they contain a description of the Project Area, the purpose and need for the plan, identification of transportation needs and ITS applications and Market Packages that address those needs, inventory of existing ITS services and infrastructure and projects prioritized with cost estimates. This strategic plan for Regions 3 and 5 was prepared to be consistent with the approach used for other Strategic Plans prepared for CDOT. This was also prepared to be consistent with the Statewide ITS Strategic Plan.

There are several sound reasons for preparing this Regional ITS Strategic Plan:

- **Focus a Number of Disparate ITS Initiatives or Transportation Plans** - One of the most compelling reasons to develop an ITS strategic plan is to coordinate a number of transportation and ITS planning efforts within a region or state. This type of coordination promotes cost-efficiencies throughout the entire system life-cycle (e.g., planning, design, implementation, construction, Operations & Maintenance, management, etc.), added functionality realized through integrated and coordinated ITS systems, economies of scale through coordinated procurement, systematic deployment and improved agency cooperation and coordination.

- **Improve Coordination of Transportation Operations** - An ITS strategic plan can also be the catalyst for promoting greater consideration of systems management and operations as a part of a state and/or region's overall approach to addressing their existing and anticipated transportation needs. The ITS strategic plan can often provide the mechanism for bringing stakeholders together to address transportation operations and management issues that may affect multiple agencies or organizations. Then, the ITS strategic plan can be used to “jump-start” ITS deployments for a broad cross-section of organizations in states or rural regions.

- **Prioritize or Select Specific Projects for Inclusion in State Transportation Plans** - With the limited availability of funds, priority needs for specific ITS projects and programs can be defined within the framework of the region's overall transportation program, comprised of the individual Regional Transportation Plans, and the Statewide Transportation Plan. However, these plans do not include the level of detail needed to ensure cost-effective implementation and coordinated ITS operations. The ITS strategic plan provides the kind of specific ITS planning effort that will provide the requisite level of detail.

**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 business 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 inter-modal 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 inter-modal connectivity between services provided by public and private transportation providers.

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

<table>
<thead>
<tr>
<th>Principal Benefits</th>
<th>Performance Measure Metrics</th>
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<tbody>
<tr>
<td>Maximizing productivity of current transportation system</td>
<td>Increase in vehicle and passenger throughput. 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. Reduction of secondary accidents due to incidents.</td>
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</tbody>
</table>

**I.B. Project Process**

The development of the ITS strategic plan and regional architecture follows a structured process to ensure proper coverage of relevant transportation issues, gather key input from transportation stakeholders within the Project Area, 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 Program (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 that 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 Process Flow Chart.

**Figure 1: Project Process Flow Chart**
Stakeholder Participation Process
A series of Stakeholder workshops was conducted in Alamosa, Durango, Glenwood Springs and Grand Junction from July 2004 to November 2004. At the first series of workshops an extensive list of ITS issues and needs was developed and subsequently expanded 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 Strategic Plan. 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. Each round of workshops included one meeting in CDOT Region 3 and another in CDOT Region 5. The dates and locations were as follows:

CDOT Region 5, July 8, 2004 in Durango
CDOT Region 3, July 9, 2004 in Grand Junction
CDOT Region 5, August 24, 2004 in Durango
CDOT Region 3, August 25, 2004 in Glenwood Springs
CDOT Region 5, October 5, 2004 in Alamosa
CDOT Region 3, October 6, 2004 in Glenwood Springs
CDOT Region 3, November 17, 2004 in Glenwood Springs
CDOT Region 5, November 19, 2004 in Durango

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
- Six 2030 Regional Transportation Plans, CDOT 2004
  - Grand Junction/Mesa County Transportation Planning Region 2030 Plan
  - Gunnison Valley Transportation Planning Region 2030 Plan
  - Intermountain Transportation Planning Region 2030 Plan
  - Northwest Transportation Planning Region 2030 Plan
  - San Luis Valley Transportation Planning Region 2030 Plan
  - Southwest Transportation Planning Region 2030 Plan
  - I-70 Mountain Corridor Incident Management Plan, CDOT 2004
- Riverside Parkway Environmental Assessment, City of Grand Junction, 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 needs 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.

**2030 Statewide Transportation Plan, Moving Colorado – Vision for the Future**, CDOT 2004 – This plan melded 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 draft 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 statewide described in terms of:

Infrastructure, including more than 1200 devices and the network infrastructure to communicate with them,
• Centers, the four 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 operations and 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 2002 – 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, six TPRs are contained in CDOT Regions 3 and 5:

- Grand Junction/Mesa County Transportation Planning Region 2030 Plan
- Gunnison Valley Transportation Planning Region 2030 Plan
- Intermountain Transportation Planning Region 2030 Plan
- Northwest Transportation Planning Region 2030 Plan
- San Luis Valley Transportation Planning Region 2030 Plan
- Southwest Transportation Planning Region 2030 Plan

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

At least four of the six TPRs indicated their desire for economic growth, and all requested consideration for multi-modal facilities except for the Gunnison Valley TPR whose goal list was the shortest, focusing on quality of life, retaining western values, maintaining sense of community, and supporting economic growth. Both the SWTPR and Grand Junction/Mesa County TPR specifically mention the development or enhancement of trail systems. The SWTPR went as far to make trails a standalone goal for the TPR. Overall, the TPRs of the Project Area appear to be similar in terms of what they desire for their transportation system.

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.

Riverside Parkway Environmental Assessment, City of Grand Junction 2004 – the document provides a description of the improvement for a new expressway across the south side of Grand Junction. A description of proposed ITS services and devices in the corridor is provided including fiber optic cable, traffic signal control, road and weather information and video surveillance.
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 Regional ITS Architecture includes, at a minimum, the following eight elements:

1. A description of the region
2. Identification of participating agencies and 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); and
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.

The 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**

This 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.

This ITS Strategic Plan should be incorporated into the on-going transportation planning and programming activities in the study area. In this region this requirement means that the Regional Transportation Plans for the Transportation Planning Regions in Western Colorado, which are updated every three years. The ITS Strategic Plan will provide input to the TPR with regard to ITS projects and ITS deployment within the regions.

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 CDOT and the ITS Working Group with 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 Strategic Plan will consider the projects and activities identified in this ITS Strategic Plan.

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

Following this introduction, Section I, 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 – Linking Market Packages to Transportation Needs: Presents the rationale as to which of the market packages in the ITS National Architecture appropriately address the issues and needs of the region.

Section V – ITS Strategic Goals: This section develops the goals for ITS deployment in the Project Area and relates them to both statewide goals for ITS and the transportation issues and needs identified in the previous section.

Section VI – Strategic ITS Projects: This section identifies the projects needed to implement the ITS goals, categorizes them by priorities, and 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

This Regional ITS Strategic Plan for Western Colorado covers the area including both CDOT Region 3 and CDOT Region 5. This area includes the entire Western Slope within these two Regions. It also includes the areas of North Park, the San Luis Valley and the Upper Arkansas Valley (see Figure 2). These areas were combined for ITS planning because of similar geographic, operational and institutional characteristics, and because ITS throughout the Project Area is primarily managed and operated from the Hanging Lake Tunnel TMC. This Project Area is described in more detail below.

II.A. Geography of the Region

Western Colorado is comprised of CDOT Regions 3 and 5 covers the entire Western Slope within these two Regions and also includes the areas of North Park, the San Luis Valley and the Upper Arkansas Valley. Colorado is divided into 15 Transportation Planning Regions (TPRs) that are responsible for transportation planning within their particular area. These TPR’s are defined and identified by geographic location (e.g., Southwest), and do not correspond exactly to CDOT’s Region boundaries. Western Colorado includes the TPRs of: Grand Junction/Mesa County, Gunnison Valley, Intermountain, Northwest, San Luis Valley, and Southwest (See

The Project Area is predominantly mountainous, including several mountains over 14,000 in elevation and numerous mountain passes over 10,000 feet. With the exception of the Grand Junction area, the Project Area is rural with several small urban areas. Grand Junction is a major urbanized center experiencing rapid growth. The Project Area also contains the small urban communities of Aspen, Glenwood Springs, Craig, Steamboat Springs, Montrose, Durango, Alamosa, and Cortez.

Most of the counties in Western Colorado experienced double digit growth between 1990 and 2000 with the counties experiencing the highest growth representing primary tourist destinations — particularly ski resort towns (provided in more detail below). Eagle County, which includes Vail and Beaver Creek, grew by 90% in the same time period. San Miguel County, home to Telluride, experienced a 71% increase, and Grand County, which includes the towns of Winter Park and Fraser, grew by 61%. Counties with no ski attractions that experienced substantial growth included Archuleta County (86% increase) and Montrose County (77% increase). Ouray County, which does not include a ski resort but provides access to Telluride, grew by 63%. The small county of San Juan is the only one in this the Project Area that experienced a population decrease (24%) between 1990 and 2000.

The State Demographer projects that population and employment growth will continue to increase over the next twenty years for many of the communities in Region 3. For example, the Regional Travel Patterns Study (2004), which cites data provided by the state demographer, project population to increase by 51% in Eagle County, by 69% for Pitkin County and by 98% for Garfield County between the years of 2000 to 2025. However, the majority of people are projected to increasingly work in communities other than where they reside, thereby increasing the percentage of commuter trips using state highways.
Figure 2: Project Area
(CDOT Regions 3 and 5)
Travel Patterns
This Region 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 Western 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.

Western Colorado includes some of the most popular ski resorts in the world including Vail/Beaver Creek, Steamboat Springs, Snowmass Village, Aspen, Telluride and Crested Butte. Several other highly popular ski areas include Winter Park, Durango Mountain, Monarch and Wolf Creek.

Western Colorado also includes several major National Parks including Rocky Mountain, Dinosaur, Black Canyon of the Gunnison, Mesa Verde, and Great Sand Dunes National Park as well as Colorado National Monument. Visitation at these destinations decreased from 1990 to 2000 with the exception of Rocky Mountain National Park. The recent redesignation of Great Sand Dunes from a National Monument to a National Park could potentially increase visitation to this attraction.
Glenwood Springs is a popular tourist destination year-round. Lake Granby and Grand Lake (the state’s largest natural lake) are popular tourist destinations. Steamboat Springs, Snowmass Village, and Aspen are popular summer tourist destinations as well as ski attractions. The Aspen area also provides access to the Maroon Bells Wilderness Area. The Upper Arkansas Valley, from Leadville to Poncha Springs provides access to “fourteeners” including Mt. Elbert, the state’s highest peak, and is a popular destination for mountain climbers. The section of the Arkansas River that flows through this area is popular with white-water rafters and other paddlers. The Gunnison and Colorado Rivers are also popular paddling destinations, and the Fruita area just west of Grand Junction is very popular for mountain biking. Grand Junction also actively promotes its 12 wineries, and tour companies provide winery tours. Durango, with the historic Durango-Silverton Narrow Gauge Railroad attracts summer tourists and provides transportation to visitors hiking some of the area’s 14,000-foot peaks.

II.B. Transportation

Most of the communities in Western Colorado are separated by several miles and connected by only a few roads. Due to the mountainous terrain, there are few parallel routes and most roads have steep grades, sharp turns and narrow cross sections in places.

Highways

The dominant travel corridor in the Project Area is the I-70 corridor. I-70 carries between 15,000 vehicles-per-day on the western end to more than 25,000 vehicles-per-day in Eagle County. This represents more than half of all east-west travel in Western Colorado and more than four times the volume that the two other major east-west routes (US 160 and US 40) carry combined. US 160, which runs through the southern portion of the Project Area, carries between 4,000 and 5,000 vehicles-per-day between communities, and carries as many as 15,000 vehicle-per-day through some of the built-up areas. Likewise, US 40 carries between 3,000 and 4,000 vehicles-per-day between Granby and Steamboat Springs. US 40 carries as many as 20,000 vehicles-per-day in the built-up areas of Steamboat Springs and the area between Winter Park and Granby.

US 50 from Salida to Montrose is another significant east-west highway. It carries between 2,000 and 3,000 vehicles-per-day on the rural segments with as many as 10,000 vehicles-per-day in the built-up areas of Salida, Montrose, and Gunnison. In Montrose, US 50 joins US 550 and continues north to Grand Junction, where traffic volumes increase substantially. The Average Vehicles-Per-Day for East – West Highways is illustrated in Table 2 below.

<table>
<thead>
<tr>
<th>East – West Corridors</th>
<th>Average Daily Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-70</td>
<td>15,000 – 25,000</td>
</tr>
<tr>
<td>US 160</td>
<td>4,000 – 5,000</td>
</tr>
<tr>
<td>US 40</td>
<td>3,000 – 4,000</td>
</tr>
<tr>
<td>US 50</td>
<td>3,000 – 10,000</td>
</tr>
</tbody>
</table>

North-south travel is considerably more complex in Western Colorado. There are no continuous corridors running from the southern portion to the northern portion of the Project Area. Essentially all north-south corridors terminate at I-70. In the southwest, US 550 runs from New Mexico, north through Durango to Montrose, where it joins US 50 and continues north to Grand Junction. US 550 carries between 3,000 and 5,000 vehicles-per-day between Durango and Montrose. US 50/550 carries about 9,000 vehicles-per-day between Montrose and Grand Junction. US 285 runs from New Mexico north through Alamosa to Buena Vista where it joins US 24 which continues north through Leadville and on to I-70 at Minturn or at Copper Mountain.
via SH 91. The Average Vehicle-Per-Day for North-South Highways is illustrated in Table 3 below.

**Table 3: Project Area Average Daily Traffic: North-South Highways (2003)**

<table>
<thead>
<tr>
<th>North – South Corridors</th>
<th>Average Daily Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>SH 82</td>
<td>15,000 – 20,000</td>
</tr>
<tr>
<td>US 550</td>
<td>3,000 – 5,000</td>
</tr>
<tr>
<td>US 285</td>
<td>3,000 – 5,000</td>
</tr>
<tr>
<td>US 24</td>
<td>4,000</td>
</tr>
<tr>
<td>SH 13</td>
<td>1,000 – 2,000</td>
</tr>
<tr>
<td>SH 131</td>
<td>1,000 – 2,000</td>
</tr>
<tr>
<td>US 50/550</td>
<td>9,000 – 10,000</td>
</tr>
</tbody>
</table>

US 285 carries between 3,000 and 5,000 vehicles-per-day while US 24 carries about 4,000 vehicles-per-day. To the north, SH 131 runs from I-70 in Eagle County to Steamboat Springs, while SH 13 runs from I-70 in Rifle to the Wyoming border just north of Craig. SH 13 and SH 131 both carry between 1,000 and 2,000 vehicles-per-day except in the built-up areas where volumes are greater. SH 82 is another significant corridor running from Leadville, through Aspen, to I-70 in Glenwood Springs. While its length is not as great as the other corridors, it carries between 15,000 and 20,000 vehicles-per-day due to the number of communities it services.
Figure 4: Project Area Roadway Systems
Nearly every major highway in Western Colorado travels over one or more major mountain passes. I-70 crosses Vail Pass. US 550 crosses Coal Bank Pass, Molas Divide, and Red Mountain Pass. SH 145 crosses Lizard Head Pass. SH 160 crosses La Veta Pass and Wolf Creek Pass. US 285 crosses Poncha Pass while US 24 crosses Tennessee Pass and SH 91 crosses Freemont Pass. US 50 crosses Monarch Pass, Cerro Summit and Blue Mesa Reservoir. US 40 crosses Muddy Pass and Rabbit Ears Pass. These passes have very steep grades, multiple sharp curves and reduced widths in many spots. In addition, due to their high elevation, they are frequently closed due to snowstorms or the need for avalanche control. I-70 also travels through Glenwood Canyon, which is sometimes closed for weather or other natural events.

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.

Transit

With increasing pressures from growth experienced throughout the state, increases in travel demand have led to congested traffic conditions in developed areas, activity centers, and resorts. Public transportation systems represent an important element in reducing the number of private vehicles on the roadway system, thereby helping to reduce the impacts of continued growth on the overall transportation system.

In addition to providing congestion relief, public transportation provides mobility to individuals who cannot travel without it. Such individuals are considered dependent upon public transportation for a variety of reasons. The four types of limitations that preclude persons from driving are physical limitations, financial limitations, legal limitations, and self-imposed limitations.

The regional transportation plans for Western Colorado identify more than 60 public and private transit providers spread throughout the Project Area. Most of these serve various special communities. Three major regional transit providers service the majority of the I-70 corridor:

**Eagle County Regional Transportation Authority (ECO)**
- ECO Transit was established in 1996 to provide regional connection between the communities of Avon, Beaver Creek, Dotsero, Eagle, Edwards, Gypsum, Leadville, Minturn, Red Cliff, and Vail

**Roaring Fork Transit Authority (RFTA)**
- RFTA operates year-round transportation services in Pitkin County, as well as parts of Garfield and Eagle counties. Services include free buses in Aspen, fare commuter buses (Down Valley Commuter Service) between Aspen, Glenwood Springs, and Rifle, and local service in Glenwood Springs. In addition, RFTA offers seasonal service both summer and winter, including transit to ski areas and special events.
- RFTA provided over 1,000,000 one-way trips on its regional commuter services between Rifle and Glenwood Springs to Aspen and Snowmass Village, and over 3,000,000 trips on their system, including the skier shuttle and Aspen local circulator services.
- Currently RFTA operates its regional commuter services along the designated HOV lane between Basalt to Buttermilk, just south of Aspen Airport, and in mixed traffic between Basalt and Glenwood Springs. The regionally-endorsed vision for this system is to
implement bus rapid transit along SH 82, which incorporated a new fleet of low-floor vehicles, improved transit stations and ITS elements such as automated fare collection, real-time information, and transit signal prioritization.

**Grand Valley Transit (GVT)**

- GVT operates a mix of fixed-route, dial-a-ride, and paratransit service. There are currently 11 fixed routes serving Grand Junction, Fruita, and Palisade. Dial-A-Ride stops are provided throughout the urban area and are charged a higher fare than fixed-route passengers. Complementary paratransit service is offered during the times that the fixed-route service is offered. Grand Valley Transit provided over 545,110 one-way trips in 2002. This included 530,600 trips serviced by the fixed-route system.

While almost every small urban area in Western Colorado has some transit service, four are particularly noteworthy:

- Steamboat Springs Transit, which provides daily service in and around the town of Steamboat Springs;
- The Link in Winter Park, which provides service to the town of Winter Park and the adjacent skiing and recreation areas;
- Mountain Valley Metropolitan District which provides service to the development next to Telluride, and;
- The Durango Lift, which provides service to the town of Durango and adjacent areas.

**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 and commercial service facilities exist within this architectural region. Commercial services exist at or near the towns of Hayden, Grand Junction, Eagle, Aspen, Montrose, Gunnison, Telluride, Alamosa, Durango, and Cortez.

**Rail**

Railroads provide passenger and freight service throughout this the Project Area. AMTRAK provides passenger service (the California Zephyr) on the main line and runs one westbound train and one eastbound train per day connecting Grand Junction to Denver. This east/westbound train makes stops at Fraser/Winter Park, Granby, and Glenwood Springs before heading into Utah. During the ski season the Winter Park Ski Train, which utilizes the Union Pacific tracks, operates between Denver and Winter Park on Saturdays and Sundays.

The historic Grand Junction Railroad Station, listed on the National Register of Historic Places, was rehabilitated. Alternative uses were evaluated for the station and emphasis was given to the concept of relocating AMTRAK back into this station. In addition, Grand Junction is a major rail freight center for the Union Pacific (UP) Railroad. The commodities shipped through Grand Junction include mixed freight, automobiles, produce and coal. The UP operates a major rail freight yard in Grand Junction, which sorts freight trains from the west (Salt Lake City, the Pacific Northwest, and California), from the east (Denver, Pueblo) and from the south (Paonia, Montrose, Delta).
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. The ITS User Service Areas are as follows:

**Traffic and Travel Management**
- **Freeway Management** – With a few exceptions, freeway management in Western Colorado focuses on information collection and dissemination. There are lane control signals approaching the Hanging Lake Tunnels and there is an active speed advisory sign westbound approaching Glenwood Canyon. Ramp metering has been discussed for Eagle County as traffic volumes and congestion increase, but no firm plans exist.

- **Incident Management** - An extensive incident management plan was developed for I-70 from the west side of Denver to the Utah border. This system uses the network of 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 sheriff departments. This has proven to be a very effective system. Recently, CDOT updated the Plan based on lessons learned and experience gained in using the Plan. However, several additional devices have been identified for installation in the future.

- **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. Three tunnel systems are actively managed in Western Colorado, the Hanging Lake Tunnels on I-70 in Glenwood Canyon, the Beaver Tail tunnel on I-70, and the Wolf Creek Pass Tunnel on US 160 just east of the summit of Wolf Creek Pass. These tunnels have continuous surveillance along with lane use control signals, message boards, and traffic detectors. The Hanging Lake Tunnels also have an active incident detection system that alerts operators if there is a stoppage in the tunnels. The Beaver Tail Tunnel on I-70 in De Beque Canyon also has an incident detection system installed that will be monitored and controlled by the Hanging Lake Tunnels TMC.

- **Rural Highways** - Rural highways present a unique challenge for ITS and providing call boxes on major routes. 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 Western Colorado. Despite these challenges CDOT has deployed arterial scale variable message signs at most critical decision points and installed remote weather stations in key segments of major roadways. Region 5 also maintains a network of avalanche forecasters to supplement their data and to support maintenance operations.

- **Arterial Management** - CDOT Region 3 operates and maintains approximately 100 traffic signals while Region 5 operates and maintains about 50. These are spread throughout Western Colorado. Due to the large distance involved, both regions have installed telephone drops to all their signals for communication. In addition, Region 5 is hardwiring the signals together in each major grouping and providing on-street master
controllers. These closed-loop systems are either installed or in progress in Alamosa, Pagosa Springs, Durango, and Cortez.

The City of Grand Junction operates 94 traffic signals. The City has had an ongoing project to connect their signals together on a fiber-optic system. These signals are operated on closed-loop systems. The City has also been installing closed-circuit television (CCTV) cameras at key locations to facilitate actively managing the arterial system.

Traveler Information

In addition to the statewide traveler information system operated by CDOT from the Colorado Transportation Management Center (CTMC), there are several other small-scale information systems operating in Western Colorado. Many of the communities provide information for local travelers via a City website. Steamboat Springs provides CDOT camera images and information from the local airport. Some of the transit agencies also provide information to their passengers as well as the public. The Roaring Fork Transit Authority (RFTA) provides CDOT images, images from the airport, and weather information on its website. However, they are hoping to be allowed to have direct access to the CDOT data and cameras if possible.

Public Transportation Management

There are several transit agencies throughout Western Colorado with varying degrees of sophistication and resources. Many of these agencies have deployed elements of transit management. Roaring Fork and Grand Valley transit have attempted route scheduling with mixed results. Roaring Fork and CDOT have implemented isolated cases of transit priority on the SH 82 corridor. Steamboat Springs and others are seriously pursuing automated vehicle locating and tracking technology. RFTA also has a robust set of transit management system tools planned associated with implementing bus-rapid-transit along SH 82 from Aspen to Glenwood Springs. Signal priority and a communications link with CDOT that will aid in the availability of real-time vehicle location information are key elements of the bus rapid transit system (the vision being implemented in coming years).

Commercial Vehicle Operations

Commercial vehicle systems are considered a statewide issue. These systems will be addressed in the Statewide Architecture effort.

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 either have already or are in the process of developing joint operation centers. Many of these agencies are also migrating, along with CDOT, to a statewide digital trunk radio system to facilitate on sight coordination of emergencies and incidents.

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.

Data Management

- **Data Management** - Currently CDOT compiles databases of much of the data collected, especially that collected by the CTMC. However, there is also considerable data that is
not complied 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 Western Colorado. With the exception of the Glenwood Canyon area, 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 Western Colorado. Deployment of the digital trunk radio system is hampered due to lack of towers and limited range as a result of the mountainous terrain.

The City of Grand Junction is deploying an extensive fiber-optic system throughout town and the City of Glenwood Springs has deployed a citywide fiber-network, which connects all the stakeholders in town. CDOT also has fiber optics installed from the east end of Glenwood Canyon to Glenwood Springs connecting the CDOT Resident Office in Glenwood Springs to the Hanging Lake Tunnel TMC. RFTA is working on installing a wireless network along the SH 82 corridor to provide Internet access for bus passengers and to be used for automatic vehicle location service.

**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. Region 5 is contemplating instrumenting its maintenance vehicles to provide more real-time road condition data as the maintenance vehicles are performing their duties throughout the Project Area. 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 Hanging Lake Tunnel (HLT) system, which includes a major Transportation Management Center. There are also a number of dynamic message signs, CCTV camera sites, call boxes, highway advisory radios, and remote weather stations. All of the major ports of entry (POE) have weigh-in-motion and 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. In addition, the City of Grand Junction is developing a Traffic Management System and many transit agencies are developing transit management systems. These are described in more depth 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 Western Colorado as well. About 450 devices have been installed in Western 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 3</th>
<th>Region 5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATR</td>
<td>17</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>ATR Piezo</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Callbox</td>
<td>42</td>
<td>5</td>
<td>47</td>
</tr>
<tr>
<td>CCTV</td>
<td>15</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Highway Advisory Radio (HAR)</td>
<td>12</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Lane Control Sign</td>
<td>162</td>
<td>0</td>
<td>162</td>
</tr>
<tr>
<td>Over Height Detection</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Portable VMS</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>RTMS</td>
<td>21</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Ramp Back Up/Wrong Way Detection</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Static HAR Beacon Sign</td>
<td>24</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>Tunnel *</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>VMS</td>
<td>52</td>
<td>39</td>
<td>91</td>
</tr>
<tr>
<td>VMS Speed Control Radar</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Weather Station</td>
<td>21</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Weigh In Motion (Load Cell)</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>384</strong></td>
<td><strong>72</strong></td>
<td><strong>456</strong></td>
</tr>
</tbody>
</table>

* The following ITS devices are used for tunnel operations: HLT: Air Velocity Sensors (4), Carbon Monoxide Sensors (18), CCTV – fixed (26), CCTV – PTZ (19) and Liner Heat Detectors (8). Wolf Creek, CCTV – PTZ (2), Beaver Tail: VMS and CCTV.

While many of these devices are concentrated along the I-70 corridor, they are also distributed throughout Western Colorado as shown on Figure 5.
Figure 5: Project Area ITS Infrastructure
(Western Slope)
Traffic Management Centers

Statewide ITS operations are managed through four major centers including the Hanging Lake Tunnels TMC in Glenwood Canyon between the towns of Glenwood Springs and Gypsum. The other three centers are located outside of the project area. 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 Western Colorado.

The CTMC is responsible for coordinating and providing traveler information throughout the state, especially information dissemination. In Western Colorado, information collection requires a coordinated effort between HLT TMC and CTMC since HLT TMC actually operates and controls many of the devices. 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. Traffic sensors, CCTV images, radar detectors, and other devices are monitored by HLT TMC and this 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 cotrip.org website, 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 radio.

The HLT TMC primarily performs traffic management, incident management, and event management for CDOT Regions 3 and 5. The HLT manages several devices in the Glenwood Canyon as well as managing the Hanging Lake Tunnels and the Wolf Creek Pass Tunnel. HLT TMC also is designed to function as a backup to the CTMC although the lack of high-speed communications between the two facilities limits this capability.
III. Transportation Issues and Needs

The architecture process followed both a top-down approach and a bottom-up approach simultaneously. The top-down portion is described in the ITS 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 needs in the Project Area 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 Project Area. This process identified the following critical issues:

- Weather and crash related incidents on I-70
- Weather related closures on mountain passes
- Congestion in Grand Junction
- Congestion in mountain communities, esp. Durango, Steamboat, Vail/Avon and SH 82 corridor
- Special event impacts
- Wildlife crashes
- Natural or manmade emergencies
- Homeland security
- Maintenance of ITS
- Lack of transit
- Lack of communications/electrical infrastructure

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

III.A. TPR Goals

There are six Transportation Planning Regions (TPRs) in Western Colorado. (See Figure 3). They are:

- San Luis Valley TPR
- Southwest TPR
- Gunnison Valley TPR
- Grand Junction/Mesa County TPR
- Intermountain TPR
- Northwest 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. Four of the six TPRs indicated their desire for economic growth, and all requested consideration for multi-modal facilities except for the Gunnison Valley TPR whose goal list was the shortest, focusing on quality of life, retaining western values, maintaining sense of community, and supporting economic growth. Both the SWTPR and Grand Junction/Mesa County TPR specifically mention the development or enhancement of trail systems. The SWTPR went as far to make trails a standalone goal for their region.
Overall, the TPR’s in the Project Area appear to be similar in terms of what they desire for their transportation system. Recurring themes in goals for each TPR 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

### III.B. Stakeholder Issues and Needs

A broad overview of needs and issues identified by thorough 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 the Western Slope 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 on the Western Slope is also patchy; some areas have very good coverage while others have no coverage at all. The coverage also varies dramatically between different cellular telephone carriers. The mountainous 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 Glenwood Canyon area but Colorado State Patrol does not have direct access to this. These cameras recordings would be extremely useful to the Colorado State Patrol (CSP) in the event of an incident in the canyon, but CSP dispatch cannot get direct access to the images because the needed protocols have not been put in place. Hence, CSP can only get the images over the Internet and these are often not available during high demand periods.

Many localities have information that would be valuable to other jurisdictions but that information is not used due to lack of awareness, formatting, and other issues. For example, in southwestern Colorado the 911 dispatch uses latitude and longitude to dispatch emergency services while emergency calls frequently, are based on 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

- Communication infrastructure is unreliable
- Need for better communication (especially fiber optics)
- Connectivity of systems
- Coordination communication with Amtrak
- GIS integration/coordinating and sharing
- Inter jurisdiction coordination
- Request for more timely and accurate information disbursements
- Bi/multi-lingual information
- Establish better communication channels (e.g. maintenance calls CDP sites at Montrose)
- Coordination with multi-use net of the Dept. of Information Technology (DOIT)
- Web links (location specific information)
- Better cellular connections
- More fiber optics
- Mountain communications by radio
- Microwave
- Automated weather stations – beyond passes
- Need more call boxes

Trip and Mode Options
The Western Slope 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.

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>Increased transit ridership</td>
</tr>
<tr>
<td>Increased alternative modes</td>
</tr>
<tr>
<td>Increased BRT express service</td>
</tr>
<tr>
<td>Transit traveler information/transit communications (mobile radio)</td>
</tr>
<tr>
<td>Trip options (Steamboat related to Greyhound)</td>
</tr>
<tr>
<td>“Next Bus” indicator system</td>
</tr>
<tr>
<td>Traffic/transit data collection and dissemination</td>
</tr>
<tr>
<td>Transit signal priority</td>
</tr>
<tr>
<td>Better passenger transfer points – proposing station for all buses</td>
</tr>
<tr>
<td>National Park Service transit options are under study</td>
</tr>
</tbody>
</table>

Traffic Congestion
Most rural routes, between communities, are not very congested. However, many of the mountain communities, especially the resort towns, experience severe traffic 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 western 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 with both primary and secondary accidents related to this congestion on narrow roads with few alternate routes. 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>• Communication with traffic signals</td>
</tr>
<tr>
<td>• Congestion in urban areas</td>
</tr>
<tr>
<td>• ITS applications for Durango for traffic management of highways</td>
</tr>
</tbody>
</table>

**Incidents/Special Events**

Many of the mountain communities hold special events that attract large number of visitors from throughout the country and in some cases throughout world. Examples of this are the Telluride Bluegrass Festival, the Winter Park Music Festival, World Cup Skiing, and the X-Games. 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 Red Mountain Pass on US 550, which is closed 20 to 30 times a year due to weather conditions or avalanche control measures. Each time it closes travelers must either wait for the road to reopen, or detour more than 50 miles out of the way. 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>Incidents/Special Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Incident re-opening functional requirements</td>
</tr>
<tr>
<td>• Incident detection</td>
</tr>
<tr>
<td>• Need more extensive road/weather information systems</td>
</tr>
<tr>
<td>• Wildlife detection/number of accidents related to wildlife</td>
</tr>
<tr>
<td>• Seasonal/special events</td>
</tr>
<tr>
<td>• Adherence to incident management plans</td>
</tr>
<tr>
<td>• Joint incident management/emergency management planning</td>
</tr>
<tr>
<td>• Incident management plans – by sub region</td>
</tr>
<tr>
<td>• Coordination of stakeholders in the regions:</td>
</tr>
<tr>
<td>• Consider TPR priorities such as:</td>
</tr>
<tr>
<td>Traffic reliability and safety</td>
</tr>
<tr>
<td>Accidents</td>
</tr>
<tr>
<td>Mobility and congestion relief</td>
</tr>
<tr>
<td>ITS for problem areas</td>
</tr>
<tr>
<td>Includes 1/3 of money for intersection improvements</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 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>• Coordination between Emergency Management Service and ITS - interconnects</td>
</tr>
<tr>
<td>• Hazardous material information relay to emergency response</td>
</tr>
<tr>
<td>• 911 routing</td>
</tr>
<tr>
<td>• Make 511 Service more reliable</td>
</tr>
<tr>
<td>• 800 MHz Digital Trunk Radio (DTR) System</td>
</tr>
<tr>
<td>• Route guidance</td>
</tr>
<tr>
<td>• Emergency dispatch needs state highway milepost used versus rural addressing system</td>
</tr>
<tr>
<td>• Latitude/longitude - interconnecting</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.

<table>
<thead>
<tr>
<th>Safety and Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Passenger security/ Digital Video Recorders (DVR)</td>
</tr>
<tr>
<td>• Automated vehicle location</td>
</tr>
<tr>
<td>• Hazard Advisory Radio (HAR) traveler information on passes</td>
</tr>
<tr>
<td>• Virtual Port of Entry (POE) – Statewide</td>
</tr>
<tr>
<td>• Homeland Security/DTR enabling technology</td>
</tr>
<tr>
<td>• Wildlife detection/number of accidents related to wildlife</td>
</tr>
<tr>
<td>• Tie road surface temperature to Global Positioning Service for automobile reporting</td>
</tr>
<tr>
<td>• Priority mountain passes are Wolf Creek, Molas, Coal Bank, Red Mountain, La Veta, and Monarch (highest accident rate)</td>
</tr>
<tr>
<td>• Increased surveillance at critical locations (such as passes) on weather stations</td>
</tr>
<tr>
<td>• Need to plan for homeland security, emergency evacuation</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

- GPS/Automated Vehicle Location on Maintenance
- Need more work zone safety; coordination of work zone/event information (including Bicycle events)
- Daily or real time construction information
- Small work zone intersection, utility development
- De-icing
- Environmental safety (fog, dust, etc.)
- Funding and budgeting inefficiencies – important side issue

### Commercial and Freight Mobility

Commercial deliveries and freight are both important elements of transportation. This is especially true in Western 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 communities in Western 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

- Capacity/sufficiency of bridges information sharing
- Commercial vehicle information
- Virtual Port of Entry (POE) – Statewide
- Port-of-Entry/Weigh in Motion (WIM) Technology – Virtual Weigh Stations
- Truck information/warning systems
- Over height, overweight (tunnels too low, trucks to high, trucks too heavy)
- Truck speeds (speed warnings/advisories)
IV. Linking Market Packages to Transportation Needs

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 or the City of Grand Junction. There are several automatic traffic recorders along I-70 and other major highways (Network Surveillance), CDOT and Grand Junction 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 Glenwood Canyon. 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-70 through the regions (Incident Management System) Additional services are needed to close mountain passes (Roadway Closure Management). CDOT and Grand Junction are discussing coordinating traffic signals in the Grand Junction area between jurisdictions and sharing real-time data (Regional Traffic Control). Finally, while there are no specific plans, SH-82 has an HOV lane so it 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 (proposed)</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>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 area 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. Transit signal priority (Multi-modal Coordination) has also been specifically recommended for the SH-82 corridor.

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 Infrastructure Protection (prop.)</td>
<td>Uses surveillance cameras and sensors to monitor critical infrastructures such as bridges, tunnels, etc.</td>
</tr>
<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>
<tr>
<td>Work Zone Management (prop.)</td>
<td>Enables construction delay and routing information to be provided en-route to drivers, and also facilitates providing this information to other agencies.</td>
</tr>
<tr>
<td>Work Zone Safety Monitoring (prop.)</td>
<td>“Intrusion Alarms” and other devices that warn if a vehicle is approaching a work zone at a high rate of speed or has entered the work zone. May also monitor movements of workers.</td>
</tr>
<tr>
<td>Maintenance and Construction Activity Coordination (prop.)</td>
<td>Coordination of maintenance and construction activities between various agencies for improved operations.</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><em>ITS Data Mart (prop.)</em></td>
<td>Collect data for future analysis for one agency only.</td>
</tr>
<tr>
<td><em>ITS Virtual Data Warehouse (prop.)</em></td>
<td>Supports networked access to data archives for multiple agencies.</td>
</tr>
</tbody>
</table>
V. ITS Strategic Goals

While the review of the regional transportation plans and the stakeholder workshops focused on a bottom-up process, statewide and national priorities were considered to provide a top-down approach as well.

V.A. Statewide Goals

CDOT prepared a Statewide ITS Strategic Plan. That plan listed four primary goals for the CDOT ITS program. These are:

**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 business 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 11 below presents CDOT Statewide ITS strategies associated with ITS Core Services.
Table 11: CDOT Statewide ITS Strategies

<table>
<thead>
<tr>
<th>Core Services</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Management</td>
<td>Establish active traffic management in priority corridors.</td>
</tr>
<tr>
<td>Traveler Information</td>
<td>Continue statewide deployment of ITS devices used for collecting pre-trip and en-route travel planning information. Develop the advanced traveler information system – disseminate statewide traveler information.</td>
</tr>
<tr>
<td>Incident Management</td>
<td>Use real-time road condition information to deploy and assist with incident response. Use active traffic management capabilities to reduce congestion arising from recurring/non-recurring incidents and provide traveler information about incidents.</td>
</tr>
<tr>
<td>ITS Maintenance</td>
<td>Establish a statewide ITS maintenance planning, replacement, and budgeting process.</td>
</tr>
<tr>
<td>ITS Planning and Project Prioritization</td>
<td>Conduct statewide ITS deployment planning and provide leadership for implementing the statewide ITS enabling infrastructure. Use performance measures to evaluate ITS contributions to CDOT investment categories. Institutionalize ITS into the statewide and regional planning processes. Institutionalize ITS into CDOT’s project scoping processes.</td>
</tr>
<tr>
<td>ITS Enabling Infrastructure</td>
<td>Deploy ITS enabling infrastructure on a statewide basis.</td>
</tr>
<tr>
<td>ITS Project Delivery Support</td>
<td>Establish statewide ITS device procurement specifications and guidelines. Establish policies, procedures, and provide guidelines for inspection and acceptance of ITS components. Develop and establish statewide design standards for ITS systems and devices.</td>
</tr>
</tbody>
</table>

V.B. **ITS Services**

Combining the statewide goals with the needs identified in the stakeholder workshops and cross-referencing them to the goals of the National ITS Architecture points to the suggested ITS User Services and/or Market Packages for Western Colorado.

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

Each of these is described in more detail below.
Freeway Management

With a few exceptions, freeway management in Western Colorado focuses on information collection and dissemination. There are lane control signals approaching the Hanging Lake Tunnels and there is an active speed advisory sign westbound approaching Glenwood Canyon. Ramp metering has been discussed for Eagle County as traffic volumes and congestion increase, but no firm plans exist.

Incident Management

Incident management refers to the management of incident and highway traffic in response to an incident. Like traveler information and freeway management, mobility is the primary objective of incident management; however, there is a safety aspect as well. The goal of incident management is to reduce the response times for incidents and clear roads of obstructions, keep traffic moving, and minimize related secondary incidents. CDOT developed an Incident Management Plan for the I-70 Mountain Corridor; from the Utah state line to the west side of the Denver region, in the late 1990s. CDOT Region 1 and Region 3 have recently updated the IMP for I-70; however, many of the devices such as variable message signs and CCTV cameras that have been recommended have not been installed. Furthermore, incident management plans have not been developed for the other significant highways in Western Colorado. This is particularly important for the major mountain passes because of the frequent closures and the distances required diverting around them. In addition, several passes such as Fremont Pass and Tennessee Pass are critical alternate routes for I-70.

The recommendations of the I-70 IMP, with respect to devices, should be implemented. This corridor carries more than half the east-west traffic in Western Colorado and is critical to interstate travel. Major highway closures on I-70 disrupt traffic in adjoining states as well. Automated road closure systems are also needed for I-70 in Glenwood Canyon. This section is closed several times each winter and requires State Patrol or Sheriff vehicles to occupy the roadway during a closure. Road closure systems are needed on each of the major passes as well as road and weather information systems. Finally, incident management plans need to be prepared for the rural portions of each of the major state highways in Western Colorado.

Incident Management Strategies:

- Complete the recommended improvements identified in the I-70 IMP.
- Implement automated road closure management for I-70 through Glenwood Canyon.
- Implement road closure management and road and weather information systems for the major passes.
- Develop incident management plans for the rural portions of major state highways.

Traveler Information

CDOT has committed to plan and finance a statewide traveler information system that meets both regional and statewide needs. Information on road and weather conditions, road and lane closures, construction activities, and several other elements of traveler information are provided to the public through the CoTrip.org website. This site includes weather station data, CCTV camera images, access to variable message sign (VMS) messages, and speed and volume maps where available. This information is also available through cell phones and PDA’s/palm pilots via wireless Internet access. CDOT has recently deployed a new road information service using the national 511 protocol that provides road information in a similar manner to the way the 911 number can be used to access emergency services. CDOT also distributes road advisories via broadcast fax and email. In addition, through partnerships with the media, CDOT is able to broadcast messages and images to the public. En-route information is also disseminated to the
public through variable message signs and highway advisory radio using the AM 530 channel and low-power radio in selected areas.

This system should be enhanced in Western Colorado by adding instrumentation to more roadways, facilitating the data collection from those sensors, and by providing mechanisms for other stakeholders to provide input to CDOT. In addition, mechanisms should be developed to allow stakeholders to collect data from CDOT and filter that data to tailor it to their specific users. This includes destinations, such as Steamboat Springs, providing CDOT traveler information customized for travelers destined to their community. It also includes transit agencies customizing travel information for their riders.

**Traveler Information Strategies:**
- Deploy additional sensors along I-70 to monitor road conditions.
- Deploy additional VMS and HAR along I-70 to provide en-route traveler information.
- Deploy additional VMS at common closure locations on major routes such as passes and canyons for en-route information.
- Deploy additional sensors at critical locations to improve accuracy of travel information.
- Develop reporting mechanism to allow stakeholders to provide road condition data. (CDOT is currently working to supplement collection of road condition information using its maintenance forces).
- Develop secure interface to provide access to raw road data for stakeholders, such as emergency and transit providers.
- Explore additional information dissemination means such as satellite radio to improve information dissemination in areas with poor traditional reception.

**Arterial Traffic Management**
Traffic management entails the active management of the right-of-way to use the available capacity in the most efficient way. It includes traffic signal control systems, which may employ a variety of advanced control strategies. Sensors to monitor traffic flow in real-time are a key element of all advanced control strategies. Surveillance cameras may also be used at critical locations so that operations staff can visually monitor traffic in real-time.

As congestion increases in the small urban and urbanized communities, actively managing traffic signals is an important tool to maximize the use of the existing capacity. These systems can also be combined with transit priority, where appropriate, to increase the attractiveness of transit. These systems also facilitate adjusting signal timing for special events.

**Arterial Traffic Management Strategies:**
- Implement the Grand Junction regional arterial traffic management system.
- Implement arterial management systems on major state highways through small urban communities.
- Develop multi-modal coordination with transit operators.

**Transit Management and Multi-modal Coordination**
This service consists of automating many of the operations involved in transit service. This includes automating vehicle location, fare payment, and passenger counting. Providing real-time transit information at major transfer points and over the Internet are also key elements. While each of the transit agencies has differing levels of commitment to automated operations, all of them would benefit from some application of automated transit management. Providing prioritization for transit at key heavily congested intersections is another valuable transit
management tool. Increasing the operational efficiency of transit in the congested communities is an effective way to reduce delay and increase rider comfort. Each agency will select the specific services most appropriate to that agency. However, where multi-modal coordination is required, this will have to be closely coordinated with CDOT.

**Transit Management and Multi-modal Coordination Strategies:**

- Provide transit management systems.
- Disseminate transit traveler information.
- Develop multi-modal coordination (Transit Signal Priority).

**Safety Management**

Safety Management Systems serve to reduce crashes and their severity to aid in the rapid identification and response to a crash or emergency. These systems include speed warning systems, automatic speed advisories, oversized vehicle detection, wildlife warning systems, surveillance systems, and mayday support. In Western Colorado, emergency response time is a critical issue, as it is in many rural areas. Strategies to enhance emergency response have a direct and significant safety benefit by reducing the severity of injuries.

Two strategies that are particularly promising for improving emergency response are integrating reference systems and providing direct access to video images. Currently CDOT and CSP use the CDOT highway number and milepost to identify a location while emergency dispatch frequently uses latitude and longitude to reference locations. CDOT has cross-referenced these two systems for GIS purposes. Integrating this cross-reference system with all the rural emergency responders will reduce the time to correctly identify the location of an event and to dispatch the correct resources. Direct access to video images will also aid dispatchers in determining which resources to dispatch to an incident.

The other strategic element of Safety Management is providing greater detection for wildlife at concentrated highway crossings. Wildlife related crashes are a major cause of crashes in Western Colorado. As indicated previously, wildlife crashes are the largest cause of crashes, accounting for more than 50% of the crashes on some stretches of highway. CDOT is currently testing several strategies to automatically detect wildlife and reduce these types of incidents. Implementation of automated wildlife detection systems could potentially reduce the number of crashes on state highways in Western Colorado by a few hundred crashes per year, a significant reduction. Furthermore, studies show that by merely reducing the speed where these crashes occur, via warning systems, the accident severity would drop considerably.

**Safety Management Strategies:**

- Employ emergency response system for I-70.
- Develop rural emergency response system for Northwest.
- Develop rural emergency response system for Southwest.
- Deploy automated wildlife detection systems.

**Communication and Connectivity**

Communications is a critical element of the regional deployment of ITS. Without communications there is no way to manage devices in the field or to bring back data from the field. Communications is what enables the connections between management centers and stakeholders, and supports the sharing of information and the coordination of responses to incidents and events. However, due to the terrain and sparse population, there is very little existing communications infrastructure, especially the high-speed telecommunication links.
needed for real-time video or to support connectivity between centers. Improving communications is essential to the success of the other strategic objectives.

At the statewide level, CDOT has identified a fiber-optic network connecting the major TMCs as a statewide priority. Recently, a fiber-optic connection was installed between the CTMC and the Eisenhower-Johnson Tunnel TMC. However, no such connection exists between the EJT TMC and the Hanging Lake Tunnels TMC. Completing this network to the HLT TMC is essential toward accomplishing the statewide goal of connecting the major TMCs.

Another critical element is developing communications to devices in the rural areas of Western Colorado. Many of these areas are without electrical or telephone utilities, and wireless communications or cell phone coverage is sporadic due to the terrain. This lack of communications infrastructure limits the deployment of devices, hampers reporting of accidents and incidents, and prevents reception of traveler information. While several potential alternatives for communications exist, this information has not been complied in a central location and been made available for designers and operations staff to use in deploying systems. Development of a communications plan for Western Colorado would provide the information that planners, designers and engineers need to determine the appropriate communications medium and source for individual projects.

Finally, CDOT is gathering a wealth of valuable information from the infrastructure it has deployed and will continue gathering even more in the future. However, much of this information is not readily available to other stakeholders in the format that they need it. While CDOT makes most of this information available on the CoTrip.org website, that format does not fit the needs of some stakeholders and partners. Dispatch centers need direct access to camera images to facilitate dispatch and coordinate emergencies and incidents. Other stakeholders need to be able to conveniently repackage traveler information to customize it for their particular clientele. Both these applications can be accommodated by providing a secure access to the CDOT images and data so that approved stakeholders could access the information without going through the front end steps of the CoTrip.org website.

**Communication and Connectivity Strategies:**

- Install fiber-optic telecommunications from Hanging Lake Tunnels TMC to Eisenhower-Johnson Tunnel TMC, and install fiber-optic telecommunications from HLT TMC to Grand Junction.
- Develop Regional Communications Master Plan.
- Link HLT TMC to emergency operation centers throughout Western Colorado.
- Provide direct and secure access to camera images and other data for stakeholders and partners.

**Maintenance and Construction**

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. Region 5 is contemplating equipping its maintenance vehicles to provide more real-time road condition data as the maintenance vehicles are performing their duties throughout the Project Area. 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.
V.C. Regional ITS Goals

Combining all the information gathered to date regarding transportation needs in the Project Area, the following ITS goals were developed and grouped by geographic location (see Figure 6).

Figure 6: Project Area ITS Goals
VI. Strategic ITS Projects

Ultimately, the realization of the strategic goals for intelligent transportation systems in Western 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 goals are important, some are more critical than others. 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, an ITS project can be significant on different levels, just as transportation facilities can. 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 Project Area. Finally, some projects implement strategic objectives, but on a more localized basis.

VI.A. Recommended ITS Projects

With the aforementioned framework in mind, the following ITS strategic projects are recommended to address the ITS strategic objectives in Western Colorado (Figure 7 Error! Reference source not found.):

Projects of Statewide Significance

1. Install fiber-optic cable along I-70 from Frisco to Glenwood Canyon including all equipment, connections with lateral devices and C2C connectively with CSP and local jurisdictions (the segment from Frisco to Vail is physically in Region 1, but is included to provide interconnectivity between EJT TMC and HLT TMC)
2. Install fiber-optic cable along I-70 from Glenwood Springs to Grand Junction including all equipment, connections with lateral devices and C2C connectively with CSP and local jurisdictions.
3. Completion of the I-70 Incident Management Plan improvements from Vail to Grand Junction, including automated road closure for Glenwood Canyon.
4. Provide a secure interface so that participating agencies, such as transit providers or local governments, can access camera images and other data directly.
5. Develop a communications master plan for the rural areas of Western Colorado where existing communication infrastructure is inadequate.
6. Instrument maintenance vehicles to provide road and weather condition data.

Projects of Regional Significance

7. Installation of Automated Pass Maintenance and Management Systems on the major highway routes, including:
   7.1 US 550 between Durango and Ouray (Coal Bank Pass, Molas Divide, Red Mountain Pass),
   7.2 US 160 over Wolf Creek Pass,
   7.3 US 40 between Kremmling and Steamboat Springs (Muddy Pass and Rabbit Ears Pass),
   7.4 US 50 over Monarch Pass,
   7.5 SH 145 over Lizard Head Pass,
7.6 US 24 over Tennessee Pass,
7.7 US 50 over Cerro Summit,
7.8 SH 91 over Fremont Pass,
7.9 US 160 over La Veta Pass, and
7.10 US 50 in the Blue Mesa Reservoir area.

8. Implementation of a Transit Signal Priority System on State Highway 82 from Glenwood Springs to Aspen (this is separate from the arterial management system for SH 82).


10. Implementation of arterial management systems on:
    10.1 SH 82 from Glenwood Springs to Aspen,
    10.2 US 40 through Steamboat Springs,
    10.3 US 40 through Winter Park,
    10.4 US 550 and US 160 through Durango,
    10.5 US 160/US 285 through Alamosa,
    10.6 US 550 and US 50 through Montrose, and
    10.7 US 50 through Gunnison.


12. Develop communication links between the HLT TMC and major Emergency Operations Centers and other transportation providers.

13. Enhance transit management systems for local transit operators, to include automatic vehicle location, automatic fare collection, and real-time transit passenger information.
Figure 7: Recommended ITS Strategic Projects

These projects are discussed in more detail in the following sections.
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 corridor. This corridor is a critical part of the interstate transportation system connecting Denver and other cities to the east, with cities in Utah, Nevada, and California. Disruption of this roadway affects other roadways throughout the western United States. 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 objective for the I-70 corridor:

Fiber optic cable installation along I-70

While numerous ITS devices have been deployed along the I-70 corridor 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 and to manage the numerous devices needed for efficient management of 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 centers at Hanging Lake Tunnel and the CTMC now in Golden. With the exception of about 20 miles in Glenwood Canyon, there is no direct communication along I-70.

Recently, CDOT completed installation of fiber optic lines from the Denver Metro area to Frisco. Extending this system from Frisco to Glenwood Canyon and from Glenwood Springs to Grand Junction provides a critical piece of supporting infrastructure, which will support the deployment of more extensive incident and emergency management systems along I-70, as well as significantly improve the quality of traveler information along the I-70 corridor. Given that I-70 is the most important corridor in the project area and that the fiber-optic communications is a critical piece of supporting infrastructure for other strategic goals, these two fiber optic projects are the highest priority in the Project Area, and are presented in more detail below.

1. Install fiber-optic cable along I-70 from Frisco 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. The segment from Frisco to Vail is physically in Region 1, but is included here to provide connectivity between the HLT TMC and the EJT TMC. This project also installs the network communication hardware necessary to manage a high-speed network and provide center-to-center connectivity. Equipment and lateral connection are included in the incident management system.

Estimated Construction Cost: $10,500,000
Design Costs (8%): $840,000
Annual Maintenance and Repair (10%): $1,050,000
2. **Install fiber-optic cable along I-70 from Glenwood Springs to Grand Junction**

Fiber-optic cable has been extended from HLT TMC to the CDOT Resident Offices in Glenwood Springs; however, there is no high-speed communication available to CDOT between Glenwood Springs and Grand Junction, a distance of 88 miles. This project also installs the network communication hardware necessary to manage a high-speed network and provide center-to-center connectivity. Equipment and lateral connection are included in the incident management system.

| Estimated Construction Cost: | $10,500,000 |
| Design Costs (8%): | $840,000 |
| Annual Maintenance and Repair (10%): | $1,050,000 |

**I-70 Incident Management Plan Improvements**

Due to the volume of traffic it carries and the inter-regional and interstate nature of trips along it, I-70 has a unique strategic importance in the project area. For this reason, incident management and traveler information along I-70 are important to the Project Area, 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.

Due to limited funding and the lack of communication infrastructure, many of these recommendations have not been implemented. While numerous devices such as surveillance cameras, variable message signs and highway advisory radios have been deployed at several locations along the corridor, these deployments have been limited in the western slope. Several locations have been identified as part of the incident management plan development, but the lack of high-speed communications has limited these deployments. Once a fiber optic network is installed along I-70, completion of the identified devices should be the next priority. Along with this, automatic road closure systems are needed to assist with incident management, especially at the westbound entrance to Glenwood Canyon.

3. **Completion of the I-70 Incident Management Plan improvements from Vail to Grand Junction, including automated road closure for Glenwood Canyon**

Recently, CDOT updated the Incident Management Plan for I-70. Based on the plan, I-70 will require the following: 9 VMS, 10 CCTV, 21 Call Boxes, and HAR. This estimate also includes the communication equipment and lateral cables.

| Estimated Construction Cost: | $2,900,000 |
| Design Costs (8%): | $232,000 |
| Annual Maintenance and Repair (15 %): | $435,000 |

4. **Providing 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.

5. Developing a communications master plan for Western Colorado

Several areas of Western 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

6. 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

Automated Pass Management

One of the major issues in Western 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. This package of improvements closes roadways to vehicular traffic over mountain passes when driving conditions are unsafe, maintenance must be performed, and for other scenarios when access to the roadway must be prohibited. Roadway Closure Management, the Market Package for this ITS applications includes automatic or remotely controlled gates that manage access to roadway segments. Remote control systems allow the gates to be operated from a central location, improving system efficiency and reducing personnel exposure to unsafe conditions during severe weather events and other situations that necessitate road closure. Surveillance systems allow operating personnel to visually verify the safe activation of the closure system and driver information systems (e.g., VMS and HAR) provide closure information to motorists in advance of the closure.

Roadways requiring automated pass management systems include:

1. US 550 between Durango and Ouray (Coal Bank Pass, Molas Divide, Red Mountain Pass),
2. US 160 over Wolf Creek Pass,
3. US 40 between Kremmling and Steamboat Springs (Muddy Pass and Rabbit Ears Pass),
4. US 50 over Monarch Pass,
5. SH 145 over Lizard Head Pass,
6. US 24 over Tennessee Pass,
7. US 50 over Cerro Summit,
8. SH 91 over Fremont Pass,
9. US 160 over LaVeta Pass,
10. US 50 in the Blue Mesa Reservoir area.

7. Automated Pass Maintenance and Management

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 shoulder delineation for snow removal, 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 $50,000 per location. An incremental deployment could consist of manual gates and warning signs and would cost about $150,000. However, several of the required devices are already deployed throughout the Project Area and devices can be shared between adjacent passes such as Coal Bank and Molas Divide (i.e. closing both passes simultaneously).

Estimated Construction Cost (full system): $2,650,000  
Design Costs (8%): $212,000  
Annual Maintenance and Repair (15%): $397,500  
Estimated Construction Cost for Manual System = $1,650,000

8. Transit Signal Priority System on State Highway 82 from Glenwood Springs to Aspen

SH 82 from Glenwood Springs to Aspen is the most heavily traveled corridor in the Project Area with the exception of I-70. Much of the traffic is daily commuter travel combined with tourism and recreation travel. A rapid transit corridor has been designated parallel to the highway. However, funding for the ultimate transit solution is several years away. Currently RFTA operates its regional commuter services along the designated HOV lane between Basalt to Buttermilk, just south of Aspen Airport and in mixed traffic between Basalt and Glenwood Springs. The regionally-endorsed vision for this system is to implement bus rapid transit along SH 82, which incorporates a new fleet of low-floor vehicles, improved transit stations and ITS elements such as automated fare collection, real time information, and transit signal prioritization. Currently, delays at signalized intersections reduce the operational efficiency of transit as a mode choice and disrupt bus scheduling. A transit signal priority system will improve the on-time performance and increase the attractiveness of transit as a trip choice in this corridor. In addition, the necessary communications infrastructure will facilitate improvements in the signal operations for general-purpose traffic as well. This project could entail installing transponders on each bus that uses the system, receivers at each signalized intersection, and communications between the signal controllers and a master controller. This infrastructure also uses the arterial management system through the built up areas of the corridor.

Estimated Construction Cost: $1,000,000  
Design Costs (12%): $120,000  
Annual Maintenance and Repair (15%): $150,000
9. Regional Traffic Management System in Grand Junction

Grand Junction is currently in the process of extending fiber-optic cable to most of the arterial intersections in the urban area and placing the traffic signals under closed-loop control. This is a critical first step in improving active management of the traffic signals and increasing the efficiency of the transportation network. Bringing all the signals in the Grand Junction area, including CDOT and Mesa County, under control of a single multi-jurisdictional control system is the next step in improving traffic operations in this sub-region. This would allow each jurisdiction to maintain autonomous control of its own signals while ensuring that signals remain coordinated. It also provides the mechanisms for more advanced traffic control strategies.

Estimated Construction Cost: $1,500,000
Design Costs (8%): $120,000
Annual Maintenance and Repair (15%): 225,000

10. Arterial Management Systems

Congestion management is an essential strategy for preserving mobility in the western communities. This entails providing closed-loop signal control along the state highways, coordinating adjacent signals not on the state highway, and providing traffic sensors and video cameras for real-time monitoring of traffic. These systems are required on the following:

1. SH 82 from Glenwood Springs to Aspen,
2. US 40 in Steamboat Springs,
3. US 40 in Winter Park,
4. US 550 and US 160 in Durango,
5. US 160 and US 285 in Alamosa,
6. US 50 and US 500 in Montrose,
7. US 50 in Gunnison.

Each of these systems is estimated to cost $500,000.

Estimated Construction Cost: $3,500,000
Design Costs (8%): $280,000
Annual Maintenance and Repair (15%): $525,000

11. Automated Wildlife Detection Systems

Wildlife crashes are a significant safety problem in Western Colorado. CDOT is testing several different wildlife detection systems to alert drivers of wildlife on the road and to scare wildlife away from concentrated crossing areas. However, none of these have been selected as the preferred treatment at this time. Once CDOT determines which technology is the most appropriate for deployment, formal cost estimates, budgets, and locations will be determined. For the time being, an aggregate cost of $2,000,000 has been assigned as a placeholder for a pool of funds to address potential wildlife detection areas in the Project Area.

Estimated Construction Cost: $2,000,000
Design Costs (8%): $160,000
Annual Maintenance and Repair (20%): $400,000
12. **Communications links between HLT and EOCs.**

Local emergency management centers are responsible for coordinating police, fire, and other emergency responders for incidents and for evacuations. These activities are greatly enhanced by access to real-time information, especially video images, as well as access to advisory radio and message signs. However, most emergency management centers do not have access to cameras or other sensors. Communications links would provide access to existing CCTV installations and facilitate coordination with the HLT TMC for disseminating information to travelers. Due to the number of emergency operations centers, their varying requirements, and other parallel efforts, this action has not been quantified.

13. **Transit Management Systems**

Enhancing transit systems and increasing ridership is a key tool for managing congestion in communities in Western Colorado. Advanced transit management systems have been shown to reduce cost per passenger mile as well as increasing ridership. These transit management systems could include automatic vehicle location, automatic fare collection, and real-time transit passenger information. Since each transit system differs in the amount of automation and the extent of transit system they want to manage, this item has not been quantified.

**VI.D. Relating Projects to Goals**

Table 12 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.

**VI.E. Corridor Prioritization**

Corridors were prioritized based on the classification of the roadway, the traffic volumes along the roadway, and other considerations such as trip lengths and commercial vehicle characteristics. The corridors were prioritized within the following categories: Interstate Highways, Statewide Significant Corridors, and Regionally Significant Corridors. These categories and assignments of roadways to them are defined in the 2030 Statewide Transportation Plan. Table 13 provides the relative priority of corridors in the region.
### Table 12: Strategic Goals to Projects

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Strategic ITS Project</th>
<th>Northwest</th>
<th>I-70</th>
<th>Grand Junction</th>
<th>Mountain Communities</th>
<th>South-west</th>
<th>Region-wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Install Fiber optic Cable along I-70 from Glenwood to Kill</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Install fiber optic Cable from Glenwood to Grand Junction</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Complete Incident Management and Traveler Information System</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Provide a secure web interface to camera images</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Develop a Communications master-plan</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Instrument maintenance vehicle for road and weather information</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Install Pass maintenance and management system on Molas, Red Mountain, and Coal Bank Passes</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>Install Pass Maintenance and Management system on Wolf Creek Pass</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3</td>
<td>Install Pass Maintenance and Management System on Muddy Pass and Rabbit Ears Pass</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4</td>
<td>Install Pass Maintenance and Management System on Monarch Pass</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5</td>
<td>Install Pass Maintenance and Management System on Lizard Head Pass</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.6</td>
<td>Install Pass Maintenance and Management System on Tennessee Pass</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.7</td>
<td>Install Pass Maintenance and Management System on Cerro Summit</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.8</td>
<td>Install Pass Maintenance and Management System on Freemont Pass</td>
<td></td>
<td>✓</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.9</td>
<td>Install Pass Maintenance and Management System on La Veta Pass</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.10</td>
<td>Install Pass Maintenance and Management System in the Blue Mesa Reservoir area</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Implement Transit Signal Priority on SH 82 from Glenwood to Aspen</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Complete the Regional Traffic Management system in Grand Junction</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>10.1</td>
<td>Implement Arterial Traffic Management System on SH 82 from Glenwood to Aspen</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>10.2</td>
<td>Implement Arterial Traffic Management System on US 40 in Steamboat Springs</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.3</td>
<td>Implement Arterial Traffic Management System on US 40 in Winter Park</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.4</td>
<td>Implement Arterial Traffic Management System on US 550 and US 160 in Durango</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.5</td>
<td>Implement Arterial Traffic Management System on US 160 and US 285 in Alamosa</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.6</td>
<td>Implement Arterial Traffic Management System on US 50 and US 550 in Montrose</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.7</td>
<td>Implement Arterial Traffic Management System on US 50 in Gunnison</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Implement Automated Wildlife Detection Systems on critical roadway sections</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Develop communications links between HLT and EOC's</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
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</tbody>
</table>
### Regional ITS Strategic Plan for Western Colorado

#### Goals

<table>
<thead>
<tr>
<th>Goals</th>
<th>Northwest</th>
<th>I-70</th>
<th>Grand Junction</th>
<th>Mountain Communities</th>
<th>South-west</th>
<th>Region-wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pass Closure Management</td>
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<td>Emergency Response</td>
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<tr>
<td>Incident Management</td>
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<tr>
<td>Traveler Information</td>
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</tr>
<tr>
<td>Incident Management</td>
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</tr>
<tr>
<td>Road Closure Management</td>
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</tr>
<tr>
<td>Aerial Traffic Management</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Incident Management</td>
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<td>Incident Management</td>
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<tr>
<td>Multi-modal Coordination</td>
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<tr>
<td>Congestion Management</td>
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<tr>
<td>Special Event Management</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Multi-modal Coordination</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transit Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Closure Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Aerial Traffic Management</td>
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<td>Incident Management</td>
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<td>Incident Management</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Connect Hanging Lake Tunnel</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eisenhower Johnson Tunnel</td>
<td></td>
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</tbody>
</table>

#### Project Number

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Strategic ITS Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Implement transit management systems for local transit operators</td>
</tr>
</tbody>
</table>
Table 13: Corridor Prioritization

<table>
<thead>
<tr>
<th>Roadway Classification</th>
<th>Priority</th>
<th>Roadway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate Highways</td>
<td>1</td>
<td>I-70</td>
</tr>
<tr>
<td>Statewide Significant Corridors</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>US 40</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>US 160 and US 285 through Alamosa</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>US 550</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>US 50</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>US 24</td>
</tr>
<tr>
<td>Regionally Significant Corridors</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>SH 82</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>SH 13</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>SH 131</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>SH 91</td>
</tr>
</tbody>
</table>

VI.F. Project Prioritization

Projects were prioritized based on the perceived severity of the problems addressed, the strategic importance of the improvements, any required sequencing of improvements and in conjunction with how the corridors were prioritized in the study area. Projects are prioritized and categorized within Projects of Statewide Significance and Projects of Regional Significance to distinguish between the projects that are likely to compete for statewide ITS funding versus those projects that are likely to compete for regional funding.

Table 14: Projects of Statewide Significance

<table>
<thead>
<tr>
<th>Priority</th>
<th>Project</th>
<th>Responsible Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fiber-optic cable along I-70: Frisco to Glenwood Canyon</td>
<td>HQ/R1/R3</td>
</tr>
<tr>
<td>2</td>
<td>I-70 Incident Management System improvements: Vail to Grand Junction</td>
<td>R3/R1</td>
</tr>
<tr>
<td>3</td>
<td>Communications master plan for Western Colorado</td>
<td>HQ/R3/R5</td>
</tr>
<tr>
<td>4</td>
<td>Fiber-optic cable along I-70: Glenwood Springs to Grand Junction</td>
<td>HQ/R3/R5</td>
</tr>
<tr>
<td>5</td>
<td>Secure video/data interface for participating agencies</td>
<td>HQ/CTMC</td>
</tr>
<tr>
<td>6</td>
<td>Automated Wildlife Crossing Systems at high accident locations</td>
<td>HQ/R3/R5</td>
</tr>
</tbody>
</table>

HQ CDOT ITS Branch
R3 CDOT Region 3
R1 CDOT Region 1
R5 CDOT Region 5
CTMC Colorado Transportation Management Center
Table 15: Projects of Regional Significance

<table>
<thead>
<tr>
<th>Priority</th>
<th>Project</th>
<th>Responsible Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Pass Management System on US 160 over Wolf Creek Pass</td>
<td>R5</td>
</tr>
<tr>
<td>3</td>
<td>Pass Management System on US 40: Kremmling to Steamboat Springs (Muddy Pass and Rabbit Ears Pass)</td>
<td>R3</td>
</tr>
<tr>
<td>4</td>
<td>Transit Signal Priority System on SH 82: Glenwood Springs to Aspen</td>
<td>R3/RFTA</td>
</tr>
<tr>
<td>5</td>
<td>Pass Management System on US 50 over Monarch Pass</td>
<td>R5</td>
</tr>
<tr>
<td>6</td>
<td>Communication links between HLT Management Center and major EOCs and transit agencies.</td>
<td>HLT/EOC</td>
</tr>
<tr>
<td>7</td>
<td>Pass Management System on SH 145 over Lizard Head Pass</td>
<td>R5</td>
</tr>
<tr>
<td>8</td>
<td>Pass Management System on US 24 over Tennessee Pass</td>
<td>R3</td>
</tr>
<tr>
<td>9</td>
<td>Pass Management System on US 50 over Cerro Summit</td>
<td>R3</td>
</tr>
<tr>
<td>10</td>
<td>Pass Management System on SH 91 over Fremont Pass</td>
<td>R3</td>
</tr>
<tr>
<td>11</td>
<td>Pass Management System on US 160 over La Veta Pass</td>
<td>R5</td>
</tr>
<tr>
<td>12</td>
<td>Pass Management System on US 50 in the Blue Mesa Reservoir area</td>
<td>R3</td>
</tr>
<tr>
<td>13</td>
<td>Completion of a Regional Traffic Management System in Grand Junction</td>
<td>COGJ</td>
</tr>
<tr>
<td>14</td>
<td>Instrument maintenance vehicles to provide road and weather data.</td>
<td>R3/R5</td>
</tr>
<tr>
<td>15</td>
<td>Transit management systems for regional transit operators (ECO, GVT, RFTA)</td>
<td>ECO/GVT/ RFTA</td>
</tr>
<tr>
<td>16</td>
<td>Arterial Management System on SH 82 Glenwood Springs to Aspen</td>
<td>R3</td>
</tr>
<tr>
<td>17</td>
<td>Arterial Management System on US 40 Steamboat Springs</td>
<td>R3</td>
</tr>
<tr>
<td>18</td>
<td>Arterial Management System on US 40 through Winter Park</td>
<td>R3</td>
</tr>
<tr>
<td>19</td>
<td>Arterial Management System on US 160 and US 550 through Durango</td>
<td>R5</td>
</tr>
<tr>
<td>20</td>
<td>Arterial Management System on US 160 and US 285 through Alamosa</td>
<td>R5</td>
</tr>
<tr>
<td>21</td>
<td>Arterial Management System on US 550 and US 50 through Montrose</td>
<td>R3</td>
</tr>
<tr>
<td>22</td>
<td>Arterial Management System on US 50 through Gunnison</td>
<td>R3</td>
</tr>
</tbody>
</table>

RFTA Roaring Fork Transit Agency
EOC Emergency Operations Center
COGJ City of Grand Junction
GVT Grand Valley Transit
ECO Eagle County Transit

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 16 below. Projects are categorized as near term (0 – 3 years), mid term (4 – 7 years) and long term (8 – 10 years) to distinguish between projects that should be advanced within the next two to three years from projects that have a longer deployment schedule. 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 16: 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>Fiber-optic cable along I-70 from Glenwood to Frisco</td>
<td>840,000</td>
<td>5,000,000</td>
<td>500,000</td>
<td>840,000</td>
</tr>
<tr>
<td>2</td>
<td>Fiber-optic cable along I-70 from Grand Junction to Glenwood Springs</td>
<td>232,000</td>
<td>2,900,000</td>
<td>435,000</td>
<td>232,000</td>
</tr>
<tr>
<td>3</td>
<td>Arterial traffic management system</td>
<td>150,000</td>
<td></td>
<td></td>
<td>150,000</td>
</tr>
<tr>
<td>4</td>
<td>Instrument maintenance vehicle for road and weather information</td>
<td>20,000</td>
<td>150,000</td>
<td>22,500</td>
<td>20,000</td>
</tr>
<tr>
<td>5</td>
<td>Develop a communications master plan</td>
<td>16,000</td>
<td>150,000</td>
<td>22,500</td>
<td>16,000</td>
</tr>
<tr>
<td>6</td>
<td>Pass maintenance and management system on Wolf Creek Pass</td>
<td>18,000</td>
<td>150,000</td>
<td>22,500</td>
<td>18,000</td>
</tr>
<tr>
<td>7</td>
<td>Pass maintenance and management system on Monarch Pass</td>
<td>16,000</td>
<td>150,000</td>
<td>22,500</td>
<td>16,000</td>
</tr>
<tr>
<td>8</td>
<td>Pass maintenance and management system on Lizard Head Pass</td>
<td>16,000</td>
<td>150,000</td>
<td>22,500</td>
<td>16,000</td>
</tr>
<tr>
<td>9</td>
<td>Pass maintenance and management system on Tennessee Pass</td>
<td>16,000</td>
<td>150,000</td>
<td>22,500</td>
<td>16,000</td>
</tr>
<tr>
<td>10</td>
<td>Pass maintenance and management system on Tennessee Pass</td>
<td>16,000</td>
<td>150,000</td>
<td>22,500</td>
<td>16,000</td>
</tr>
<tr>
<td>11</td>
<td>Pass maintenance and management system in the Blue Mesa Reservoir</td>
<td>16,000</td>
<td>150,000</td>
<td>22,500</td>
<td>16,000</td>
</tr>
<tr>
<td>12</td>
<td>Transit Signal Priority on SH 82 from Glenwood to Aspen</td>
<td>60,000</td>
<td>500,000</td>
<td>75,000</td>
<td>60,000</td>
</tr>
<tr>
<td>13</td>
<td>Regional Traffic Management System in Grand Junction</td>
<td>40,000</td>
<td>500,000</td>
<td>75,000</td>
<td>40,000</td>
</tr>
<tr>
<td>14</td>
<td>Arterial traffic management system on SH 82 from Glenwood to Aspen</td>
<td>28,000</td>
<td>200,000</td>
<td>30,000</td>
<td>28,000</td>
</tr>
<tr>
<td>15</td>
<td>Arterial traffic management system on US 40 in Steamboat Springs</td>
<td>28,000</td>
<td>200,000</td>
<td>30,000</td>
<td>28,000</td>
</tr>
<tr>
<td>16</td>
<td>Arterial traffic management system on US 40 in Winter Park</td>
<td>28,000</td>
<td>200,000</td>
<td>30,000</td>
<td>28,000</td>
</tr>
<tr>
<td>17</td>
<td>Arterial traffic management system on US 550 and US 160 in Durango</td>
<td>28,000</td>
<td>200,000</td>
<td>30,000</td>
<td>28,000</td>
</tr>
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### Develop communications links between HLT and EOCs
### Transit management systems for local transit operators

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Not Quantified
Not Quantified

12
13
VII. Next Steps

The ITS Strategic Plan 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. In order to satisfy federal requirements, a Regional ITS Architecture, consistent with the ITS Strategic Plan, will be completed by the ITS Working Group.

2. The ITS Branch should continue to actively work with the regions utilizing the ITS Strategic Plan 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 Strategic Plan are necessary.

3. 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.

4. Incident management planning should continue for other major corridors, such as SH-82, and also for the rural areas. These require coordination with local sheriffs and rural emergency responders as well as the regional emergency management forums.

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

6. The ITS Branch should proceed with communication master planning for Western Colorado since this forms the foundation for management and control of ITS devices throughout the region.
Appendix - Innovative Concepts

During the course of stakeholder workshops several innovative concepts to addressing the transportation issues that were discussed. While most of these are not sufficiently developed to be included in the strategic plans or regional architectures, they show the potential to address aspects of the transportation problems in the state. Because of this potential, the stakeholders felt these ideas should be documented and pursued further. These concepts are:

- Automatic detection of malfunctioning truck brakes,
- Variable speed limits or advisories,
- Use of satellite radio for traveler information,
- Use of Reverse 911 for emergency and evacuation alerts,
- Use of a statewide traveler information radio broadcast,
- Use of the statewide digital trunk radio for data transmission,
- Virtual ports-of-entry for greater enforcement of over-height and overweight vehicles,
- Expanded use of bilingual traveler information,
- Acquiring real-time compressed video from CSP and CDOT maintenance vehicles,
- Use of satellite communications for rural ITS applications.

These concepts are discussed in greater detail below.

Automatic detection of malfunctioning truck brakes

The frequent down-grades and curves on roadways in the mountains can lead to frequent and extended braking which in turn can lead to overheating or failure of the brakes on heavy vehicles. When these brakes overheat they lose their stopping ability, which leads to “run-away” trucks, a serious safety hazard. In addition, trucks in the runaway truck ramps cause a distraction to drivers leading to congestion and the potential for secondary accidents.

Over the past several years CDOT has made significant investments in truck safety including education campaigns, construction of run-away truck ramps, and installation of speed warning systems. Safety inspections at ports-of-entry were also key to detecting trucks with overheated brakes. However, the increased use of Pre-Pass has lead to reduced inspections. In order to compensate for this, CDOT is investigating the use of thermal imagery to detect trucks with malfunctioning brakes and to direct them to pull off the road for inspection and repair. The imagery can detect brakes that are either too hot, or too cold. Brakes that are too hot can lose their stopping ability while brakes that are too cool have probably already failed.
Identifying overheated brakes before a brake failure will reduce truck accidents and congestion from on-lookers. Currently the technology does not provide for detecting brake malfunctions on vehicles operating at highway speeds, but CDOT will continue to evaluate this strategy to improve the technology and refine the techniques for implementation.

**Variable speed limits or advisories**

A major cause of accidents during the winter months is vehicles traveling too fast for road conditions. This is especially true in the mountains. Traditionally, CDOT and other jurisdictions have relied on static speed limits, which are appropriate for ideal road conditions. Drivers are expected to adjust their speed based on actual road conditions, slowing down under adverse conditions such as snow and ice, fog, dust, or other conditions.

Based on accident records, the traditional approach is not entirely adequate on some sections of roadway. Anecdotally the CSP also relates that many drivers do not seem to understand this principle, complaining when they are ticketed for driving too fast for road conditions after an accident. An approach to addressing this problem is either to adjust the speed limits for road conditions or to post speed advisories based on road conditions.

CDOT currently posts advisory speeds for curves and hills on key roadway sections, but the speeds are not adjusted. This approach would use CSP observation or other means to determine when the speed should be reduced based on changing road conditions and then either post a lower speed limit or a lower advisory speed.

There are legal issues with changing the speed limit since state law requires that speed limits be set by an engineering study. A few approaches to this issue have been suggested such as having the engineer pre-determine the appropriate speed for certain conditions and essentially activate these in a similar fashion to executing a special event plan. However, the issue is still being discussed. Currently, advisory speeds are easier to adjust, but there is some concern that drivers may ignore advisory speeds if the posted speed limit isn’t changed. While the technology for doing either variable speed limits or advisories is currently available, the institutional and legal issues require further examination.

**Use of satellite radio for traveler information**

CDOT has forged many working relationships with traditional media outlets and relies on broadcast radio to provide many travel advisories to travelers in route. However, as more and more vehicles are being equipped with satellite radio there is concern that important advisories may not be reaching travelers who are listening to satellite radio. CSP officers
have reported an increasing number of the travelers they come in contact with as listening to satellite radio instead of traditional AM/FM radio. There are many technical challenges to providing traveler information over satellite radio particularly the issue of providing geographically relevant information since satellite radio covers such a wide area. However, the medium is worth exploring since the trend toward satellite radio seems to be growing.

**Use of Reverse 911 for emergency and evacuation alerts**

One of the most challenging problems for CDOT is how to reach travelers in-route, especially to advise them of major incidents or emergencies. Reverse 911 is a patented and proprietary system that some agencies use to notify the public of critical events. The system uses a cross reference of telephone numbers in a GIS to identify all the telephone exchanges in a given locale and automatically dials them to provide important public service messages such as hazardous material spills or evacuation notices.

Theoretically, Reverse 911 could also be used to contact all the cell phone users in a given location, providing critical information. This could be a valuable way to contact in-route travelers with critical messages such as emergencies or evacuations. At the same time there are a number of technical and institutional issues that have not been fully examined. While Reverse 911 sounds promising there is considerable work to do before a decision can be made on its viability for traveler information.

**Use of a statewide traveler information radio broadcast**

While CDOT has deployed numerous highway advisory radios (HAR) around the state, they have limitations. HAR has a very limited range thereby requiring many units to provide thorough coverage of the state. Also, each HAR unit requires communications for downloading messages. This is problematic in the rural parts of the state, especially in the mountains, due to the absence of power and communications infrastructure. While solar panels can be used for power, communications is still a major roadblock to deploying HAR. However, many of these areas actually have good coverage from commercial AM broadcasts.

One idea that merits further study is the use of high power AM transmission to provide statewide traveler information. The technology for such an application is certainly available. The AM broadcast has good coverage throughout most of the state, especially rural areas that are typically very difficult to reach. Such a system could also be used by emergency management agencies for their advisories as well as traditional traveler information. However, there may be institutional issues to this approach that need to be explored. While FHWA and the FCC have set aside certain frequencies for traveler information, it is not clear that these were intended for wide-area broadcasts. Also there are probably significant local zoning issues regarding the construction of new
transmission towers and repeaters. Despite the institutional challenges this approach merits further study.

**Use of the statewide digital truck radio for data transmission**

The state of Colorado is currently making a major investment in a statewide digital trunk radio system (DTR) for the use of CSP, CDOT, and local agencies, especially law enforcement and emergency response. This system pools several radio frequencies and allocates them as needed, in real time. This approach will provide greater apparent bandwidth as well as providing statewide coverage. The system will be able to carry both voice and data traffic.

The lack of communications infrastructure is one of the major limitations of ITS, especially in the rural areas. DTR could provide data communication to devices that otherwise would not be practical, such as mountain pass monitoring and closure systems and highway advisory radios in remote areas. In addition, the system might be used to facilitate increased instrumentation on maintenance vehicles providing more real-time information of road conditions throughout the state, particularly on highways that have little or no CCTV coverage.

**Virtual ports-of-entry for greater enforcement of over-height and overweight vehicles**

Studies have shown that overweight vehicles cause significant damage to the roadway system every year. In addition, oversize vehicles create safety and congestion issues. Colorado typically relies on the Port of Entry Section (POE) and CSP to enforce size and weight limitations and to police operations of permitted over-size vehicles. Trucks are checked at fixed ports of entry locations (there are 10 fixed POEs in the State) and random roadside checks are also used to enforce size and weight limitations. However, there are thousands of miles of roadway that cannot be effectively patrolled all the time and numerous border crossings that do not have ports at them. Determined violators can bypass the standard ports with a low probability of being caught.

Other states, such as Indiana, have experimented with “virtual” ports-of-entry. These systems combine a weigh-in-motion sensor with a photo recognition system which captures an image of overweight trucks for subsequent enforcement. Colorado law currently does not provide for photo enforcement so the law would have to be changed to use this type of system. Optionally, a similar system could be used to identify truckers that frequently violate limitations and the routes they use for subsequent manual enforcement. Clearly there are institutional issues with this approach, but reducing overweight and oversize violations has significant benefits for maintaining and protecting the roadway system.
Expanded use of bilingual traveler information

As the number of non-English speakers increases, bilingual information has become commonplace for many applications in Colorado from telephone answering systems and directory systems to computer systems and websites. In many parts of the state significant portions of the traveling public are non-English speaking. As this portion of the traveling public increases, providing information in a language other than English may become essential to providing effective traveler information. In most of these areas Spanish is the foremost second language.

While there may be benefits to providing bilingual traveler information, there are technical challenges as well. Variable message signs typically do not have the capacity to provide bilingual messages. HAR systems are not interactive, preventing travelers from selecting the language of choice. Hence, parallel HAR systems would be required to provide bilingual traveler information. Pre-travel systems, such as websites may be better suited to bilingual information. Telephone based systems, such as 511, may also be easier to convert to bilingual. However, most of these systems have not been set up for bilingual information at this time. As CDOT continues to develop these systems, bilingual capabilities may be a feature worth assessing.

Acquiring real-time compressed video from CSP and CDOT maintenance vehicles

One of the limitations CDOT faces in managing the transportation system is limited CCTV coverage. This is particularly important for incident management. One of the biggest challenges in incident management is quickly identifying and dispatching the appropriate response vehicles for both managing and clearing the incident. This is also an issue for dispatch of maintenance vehicles for weather or debris related issues. Video surveillance allows CDOT and emergency management staff to assess a situation and initiate the appropriate response quicker and more accurately than waiting for a vehicle to arrive on the scene and verbally describe the situation.

Both CSP and CDOT are providing more data communication capabilities in their vehicles. At the same time, the internet is fueling improved video compression and transmission standards. These trends may make it possible to transmit real-time compressed images from a scene to the appropriate responding agencies. While the response still has to wait for a vehicle to arrive on the scene, once either a CDOT or CSP vehicle arrives the images can be transmitted and the response initiated. For example, if a CDOT vehicle were to arrive at an accident before CSP, the video images could be transmitted to CSP dispatch and the appropriate response determined before the first CSP or local law enforcement vehicle arrived.
Use of satellite communications for rural ITS applications

The lack of communication infrastructure is a serious obstacle to ITS deployment in rural areas. Many of the rural areas in Colorado, especially in the mountains, have no telephone or electricity. While solar panels can be used for power, communications remains a significant challenge. Wireless communications can be used in some of these areas, but there are many areas in Colorado where the terrain interferes with wireless communications. Environmental considerations, as well as cost, preclude construction of transmission towers needed for radio networks. One alternative may be satellite communications.

Satellites have been used for communication purposes for many years, but for the most part have not been cost effective for ITS. However, in recent years satellite communication has become more available and more cost competitive with other media. Satellites have extensive coverage; almost anywhere there is an unobstructed view of the sky access to satellite communication exists. Also, satellites can provide broadband communication for high-bandwidth applications such as CCTV surveillance, making this application available in areas, such as mountain passes, where it previously was not practical. At present, satellite communication is about twice as expensive as a typical microwave transmission setup. However, where multiple repeaters would be required or where terrain does not provide line-of-sight, satellites may be a viable communication medium.