

CDOT Region 4 Intelligent Transportation Systems Architecture Plan

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Colorado Department
of Transportation

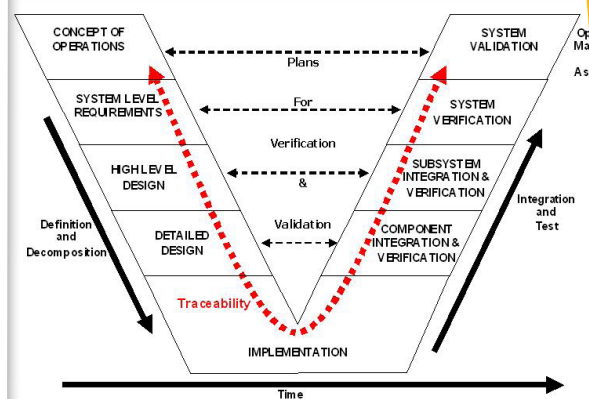
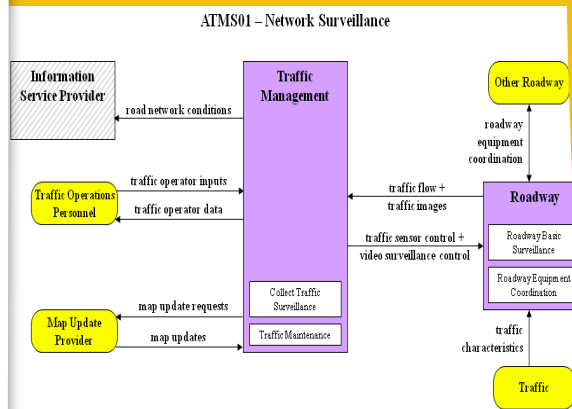
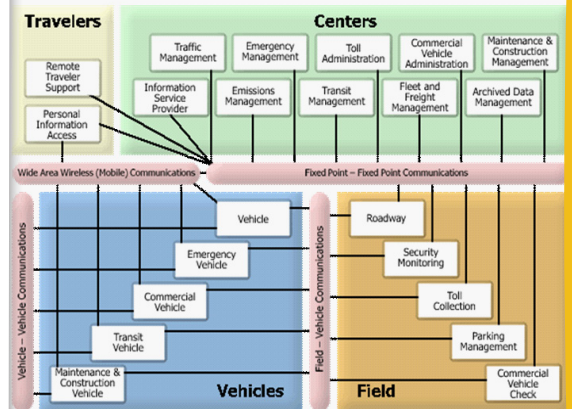
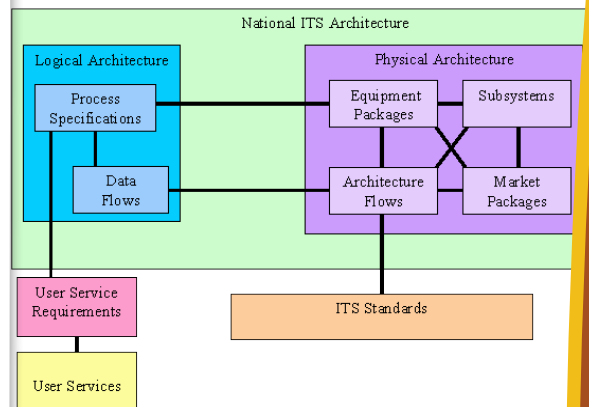
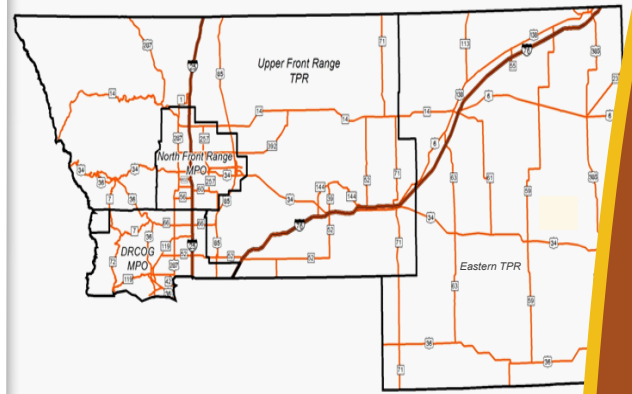




TABLE OF CONTENTS

EXECUTIVE SUMMARY 1

I. INTRODUCTION 1

A. Purpose of the ITS Architecture..... 2

B. Architecture Update Process 3

C. Related Planning Efforts 4

D. Conformance with the National ITS Architecture 5

E. Regional ITS Architecture Requirements 5

F. Overview of Physical Architecture 6

G. The Systems Engineering Approach..... 7

H. Organization of this Architecture Plan..... 8

II. DESCRIPTION OF THE REGION 9

A. Geography of the Region 9

B. Existing ITS Services and Infrastructure 11

C. Transportation Problems 11

III. MARKET PACKAGE PLAN..... 22

A. Archived Data Management 22

B. Advanced Public Transportation Systems 24

C. Advanced Traveler Information Systems..... 25

D. Advanced Traffic Management Systems 25

E. Advanced Vehicle Safety Systems..... 26

F. Commercial Vehicle Operations 27

G. Emergency Management..... 27

H. Maintenance and Construction Management..... 28

IV. OPERATIONAL CONCEPT 30

A. Regional Traveler Information..... 30

B. Regional Operations and Management 33

C. Regional Traffic Incident Management 34

D. Regional Transit Operations & Management 35

E. Maintenance and Construction..... 36



F. Regional Parking Management 37

G. Regional Data Management 38

H. Regional Emergency Management 38

I. Commercial Vehicle Operations 39

V. AGREEMENTS 42

VI. FUNCTIONAL REQUIREMENTS 44

VII. INTERFACE REQUIREMENTS 58

VIII. ITS STANDARDS 59

IX. ITS DEPLOYMENT STRATEGIES FOR REGION 4 68

A. Recommended ITS Strategies for Region 4 68

X. ARCHITECTURE MAINTENANCE PROCESS 72

List of Tables

Table 1: Archived Data Management Market Packages Summary 23

Table 2: Advanced Public Transportation Systems Market Packages Summary 24

Table 3: Advanced Traveler Information Systems Market Packages Summary 25

Table 4: Advanced Traffic Management Systems Market Packages Summary 26

Table 5: Commercial Vehicle Operations Market Packages Summary 27

Table 6: Emergency Management Market Packages Summary 28

Table 7: Maintenance and Construction Market Packages Summary 29

Table 8: Equipment Packages By Entities 45

Table 9: Standards Application Areas Table 59

Table 10: CDOT Region 4 Candidate ITS Standards 62

List of Figures

Figure ES-1: CDOT Region 4 Planning Regions 2

Figure ES-2: ITS Data Mart Architecture Flow Chart 6

Figure 1: National ITS Architecture Subsystems 7

Figure 2: CDOT Region 4 Planning Regions 9

Figure 3: ITS Data Mart Architecture Flow Chart 58



List of Appendix

Appendix A: Market Package Analysis for Region 4 A-1Error! Bookmark not defined

EXECUTIVE SUMMARY

Background and Architecture Requirement

Intelligent Transportation Systems (ITS) consist of the application of computers, electronic sensors, communications, and data management for the purpose of effectively and efficiently managing the transportation system to improve transportation mobility, safety, and to provide timely and accurate information to travelers.

On April 8, 2001, the FHWA established a Final Rule (the Rule) that jurisdictions intending to deploy ITS projects using Highway Trust Funds must conform to the National ITS Architecture and appropriate standards. 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 also required that regions, which were already deploying ITS projects, prepare a Regional ITS Architecture – a specific framework for ITS deployment tailored to the region from the National ITS Architecture. The Rule established April 8, 2005, as the deadline for such regions to have their Regional ITS Architecture prepared.

The previous CDOT Region 4/NFRMPO ITS Architecture was completed in early 2004. It was developed within the context of the National ITS Architecture Version 5.0 as a framework. Since that Architecture was developed, there has been more deployment of ITS infrastructure in the Region and the National ITS Architecture has been upgraded to Version 6.1. The Architecture provides a framework through which these numerous stakeholders can achieve cooperative, coordinated, interoperable region-wide deployed systems to provide maximum public benefit for dollars spent.

Purpose of ITS Architecture Plan

The National ITS Architecture describes a high-level framework for developing regionally integrated transportation systems. The National ITS Architecture addresses the systems to be deployed, the stakeholders involved, the roles and responsibilities of the stakeholders, and the relationships and information exchange requirements between the stakeholders in order to support integrated operations.

The purpose of this project was to update and expand the existing Regional ITS Architecture to guide the deployment of ITS applications in the CDOT Region 4 Project Area over the next ten years. This CDOT Region ITS Architecture Plan (Region 4 ITS Architecture) was developed in conformance with the National ITS Architecture Version 6.0, which was updated near the completion of the project to Version 6.1.

This Region 4 ITS Architecture for the deployment of Intelligent Transportation Systems is based on the National ITS Architecture. It describes, among other things, the relationships between the ITS elements and the roles and responsibilities of local stakeholders. Turbo Architecture Version 5.0, which is an interactive software program based on the National ITS Architecture and designed to facilitate the development of a project architecture or regional architecture, was used in conjunction with this update of the CDOT Region 4 ITS Architecture. The Region 4 ITS Architecture builds upon these efforts to define the technical and institutional relationships among transportation related agencies and to ensure integration of individual systems into a coordinated ITS deployment.

- **Advanced Traveler Information Systems (ATIS):** Provide real-time information to travelers.
- **Advanced Traffic Management Systems (ATMS):** Manage operation of the roadway network.
- **Advanced Vehicle Safety Systems (AVSS):** In vehicle technologies to improve safety and vehicle control.
- **Commercial Vehicle Operations (CVO);** Manage Commercial vehicle operations, safety and permitting.
- **Emergency Management (EM):** Manage emergency response operations.
- **Maintenance and Construction Management (MC):** Manage maintenance and construction activities and operations.

The Advanced Traffic Management System Market Packages Summary is shown for illustrative purposes.

Table ES-2: Advanced Traffic Management Systems Market Packages Summary

Market Package	ATMS01	ATMS02	ATMS03	ATMS04	ATMS05	ATMS06	ATMS07	ATMS08	ATMS13	ATMS16	ATMS17	ATMS19	ATMS21
Jurisdiction	Network Surveillance	Traffic Probe Surveillance	Surface Street Control	Freeway Control	HOV Lane Management	Traffic Information Dissemination	Regional Traffic Control	Traffic Incident Management System	Standard Railroad Grade Crossing	Parking Facility Management	Regional Parking Management	Speed Monitoring	Roadway Closure Management
CDOT ITS	E	P				E	P	E			P	P	P
CDOT DTD	E												
CDOT Region 4	E		E	E	P			E	E			P	P
Emergency Management								E					
Law Enforcement								E				P	P
Fort Collins	E		E						E				
Greeley	E		E						E				
Loveland	E		E						E				
Town of Estes Park	E		E							P	P		

Market Package	ATMS01	ATMS02	ATMS03	ATMS04	ATMS05	ATMS06	ATMS07	ATMS08	ATMS13	ATMS16	ATMS17	ATMS19	ATMS21
Jurisdiction	Network Surveillance	Traffic Probe Surveillance	Surface Street Control	Freeway Control	HOV Lane Management	Traffic Information Dissemination	Regional Traffic Control	Traffic Incident Management System	Standard Railroad Grade Crossing	Parking Facility Management	Regional Parking Management	Speed Monitoring	Roadway Closure Management
RMNP										P	P		
Local Jurisdictions	E		E						E				

Operational Concept

The Operational Concept identifies the stakeholders that will be responsible for implementing transportation services and their roles and responsibilities regarding those services. A detailed list of the stakeholders and their roles and responsibilities was developed in Turbo Architecture.

The Region 4 ITS Architecture provides a summary of stakeholder roles and responsibilities and their status (existing and planned) within four functional areas, if applicable, based on TSA and its associated Market Package. The four functional areas are as follows:

- Implementation – specific ITS elements already existing and identified for deployment
- Maintenance – specific elements for maintenance of the existing ITS infrastructure
- Management – planning and coordination activities
- Operations – related to operating the ITS infrastructure

CDOT Region 4 operational concept within the Regional Operations and Management TSA is shown for illustrative purposes:

CDOT Region 4

Implementation:	Status
Deploy ramp metering system elements on freeways	Existing
Deploy interconnected traffic signal system elements along state highways	Existing
Develop signal timing plans for major corridors	Existing
Deploy traffic responsive/traffic adaptive control on select corridors	Existing
Maintenance:	Status
Maintain field system elements.	Existing
Maintain communications to CTMC	Existing
Management:	Status
Develop deployment plan for ramp meters	Existing
Assist Colorado Tolling Enterprise (CTE) in development of a plan for management and	Planned

operations of managed lanes.	
Operations:	Status
Monitor and operate ramp meter system	Existing
Monitor and operate traffic signal system	Existing
Feed system health and traffic conditions data to regional transportation operations display	Planned

Agreements

In order to fully implement the operational concept, formal agreements are necessary to define the roles and responsibilities of the agencies involved including such items as performance requirements, funding arrangements, data sharing arrangements, etc. The Region 4 ITS Architecture identifies existing agreements between stakeholders and which agreements still need to be developed to further ITS services coordination and cooperation in the Region.

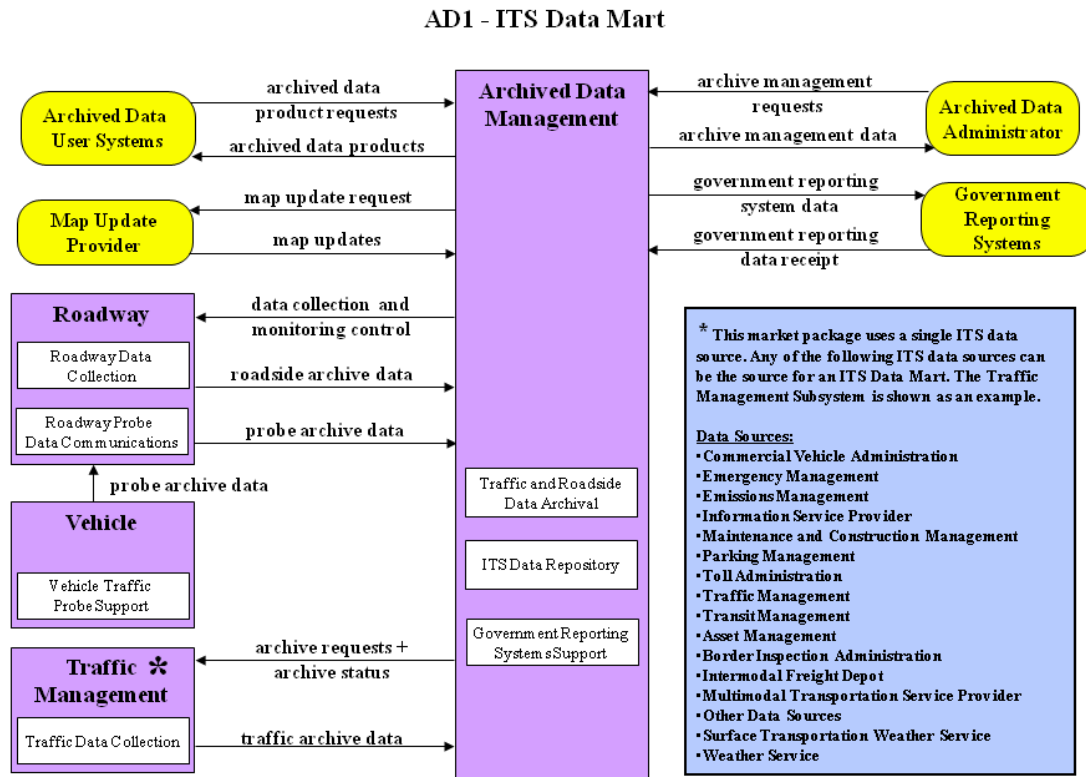
Functional Requirements

The definition of functional requirements is a mandatory component of a regional ITS architecture as identified in the FHWA/FTA rules and policies. Functional requirements identify the tasks or activities that are, or will be, performed by each system or subsystem in the region. Detailed functional requirements are generally best left to project architectures or individual designs. At the regional architecture level, these functional requirements are high-level descriptions of the tasks derived from the operational concept. In the context of the National ITS Architecture, functional requirements can be stated in terms of Equipment Packages and implementable groupings of processes within a given subsystem (Equipment packages are the building blocks of the physical architecture subsystems and group similar processes of a particular subsystem together into an “implementable” package). The major physical entities in the regional architecture and the equipment packages that define the functional requirements are identified in Region 4 ITS Architecture.

Interface Requirements

The Federal Rule requires that interface requirements and information exchanges be addressed with the context of a regional architecture. The National ITS Architecture defines information exchange or flow and architecture flow as terms that are used interchangeably regarding information that is exchanged between subsystems and terminators in the physical view of the National ITS Architecture, and the architecture flows are the primary tool that is used to define the regional ITS architecture interfaces. As an example, Figure ES-2 illustrates the interface requirements and data flows for the Market Package ITS Data Mart (AD1) and associated Equipment Packages. The Turbo Architecture database for CDOT Region 4 is available at <http://www.cotrip.org/ITS/arch.htm>

Figure ES-2: ITS Data Mart Architecture Flow Chart



ITS Standards

ITS Standards facilitate interoperability and integration of ITS devices and systems. In addition, the federal regulations require that ITS projects funded with federal funds must use USDOT federally-adopted ITS standards:

“All ITS projects funded with highway trust funds shall use applicable ITS standards and interoperability tests that have been officially adopted through rulemaking by the DOT.”

Region 4 ITS Architecture has identified candidate standards, i.e. (standards that may be applicable to this architecture) Candidate standards were selected from the *Colorado ITS Standards Plan – Statewide (Version 0.1)*, which identifies standards adopted for use by the state. The standards currently in use are also identified. A priority was assigned to each of the candidate standards. The priority indicates the level of consideration to be applied to the standard during ITS project development in the region.

Recommended ITS Strategies for Region 4

Strategy #1- Implement ITS Deployments that Provides Benefits on interstates, state highways and regionally significant corridors.

These corridors carry the highest traffic volumes within the Region and would receive the greatest benefits from ITS implementation, and they would be able to demonstrate greater overall mobility and safety benefits. It should be noted that local agencies are not precluded from deploying ITS on their local street and roadways that serve local needs; however, deployment should be considered in terms of

technical integration and jurisdiction coordination with the Regional ITS network. ITS deployments for Strategy #1 include:

- Communication Infrastructure (Fiber Optic Cable & Network Equipment)
- Traveler Information
- Colorado Transportation Management Center (CTMC) & Urban Traffic Operation/Management Centers (TOC/TMC)
- Traffic Incident Management Plan (TIMP)
- Courtesy Patrol/Tow Vehicles
- Traffic Responsive/Traffic Adaptive Control
- Dynamic Message Sign
- Ramp Meters
- Closed Circuit Television Cameras (CCTV)
- Weather Stations

Strategy #2 - Increase transit ridership and demand by integration and coordination with alternative travel modes.

Transit, vanpool, carpool, bicycle and PNR modal options should be integrated to foster usage of alternative modes of travel. ITS deployments for Strategy #2 include:

- Add Static/Transit Route Information to Google
- On-line Trip Planning Services Website
- Automated Fare Collection System
- Transit Passenger Counting System
- Transit Services to PNR Location
- NextBus Applications
- Fare Collection Kiosks

Strategy #3- Implement and promote Regional projects that increase cooperation and coordination within and between agencies.

ITS deployments for Strategy #3 include:

- Access to MDSS and Traffic Video for Agencies
- Regional Guidelines for Arterial Conditions Display and Sharing with CDOT
- Performance Monitoring for Corridors
- Traveler information for Estes Park/RMNP
- CDOT Maintenance Vehicles with AVL/Camera and In-Vehicle Interface Device
- Expansion of MDSS System
- Event Management Plans



CDOT Region 4 ITS Architecture

- Expansion of CCTM Application for Traffic Agencies
- Expand CTMS Functionality for Maintenance and Construction Activity Information
- Portable Monitoring System for Load Deficient Structures for Size and Weight Enforcement

ITS Architecture Update Process

As identified in the Region 4 ITS Plan, Region 4 will establish an ITS working group committee and conduct committee meetings every six months to review ITS implementations and to identify and document changes and revisions that need to be made to the Plan. The Plan will then be updated every three years. With regard to the Region 4 ITS Architecture, Region 4 will update Turbo Architecture as projects are implemented, and update the Region 4 ITS Architecture every three years in conjunction with the Region 4 ITS Plan update.

I. INTRODUCTION

Intelligent Transportation Systems (ITS) consist of the application of computers, electronic sensors, communications, and data management for the purpose of effectively and efficiently managing the transportation system to improve transportation mobility, safety, and to provide timely and accurate information to travelers. The ITS Architecture is a 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.

Although ITS had its beginnings in urban areas, falling cost and increased availability of proven transportation technologies has enabled ITS to be successfully deployed in rural areas and small cities nearby allowing them to realize the operational, safety, and mobility benefits that ITS can provide. Within the CDOT Region 4 boundaries, CDOT and several agencies have invested significant resources in the deployment of ITS infrastructure. CDOT and local agencies intend to continue this ITS investment in the future given the mobility and safety benefits derived from actively managing the transportation system.

In early 2004, an ITS Strategic Plan and Architecture was completed that covered the geographical areas of the North Front Range Metropolitan Planning Organization (NFRMPO) and the Town of Estes Park.

Several projects were implemented from the previous ITS Plan for the NFRMPO, including;

- Cameras at US-34 and SH-402 Park-N-Rides (PNRs) along I-25
- Greeley and Loveland Traffic Operation Centers
- Installation of VMS and cameras on I-25 and US-35

Also, ITS elements from the Plan are included in the I-25 Environmental Impact Statement (EIS). The fiber optic project plan sheets, including all clearances, for I-25 from 120th Avenue to the Colorado/Wyoming State Line has been completed.

To promote efficient investment across the nation in intelligent transportation systems, federal regulations were established that require that regions provide focused planning for the deployment of ITS. In order to be eligible to receive federal funding 23 CFR 940.9 (a) states:

A regional ITS architecture shall be developed to guide the development of ITS projects and programs and be consistent with ITS strategies and projects contained in applicable transportation plans.

The USDOT has prepared the National ITS Architecture as a guide for the development of regional architectures. This project used Version 6.0, which was updated near the completion of the project to Version 6.1. The National ITS Architecture describes a high-level framework for developing regionally integrated transportation systems. The National ITS Architecture addresses the systems to be deployed, the stakeholders involved, the roles and responsibilities of the stakeholders, and the relationships and information exchange requirements between the stakeholders in order to support integrated operations.

This CDOT Region 4 ITS Architecture Plan “Region 4 ITS Architecture” for the deployment of Intelligent Transportation Systems is based on the National ITS Architecture. It describes, among other things, the relationships between the ITS elements and the roles and responsibilities of local stakeholders.

Turbo Architecture (Version 5.0), which is an interactive software program based on the National ITS Architecture and designed to facilitate the development of a project architecture or regional architecture, was used in conjunction with this update of the Region 4 ITS Architecture. The Region 4 ITS Architecture builds upon these efforts to define the technical and institutional relationships among transportation related agencies and to ensure integration of individual systems into a coordinated ITS deployment.

Due to the special requirements of ITS projects, which follow a process more typical of a technology project than a roadway project, CDOT in cooperation with several stakeholders developed an ITS Strategic Implementation Plan for the deployment of ITS in CDOT Region 4 over the next ten years. CDOT Region 4 covers the northeastern corner of Colorado comprising 9 counties, and includes the NFRMPO, portion of the Denver Regional Council of Governments (DRCOG) MPO and the Eastern and Upper Front Range Transportation Planning Regions (TPRs). The CDOT Region 4 ITS Strategic Implementation Plan “Region 4 ITS Plan” provides a comprehensive document that details a vision and framework for the application of ITS to meet recognized transportation problems within the Region.

The Region 4 ITS Plan shows how ITS applications will be implemented in a systematic and coordinated manner using a corridor approach. The Region 4 ITS Plan also identifies the funding needs, recommended deployment timeframes and potential funding sources. The Plan can be used by CDOT Region 4 and other agency staff in communicating ITS needs within the Region.

A. Purpose of the ITS Architecture

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

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

Typically, a region contains multiple transportation agencies and jurisdictions. These may have both adjoining and overlapping geographic areas, but all of the agencies have a need to provide ITS solutions to transportation problems such as traffic congestion and safety hazards. The purpose of developing a regional ITS architecture is to foster regional integration so that planning and deployment can proceed in a coordinated and organized manner. For purposes of this project, the “Region” is defined as the entire geographical area within CDOT Region 4.

Regional integration allows for the coordination of activities and sharing of information among different transportation systems to efficiently and effectively operate the ITS infrastructure. Regional integration also has a synergistic effect in that information from one system may be used by another system for another purpose, reducing the need for redundant systems. For example, Tolling Authorities primarily use toll tag technology to serve the users of the toll facility. The same toll tags technology can be used by a freeway management center as probe data to obtain speed information on freeway segments. A regional

ITS architecture illustrates this integration and provides the basis for planning the evolution of existing systems and the definition of future systems that facilitate the integration over time.

One important goal of a regional ITS architecture is to foster institutional integration by providing a framework within which regional stakeholders can address transportation issues together. As indicated earlier, a strategic plan is a road map for implementing a system of strategies over a period of time. It provides a starting point for bringing ITS projects and systems together into an integrated plan, and identifying transportation related needs that can be addressed by ITS applications within the context of a systematic approach. This framework addresses the institutional and operational elements required for effective, integral statewide and regional transportation systems.

High-level Statewide ITS Goals

The goals of ITS are primarily to maximize the operational effectiveness and efficiency of the transportation system thereby enhancing mobility and safety for transportation users. The CDOT Statewide ITS Strategic Plan identifies the following major goals for ITS, which are also applicable to CDOT Region 4.

Improve mobility through maximizing the productivity of the transportation system by using ITS to increase the throughput of passengers/vehicles on the transportation system and effectively increases the available capacity of the existing transportation system. Regional stakeholders 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.

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

Increase 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. Regional Stakeholders 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.

Enhance intermodal connectivity and inter-jurisdictional coordination by promoting and supporting seamless connectivity between multiple modes of transportation and regional ITS systems. It is envisioned that information will be managed as a resource that will enhance intermodal connectivity between services provided by public and private transportation providers.

B. Architecture Update Process

The previous Region 4 ITS Architecture was completed in early 2004. It was developed within the context of the National ITS Architecture Version 5.0, as a framework. Since that Region 4 ITS Architecture was developed, there has been additional deployment of ITS infrastructure in the Region and the National ITS Architecture has been upgraded to Version 6.1. As discussed previously, local, regional and state agencies have been implementing and operating ITS applications for nearly two decades. The

Architecture provides a framework through which these numerous stakeholders can achieve cooperative, coordinated, interoperable region-wide deployed systems to provide maximum public benefit for dollars spent.

Stakeholder Participation Process

An ITS Working Group was established as the body to provide feedback and to oversee development of the Region 4 ITS Plan. Members of the Working Group were technical staff from numerous agencies that expressed interest in ITS implementation.

Seven stakeholder groups were established to provide assistance within their respective technical areas to identify transportation problems that could be addressed by ITS applications. Additionally, each stakeholder group provided an inventory of existing and immediately pending ITS implementations of infrastructure within their jurisdiction. Each member participated with the understanding that ITS planning integrates Regional, local, modal and organizational requirements. The following list summarizes the stakeholder groups and agencies that participated:

- **CDOT** – CDOT Region 4 (Traffic, Maintenance, Planning), CDOT ITS Branch and CDOT Division of Transportation Development (DTD)
- **Transit** – Transfort, Greeley Evans Transit (GET), City of Loveland Transit (COLT) and Town of Timnath
- **Urban** – Loveland, Fort Collins, Greeley, NFRMPO and Town of Timnath
- **Rural** – Local cities and counties in rural areas
- **Law Enforcement** – Colorado State Patrol (CSP), Police from Fort Collins, and Broomfield, Loveland, Greeley and Larimer County Sheriffs
- **Commercial Vehicles** – Department of Revenue - Port-of-Entry (POE) and CDOT Permits
- **Technology** – University of Northern Colorado (UNC), Colorado State University (CSU), Towns of Estes Park and Timnath, and the CDOT ITS Branch

In addition to the above stakeholder groups, the project team met separately with Rocky Mountain National Park (RMNP) and the Town of Estes Park to discuss transportation issues in the area.

C. Related Planning Efforts

As part of the development of the Region 4 ITS Plan several documents were reviewed. They include:

- NFRMPO 2035 Regional Transportation Plan
- NFRMPO CMP Report
- NFRMPO Transportation Demand Management Plan
- NFRMPO I-25 Carpool PNR Study
- City of Loveland ITS Progress Report/5 Year Plan

NFRMPO 2035 Regional Transportation Plan – The long range RTP was developed in December 2007. The Plan references the previous Region 4 ITS Strategic Plan that was developed for NFRMPO and the Estes Park area. In order for ITS projects to move into the Transportation Improvement Program (TIP),

they must be compatible with the Strategic Plan. The Plan uses the regionally significant corridors concept to focus on the corridors that are of most importance to the region. For the Region 4 ITS Plan, the regionally significant corridors are included for ITS deployment along with interstates and state highways.

NFRMPO Congestion Management Process Report – The report was developed in September 2010. In 2007, CMP was integrated into the 2035 RTP. The primary focus of the 2010 update was to build upon the MPO’s previous CMP by integrating real world data collection and performance measures into the process. The Region 4 ITS Plan recommends consideration of these measures for ITS projects. The NFRMPO publishes an annual CMP performance report at the end of each federal fiscal year.

NFRMPO TDM Plan – The Plan was developed in October 2010. The purpose of the long range TDM plan is to recommend strategies for implementation through 2035. The Plan references the previous CDOT Region 4 ITS Strategic Plan and outlines several recommendations related to ITS and the TDM program. The majority of the recommendations are addressed by the Region 4 ITS Plan.

NRMPO I-25 Carpool Park and Ride Study – The study was initiated by the NFRMPO Long Range TDM Plan to gain understanding of the travel behaviors of those who use the PNRs to carpool daily. It also included valuable information on PNR capacity and usage.

City of Loveland ITS Progress Report/5 Year Plan – The Plan was developed in 2009 and provides an update to the Plan developed in 2007. The Plan identifies the accomplishments since the previous plan and provides a year-by-year, implementation plan for ITS deployment within the City.

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 to ensure the compatibility and maintainability of the deployed technologies.

On April 8, 2001, the FHWA established a Final Rule (the Rule) that jurisdictions intending to deploy ITS projects using Highway Trust Funds must conform to the National ITS Architecture and appropriate standards. The purpose of this Rule was to foster integration between existing regional ITS and to ensure that subsequent deployments would be integrated into the existing systems.

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

The purpose of this project was to update and expand the existing Region 4 ITS Architecture to guide the deployment of ITS applications in Region 4 over the next ten years. The Region 4 ITS Architecture was developed in conformance with the National ITS Architecture Version 6.0.

E. Regional ITS Architecture Requirements

The provisions of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) 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 Region 4 ITS Architecture addresses the elements noted in the Federal Highway Administration's published Rule 23 CFR Part 940, and the Federal Transit Administration's parallel Policy. The federal regulations require that a regional ITS architecture includes, at a minimum, the following eight elements:

1. A description of region;
2. Identification of participating agencies and other stakeholders;
3. An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture;
4. Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture;
5. System functional requirements;
6. Interface requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture);
7. Identification of ITS standards supporting regional and national interoperability; and
8. The sequence of projects required for implementation.

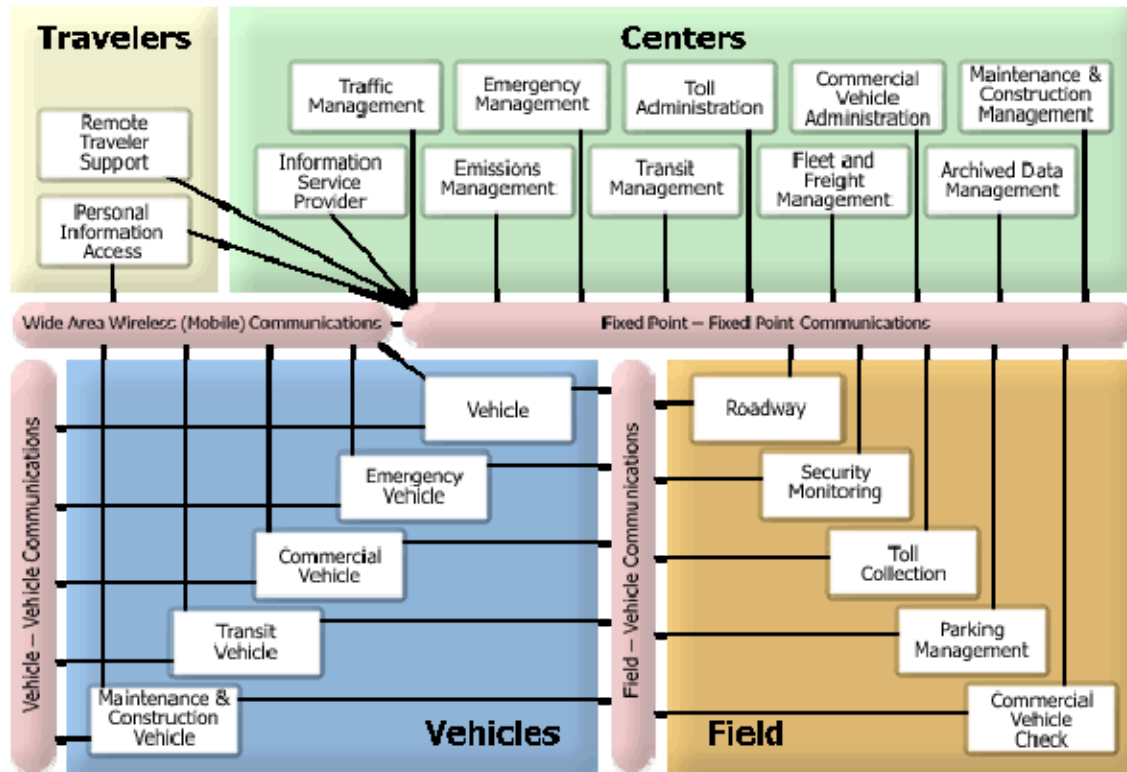
The published rule also requires that the Regional ITS Architecture include procedures and responsibilities for maintaining the Regional ITS Architecture within the region. The Region 4 Architecture provides a framework for ensuring institutional agreement and technical integration for the implementation of the ITS projects as identified in the Region 4 ITS Plan.

An Architecture database has been created using Turbo Architecture Version 5.0. Turbo Architecture is a software tool that allows users to catalogue and organize project and/or regional architectures in a database format. The software also provides users with enhanced functionality in working with architecture stakeholders, elements, Market Packages, operational concepts, functional requirements, interfaces, standards and agreements. The software defines the architecture, relationships and interconnects between stakeholders and elements and gives the user the ability to access physical and logical diagrams at multiple levels. Use of the software will facilitate consistency, version control, maintenance and subsequent updating of the Region 4 ITS Architecture.

F. Overview of Physical Architecture

The Physical Architecture is a framework of physical elements of ITS systems; these elements include cars, people, computers, buses, trucks, etc. Figure 1 shows the National ITS Architecture Subsystems and provides an illustration of the Physical Architecture. The physical elements are categorized into large groups called subsystem categories. These categories describe what functions their member physical entities (subsystems) perform.

Figure 1: National ITS Architecture Subsystems



The four major subsystem categories are:

1. **Travelers Subsystems:** Systems or applications that provide information to travelers (e.g., traffic conditions).
2. **Centers Subsystems:** Systems or applications that process and use information to control the transportation network (e.g., signal timing).
3. **Vehicles Subsystems:** Systems or applications that provide driver information and safety on vehicle platforms (e.g., in-vehicle signing).
4. **Field Subsystems:** Systems or applications that process and provide vehicle system data (e.g., traffic signals).

The bubbles (or sausages) between the subsystem categories represent the communications medium. For example, the Roadway subsystem (within the “Field” subsystem category) could potentially be communicating with the Vehicle, Transit Vehicle, Commercial Vehicle, and Emergency Vehicles subsystems (within the “Vehicles” subsystem category) via short-range wireless links.

G. The Systems Engineering Approach

Although there is currently no federal regulatory planning requirement to develop an ITS Strategic Plan, federal rules and regulations pertaining to ITS call for the development of a Regional ITS Architecture and incorporation of ITS project programming into the existing planning process in the region.

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

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

H. Organization of this Architecture Plan

Following Section I Introduction, this plan contains the following nine sections:

Section II – Description of the Region: Identifies the Region 4 Stakeholders and provides a description of the CDOT Region 4 area along with a description of the transportation system, the current state of ITS services, infrastructure and transportation issues and needs. Transportation issues and needs as related to ITS were identified through planning studies, particularly the regional transportation plans, and through stakeholder input.

Section III – Market Package Plan: Presents the rationale as to which of the user services and Market Packages in the National ITS Architecture appropriately address the issues and needs of the Region.

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

Section V – Agreements: Identifies existing agreements between stakeholders and which agreements still need to be done to further ITS services and coordination and cooperation in the Region.

Section VI – Functional Requirements: Functional requirements identify the tasks or activities that are, or will be, performed by each system or subsystem in the Region.

Section VII – Interface Requirements: Information exchanges and architecture flows with planned and existing systems and subsystems.

Section VIII – ITS Standards: A discussion of Region specific ITS standards to regulate and govern ITS technology implementation to support project applications.

Section IX – ITS Deployment Strategies for Region 4: Identifies the projects and time frames proposed for ITS technologies to be deployed to address ITS goals in the Region.

Section X – Architecture Maintenance Process: Describes the process and responsibilities for maintenance of the architecture database and plan.

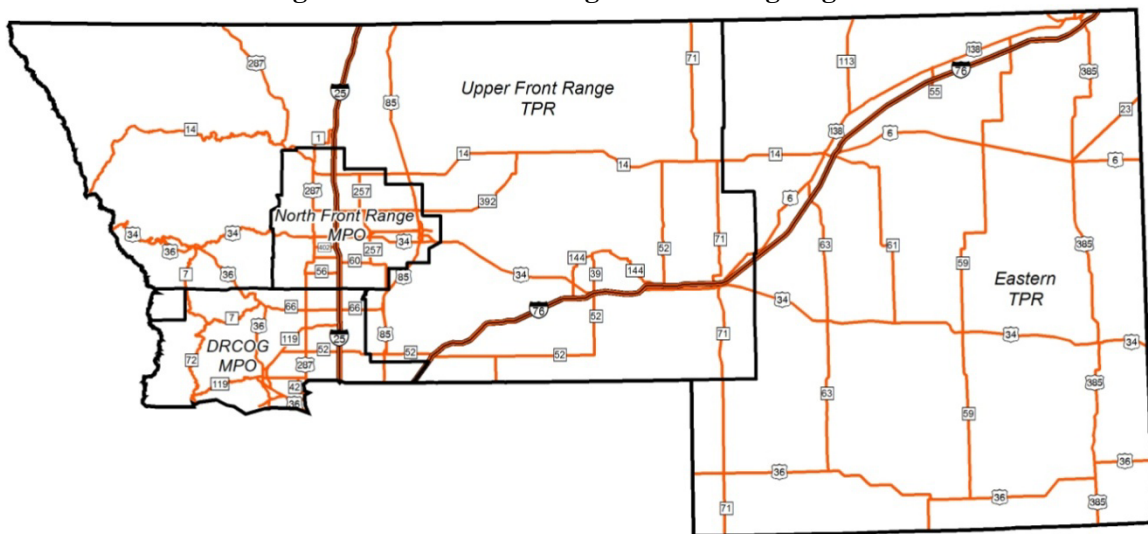
II. DESCRIPTION OF THE REGION

This Region 4 ITS Architecture covers the northeastern corner of Colorado comprising 9 counties, and including the NFRMPO, a portion of the Denver Regional Council of Governments (DRCOG) MPO , and the Eastern and Upper Front Range Transportation Planning Regions (TPRs).

A. Geography of the Region

Figure 2 shows the boundaries of CDOT Region 4, and the boundaries of the metropolitan planning organizations and transportation planning regions.

Figure 2: CDOT Region 4 Planning Regions



An ITS Working Group was established and included representatives of Federal, State, MPO/TPR, Cities, Counties, Transit, Law Enforcement, Emergency Management and Academic Institutions. The following member agencies were invited to participate:

MPO/TPR

- Denver Regional Council of Governments (DRCOG)
- Eastern Transportation Planning Region (ETPR)
- North Front Range Metropolitan Planning Organization (NFRMPO)
- Upper Front Range Transportation Planning Region (UFR TPR)

State

- Colorado Department of Revenue – Port-of-Entry (CDOR POE)
- CDOT Division of Transportation Development (DTD)
- CDOT ITS Branch
- CDOT Permits
- CDOT Region 4

Counties

- Boulder County
- Larimer County
- Logan County
- Morgan County
- Phillips County

Cities

- Akron
- Ault
- Berthoud
- Boulder
- Brush
- Dacono
- Eaton
- Eckley
- Erie
- Estes Park
- Evans
- Firestone
- Fleming
- Fort Collins
- Fort Lupton
- Fort Morgan
- Fredrick
- Garden City
- Gilcrest
- Greeley
- Grover
- Haxtun
- Hillrose
- Holyoke
- Hudson
- Johnstown

Transit

- Berthoud Area Transit Services (BATS)
- The City of Loveland Transit (COLT)
- Greeley Evans Transit (GET)
- Larimer Lift
- Morgan County

Law Enforcement/Emergency Management

- Colorado State Patrol
- Local Law enforcement agencies

- Sedgwick County
- Washington County
- Weld County
- Yuma County

- Julesburg
- Keensburg
- Kersey
- Lafayette
- La Salle
- Lochbuie
- Log Lane Village
- Longmont
- Louisville
- Loveland
- Lyons
- New Raymer
- Otis
- Ovid
- Paoli
- Pierce
- Platteville
- Sedgwick
- Sterling
- Superior
- Timnath
- Ward
- Wiggins
- Wellington
- Windsor
- Wray

- Regional Transportation District (RTD)
- Special Transit
- Transfort
- Weld County Transportation Program

- Poudre Valley Fire District

Other Members

- CDOT Division of Aeronautics
- Colorado Division of Local Affairs
- Colorado Motor Carriers Association
- Colorado State University (CSU)
- Federal Highway Administration (FHWA)
- Northeast Colorado Association of Local Governments
- Northern Colorado Economic Development Corporation
- Rocky Mountain National Park (RMNP)
- United States Department of Agriculture & Forest Services
- University of Northern Colorado (UNC)

B. Existing ITS Services and Infrastructure

Traffic

The bulk of the existing ITS equipment within the Region 4 was deployed and is operated and maintained, by the CDOT Colorado Transportation Management Center (CTMC) through the CDOT ITS Branch. CDOT CTMC monitors and operates 27 Dynamic Message Sign (DMS), 14 Closed Circuit TV (CCTV) and 19 Road Weather Information System (RWIS) within the study area. CDOT CTMC will continue to be the primary operator for ITS deployments along the freeway and State Highways. CTMC uses the Colorado Traffic Management System/Colorado Traveler Information System (CTMS/CTIS) system to facilitate agency information sharing for traffic, incidents, weather and camera images, as well as allowing secondary control of certain devices. CDOT DTD has 20 Automatic Traffic Recorders (ATR) within the Region. In addition, CDOT Region 4 operates and maintains a signal system. The Region has a significant deployment of the Maintenance Decision Support System (MDSS).

The cities of Loveland, Greeley and Fort Collins all operate and maintain separate signal systems. Fort Collins has incorporated this function into a traffic operations center that serves as the control point for all ITS elements in the City including CCTV cameras and weather stations. All three cities have some portion of their signal system on fiber optic communications. Fort Collins monitors and operates 42 CCTV and 7 RWIS, as well as 39 ATRs of both video and in-pavement sensors. The City of Greeley monitors and operates 2 CCTV and 2 RWIS within their city limits. Plans are underway to add signals under fiber control and to install additional weather stations and CCTV cameras. The City of Loveland monitors and operates 7 CCTV, 4 RWIS and 20 ATR stations.

Transit

There are several transit agencies in the Region. Three transit agencies within the Region actively participated, and they include: 1) Transfort, 2) COLT, and 3) GET. Transfort has annual boardings of 2 million riders, with 34 buses on 19 routes. All buses have Automatic Vehicle Location (AVL), and paratransit service is provided on a contracted basis. COLT has an annual ridership of 155,000 with 11 buses on 3 routes, and manages their own paratransit system. GET has an annual ridership of 590,000 over 15 buses on 7 routes, and they also manage their own paratransit system. Each agency has a central facility that uses maintenance scheduling software for routine maintenance.

C. Transportation Problems

Through working with the Stakeholder groups, a comprehensive list of critical Regional transportation problems was identified. The transportation problems were primarily assigned to one of the nine Transportation Service Areas (TSA); however, many problems also overlapped into other TSAs. Within the CDOT Region 4 ITS Plan, solutions for the transportation problems have been identified. The discussion in this section focuses on identifying issues that need to be considered in providing solutions to

the problems within each TSA. The deployment related issues, if applicable, are grouped in following functional areas: technical, interagency coordination, legal/jurisdictional and financial.

1. Regional Traveler Information

Regional traveler information involves a wide range of data that can be used by the monitoring public including: traffic conditions, travel times, incidents, construction, weather, transit operations, and alternative travel options. These data are collected, processed and disseminated to the public. For example, CDOT's traveler information system consists of the 511 phone system and the COTrip.org website. Other third-party providers to distribute this information through personalized e-mail or text messaging, mobile access and other traveler information services. The collection and dissemination of traveler information can assist travelers in making and modifying their travel decisions.

The following specific traveler information related transportation problems were identified:

- ***Not enough real-time information (traffic conditions, incidents & construction) provided to travelers*** – This problem exists on interstate highways, state highways and regionally significant corridors. The inability to provide real-time information can lead to increased delays, traveler anxiety and negative impacts to regional travel particularly for out-of-state/area drivers. This also impacts traffic operators and emergency management providers in their ability to quickly respond to incidents.
- ***Not enough real-time weather and pavement data*** – This problem exists on interstates, state highways and regionally significant corridors. Travelers are not being provided enough granular information regarding road and weather conditions. This also impacts maintenance personnel and emergency management providers and their ability to efficiently and effectively deploy resources to respond to bad weather conditions.
- ***Not much awareness of where existing real-time information can be obtained***- This is a regional problem. Travelers are generally unaware of where information can be obtained and, therefore, are unable to take advantage of traveler information displayed on the COTrip web site. Also, traveler information is not being shared across institutional boundaries.
- ***No on-line trip planning services*** – This is a growing regional problem. Travelers are not being provided with one consolidated source for alternative modal options across the Region. Each Transit program has their own website to promote their bus routes, while the NRMPO has the SmartTrips.org website to promote carpool (ridesharing), vanpool, bicycle, pedestrian and some transit. Transit ridership is being affected since information is difficult to obtain. This also tends to increase costs for paratransit services as normal bus operations do not meet user needs. This problem could have been categorized under the Regional Transit Operations and Management TSA. However, since the primary focus of this problem was providing traveler information it was assigned to this TSA.
- ***Not enough video surveillance to monitor traffic conditions, incidents and construction activities***. This problem exists at freeway interchanges and along highways that intersect with other State Highways and Regionally significant corridors. Traffic operators are not able to monitor and verify traffic conditions. The inability to know current conditions also impacts safety. Additionally, there is decreased usage at PNRs due to lack of video surveillance and perceived safety concerns.

Technical Issues
Local agencies providing traveler information within their jurisdiction should utilize CDOT guidelines to ensure consistency in displaying information on the CoTrip website.
There needs to be data quality, reliability and timeliness assurance.
Interagency Coordination Issues
Need to have CDOT's CoTrip/511 System/GovDelivery be more visible to other agencies and the public.
CoTrip website needs to include access to alternative modes of travel via SmartTrips.org and support traveler information needs for the Town of Estes Park and RMNP.
Agreements are required between agencies to coordinate/integrate traveler information systems
Coordination with other agencies regarding access to and use of the MDSS system including licensing, user management, etc.
Allow local agencies to input maintenance and construction information on the CCTM.
Local agencies should consider adding weather stations and pavement detectors to CDOT MDSS system to expand coverage and further improve data quality and granularity.
Local agencies should consider providing CDOT access to video cameras so that they are included for display on the CoTrip website.
Financial Issues
There is insufficient funding to implement traveler information system along corridors and CDOT ITS with its system management, operation and maintenance responsibilities will face additional financial challenges.
Multiple third party systems using public information sources are competing to provide traveler information and there is possibility of a potential revenue stream that public agencies can generate from the traveler information system. Revenue-sharing agreements may be necessary if a revenue stream is created.
Consider licensing the public information to private ISPs. The information may be copyrighted so that it cannot be reproduced without license.
Consider advertising and/or sponsorships, which could be used as another form of revenue to offset costs of traveler information system.
Consider fee-based value-added services.
Consider using designbuild/operate and manage contracts for information system.

2. Regional Operations and Management

Regional transportation management provides transportation monitoring and control functions coordinated across Regional jurisdictions. For example, CDOT, Fort Collins, Greeley and Loveland operate signal systems to monitor and control signals. System monitoring and control functions provide operators the ability to respond to changing operational conditions, as needed. The following specific operations and management-related problems were identified:

- **Freeway/Arterial congestion** – This problem exists on specific segments along interstates, state highways and regionally significant corridors where the traffic volume exceeds the roadway capacity. It increases delay, driver frustration and overall degradation of operations.
- **Lack of synchronization of traffic signals and strategies beyond TOD plans** – This problem exists on specific segments along state highways and regionally significant corridors where traffic signals are closely spaced (usually less than 1/4 mile from each other). Lack of proper synchronization causes unnecessary delay, increased emissions and heightened safety concerns.
- **Event traffic management** – This problem exists in urban areas. Events tend to attract more traffic and can increase delays and safety concerns.
- **Lack of communications infrastructure** – This is a regional problem. The lack of backbone fiber infrastructure seriously affects the ability to deploy ITS devices, systems and networks. This affects the ability to easily share information between agencies for ITS applications and business functions.
- **Tracking and data collection from maintenance vehicles** – This is a regional problem. Maintenance vehicles are not being used as effectively as possible to supplement traveler information and road/weather conditions.
- **Not enough reliable communication for traffic signals** – This problem exists on specific segments along state highways and regionally significant corridors where there is no reliable communications for traffic signals. This makes it difficult to troubleshoot signal problems remotely, increases maintenance cost and prevents the ability to synchronize signals.
- **Security of key infrastructure** – This problem exists on specific segments along interstates, state highways and regionally significant corridors. Higher levels of security results in deterring vandalism at PNRs, on bridges and on ITS infrastructure, such as DMS.

Technical Issues
Need to document the benefit-cost for traffic responsive strategies.
ITS solutions on freeway and intersecting corridors should complement each other.
Local agencies should consider deploying communications infrastructure that is consistent with the technology used by CDOT.
Interagency Coordination Issues
Event traffic management plans should include law enforcement agencies and CDOT.
IGAs need to be in place to support sharing of communications infrastructure in terms of operations, maintenance and management.
Financial Issues

Consider public-public and public-private partnerships to deploy the communication infrastructure.

3. Regional Traffic Incident Management

Severe and inclement weather, speeding, incidents and work zone management around construction and maintenance activities impact safety. The service area applies to two primary groups: 1) transportation operations, and 2) public safety. Using ITS devices, transportation operations employ incident detection and verification and disseminate traveler information regarding the incident. Public safety has primary responsibility for incident site management and incident clearance and coordination with transportation operations to support their activities and to promote safer operations. The following specific incident-related transportation problems were identified:

- **Weather (high winds, flooding and icing)** – This problem exists on specific segments along interstates, state highways and regionally significant corridors. It impacts the safety of the traveling public and it also disrupts traffic conditions.
- **Highway-rail crossings** – This problem exists at specific railroad crossings on state highways and regionally significant corridors. Some crossings lack protection gates, while other crossings on adjacent parallel roadways lack sufficient queue space. As a result, there is a disruption of traffic and increased localized safety and congestion concerns. Also, queue dissipation takes longer at these locations.
- **Incidents** – This problem exists on interstates, state highways and regionally significant corridors. It leads to disruption of traffic and secondary incidents. Also, there is a need to clear incidents to a safe zone location. Currently, this results in CSP resources being inordinately used to assist in clearing vehicles from the roadway.
- **Road closures** – This problem exists on specific segments along interstates, state highways and regionally significant corridors where the roadway needs to be closed due to inclement weather conditions and/or incidents. It impacts safety and disrupts traffic.
- **Speeding** – This problem exists primarily along interstates and especially on I-25. Higher speeds directly result in an increase in accident frequency and severity. Increased high speed accidents affect safety and also significantly disrupt traffic conditions, often causing lane closures.

Technical Issues
Automated incident detection is a technical challenge.
Public safety field staff often does not close out incidents with dispatch as soon as the roadway has been reopened.
Incident management plans need to be updated on a regular basis.
Legal/Jurisdictional Issues
Courtesy Patrol is planned for I-25 and would require some sort of agreement between CDOT and CSP.
Multiple contacts at multiple agencies are a communications challenge. Each agency should define an incident management contact list which follows the model adopted by both Denver and Lakewood for the US 6 Incident Management Plan.

The state maintains the Resource Ordering and Status System (ROSS). The public works elements have not yet been entered into that database.
Financial Issues
Additional costs for incident management: increased staffing, increased requirements for incident detection and management.
Additional training may be required to have public safety and transportation operations better understand each other's procedures and practices.

4. Regional Transit Operations and Management

Transit management provides monitoring and control functions for transit. Transit services need to be integrated with other alternative modes to increase its competitiveness. Transit operations are intended to improve operational efficiency. For example, Computer Aided Dispatch (CAD)/AVL systems allow for monitoring of transit vehicles for schedule adherence, etc. The following specific transit related transportation problems were identified:

- **Not enough coordination and integration between alternative travel modes** – This is a regional problem. Currently, there is little connectivity between and among travel modes, e.g., transit, van pools and bicycle routes. The SmartTrips website allows carpoolers and vanpoolers to see mapped transit routes near their work location; however, the website does not dynamically report route times and schedules. Also, none of the existing PNRs have transit connectivity. All of this negatively impacts usage of these travel modes.
- **No priority for transit vehicles at traffic signals** – This problem exists along certain transit routes on state highways and regionally significant corridors where there is traffic congestion. There is increased delay for buses that may affect schedule adherence.
- **Not many regional bus routes** – This problem exists between major urban areas within the Region. It can impact transit ridership and competitiveness.
- **Lack of dedicated outreach for transit to increase its competitiveness.** This is a regional problem. Currently, no staff resources are available to promote transit. The lack of outreach may discourage the public demand for transit. This results in not enough public demand for transit.

Technical Issues
Inter-connectivity between the transit agencies providing information about schedule adherence, arrival time, and passenger load data is needed.
Multi-modul planning tool is need in the Region to include transit, bicycle, PNR's and pedestrians.
Provide passenger count systems which can provide origin-destination data and transfer information. This information can be integrated with a passenger fare collection system.
Legal/Jurisdictional Issues
Agreements between transit agencies and NFRMPO may be required.

Financial Issues

There is a need for coordinated planning for seeking grant funding.

5. Maintenance and Construction

The primary area in which ITS is related to maintenance and construction is for traveler information functions. Also, roadway maintenance is tied to weather data collection to support such activities as snow clearing operations and roadway striping. The following specific maintenance and construction related transportation problems were identified:

- **Work zone** – This problem exists on specific segments along interstates, state highways and regionally significant corridors where construction/maintenance activities are performed. This impacts the safety of the traveling public and construction/maintenance personnel. There is limited information available online regarding work zone locations within the Region.

Technical Issues

MDSS is a useful tool to help schedule work for winter storms and for other times of the year (i.e. forecasts of improper environmental conditions could postpone work and reschedule resources more quickly).

Each jurisdiction’s permitting office should be a source of construction and maintenance activities information and should be allowed to easily input information into CDOT CCTM.

Legal/Jurisdictional Issues

All jurisdictions are not benefiting from weather information that is currently collected region wide and statewide.

Regional weather collection system plan could eliminate duplication and gaps in weather monitoring coverage.

Weather data could be valuable when used in cooperation with emergency management and law enforcement to track hazardous releases.

Local permitting offices could provide construction and maintenance operations location and schedule information to CTMC, 511 system and CDOT Permitting Office. This information could be used to aid project coordination by local agencies and trip planning by travelers.

Financial Issues

Costs to expand and maintain parallel systems versus costs required to integrate systems.

Cost of resources for road weather information systems (RWIS), environmental sensor stations (ESS) and truck equipment.

Cost of resources to pull together maintenance and construction information.

6. Regional Parking Management

Parking management supports and provides parking information to the public and operators. The following specific parking management-related transportation problems were identified:

- Parking management** – This problem primarily exists in the Town of Estes Park due to its proximity to RMNP. It can lead to increased congestion, driver frustration and increased vehicle/pedestrian conflicts. Tourists require information dissemination that is not typical of that for residents or regular commuters because they are unfamiliar with services and systems that are available. Additionally, the existing PNRs along I-25 need more capacity and there is a need for PNRs along US-287 and US-34 corridors.

Technical Issues
The main interest of jurisdictions is to provide better information to potential parking customers. Although the same infrastructure required for parking information systems will support parking management strategies, there is not a broad interest in deploying parking management strategies at this time.
Legal/Jurisdictional Issues
CDOT, Town of Estes Park and RMNP need to determine traveler information needs in the area and discuss the need for any agreements.
Financial Issues
Traveler information needs in the Town of Estes Park should take into consideration the Town’s business community needs.

7. Regional Data Management

Regional Data Management involves the organization of transportation system performance data across modal and jurisdictional boundaries. These data can be used by operators (for operational analysis and event planning), planners (for long-term planning) and by researchers. Traffic operations, operations planning, and transportation planning rely on accurate and timely data. These data are used in evaluating system performance, determining priorities, calibrating models, developing and evaluating scenarios, timing signals, and managing events and incidents. Where data are old or nonexistent, the results of these activities may be compromised. Specific transportation problems related to data management are:

- Not enough historic traffic count (volume) data** – This is a regional problem. Data are not at a centralized location. Also, there is not enough bike/pedestrian count data.
- Data sharing between agencies** – This is a regional problem. There is no sharing of data between agencies in part due to a lack of backbone communications infrastructure and data sharing mechanisms.
- Lack of performance monitoring data** – This is a regional problem. Operational decisions are based on insufficient or incomplete information. While the NFRMPO communities have recently implemented some performance requirements through the federally mandated congestion

management process, it will be a number of years before trend analysis can be used on funded projects. The lack of data affects the ability to show demonstrable benefits for ITS.

Technical Issues
The amount of data being archived needs to be managed in order to strike a balance between cost and the usefulness of the data warehouse.
A regional data user's group could be implemented to assist in the development of the data management planning.
USDOT will be establishing data exchange formats (section 1201 from SAFETEA-LU) that must be incorporated by states and local governments in order to both share data, and make the data available to the traveling public.
Examples of data of interest include: volume, speed and travel time by link; incident data (location, type, etc.); all movement data for critical intersections; traffic signal timing plan information by signal.
Legal/Jurisdictional Issues
Local jurisdictions may prefer to store data in ways that are incompatible with the regional system.
Local jurisdictions should coordinate in order to avoid duplication of data collection efforts at the same location.
Financial Issues
The costs of participation will vary by the amount of data collected, yet everyone would have equal access. Cost share between agencies needs to be defined prior to program implementation.

8. Regional Emergency Management

ITS devices and systems may be used to support the protection of critical transportation infrastructure within the Region. Note that ITS devices and systems are also critical transportation infrastructure that must remain available to support the public safety community in the event of a disaster.

- **Access to MDSS and CDOT traveler information** – The lack of availability of this information impacts local law enforcement agencies in the allocation of their resources in responding to adverse weather conditions.

Technical Issues
Security communications infrastructure and protocols may not be consistent from jurisdiction to jurisdiction.
There are multiple GIS efforts/capabilities across the region.

Legal/Jurisdictional Issues
Some security planning is sensitive information, which may conflict with the goal of distributing traveler information.
Training may be required to educate transportation professionals of security responsibilities.

9. Commercial Vehicle Operators

ITS devices and systems have been deployed in the Region to support both the Colorado State Patrol (CSP) and the Colorado Department of Revenue (CDOR) Port-of-Entry (POE) Division interactions with commercial vehicle operations. CSP is responsible for the safety of commercial vehicle operations, which involves driver credential review, truck inspections, and hazardous material routing and tracking. CDOR is responsible for commercial vehicle tax administration and assuring compliance with the State’s commercial vehicle size and weight laws. CDOT is responsible for issuing Extra-Legal and Longer Combination Vehicle permits and administering these programs. Coordination is ongoing among the primary agencies to improve and integrate the commercial vehicle operations.

- **Access to MDSS and CDOT traveler information** – The lack of availability of this information impacts the POE’s ability to provide timely information to commercial vehicles that pass through the facilities.
- **Antiquated business systems** – This problem specifically pertains to POE’s antiquated business system with Silo databases that make it difficult to perform integrated business operations and functions effectively, efficiently and in a timely manner.
- **Inadequate support infrastructure** – This problem exists on interstates and state highways where there is not enough pullout areas to perform size and weight enforcement on commercial vehicles. There is also a lack of proper size and weight enforcement on load-deficient bridges in the Region.

In addition to the problems identified, above, there were additional problems, which were more institutional in nature and are not tied to the TSAs. These problems pertain to coordination within and between local cities, counties, law enforcement agencies, and Regional and state agencies. Specific institutional transportation problems are:

- **Champion for ITS Within the Region** – This is a Regional problem. The lack of formally identifying a champion for ITS within the Region results in individual agencies trying their best to promote ITS within their agency without a truly collaborative concerted approach.
- **Lack of adequate funding** – This problem affects all of stakeholders within the Region. This affects their ability to implement solutions, improve mobility and safety within the Region and upgrade systems, facilities or roadways, etc.

Technical Issues
Oversize and overweight permitting is not tied into the weigh-in-motion (WIM) stations or the PrePass program.
CDOT Permitting is currently unable to track movements of vehicles on annual permits.

Legal/Jurisdictional Issues
Motor Carrier Services needs access to vehicle and driver records in real-time. This requires coordination within the Division of Motor Vehicles.
Ports of Entry, State Patrol and CDOT Permitting – all critical elements of CVO – are under different organizations.
There is a need to better distribute HAZMAT travel information to transportation and public safety agencies.
Financial Issues
Commercial vehicle permitting fees in Colorado have not changed for decades.
Insufficient funding is available to maintain the port-of-entry bypass program. There is currently a field equipment failure rate of about 50%.

III. MARKET PACKAGE PLAN

Market Packages are the building blocks of the National ITS Architecture. The process of identifying local transportation problems 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 ITS Architecture and are tailored to fit - separately or in combination - real world transportation problems and needs. Market Packages identify physical ITS elements (infrastructure, equipment and devices) that are required to implement a particular transportation service. A description of the entire National ITS Architecture Version 6.1 based Market Packages including graphic can be found on the USDOT National ITS Architecture website at <http://www.iteris.com/itsarch/html/mp/mpindex.htm>. Market Packages for CDOT Region 4 were selected to address the transportation problems as identified through the stakeholders. Appendix A provides a brief description of the Market Packages and identifies their applicability both existing and future, within the Region.

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

- **Archived Data Management (AD):** Store and retrieve transportation system information for future analysis.
- **Advanced Public Transportation Systems (APTS):** Manage transit operations and make transit use more convenient and safe.
- **Advanced Traveler Information Systems (ATIS):** Provide real-time information to travelers.
- **Advanced Traffic Management Systems (ATMS):** Manage operation of the roadway network.
- **Advanced Vehicle Safety Systems (AVSS):** In vehicle technologies to improve safety and vehicle control.
- **Commercial Vehicle Operations (CVO):** Manage Commercial vehicle operations, safety and permitting.
- **Emergency Management (EM):** Manage emergency response operations.
- **Maintenance and Construction Management (MC):** Manage maintenance and construction activities and operations.

Market Packages in the tables on the following pages are listed as being either “E” for “existing”, “P” for “planned” (for future deployment), or “blank” if there is no requirement for the Market Package.

A. *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 CDOT Region 4, existing ITS Data Marts include elements such as the CDOT ITS equipment and weather station data, traffic volume and speed monitoring data and traffic signal timing plans. Historical performance “traffic conditions” data is planned to be made available on City and County Traffic Management (CCTM) on corridors that support “real-time” conditions through an on-line reporting tool supported at the Colorado Transportation Management Center (CTMC). Table 1 lists the Archived Data Market Packages.

Table 1: Archived Data Management Market Packages Summary

Market Package	AD1	AD2	AD3
Jurisdiction	ITS Data Mart	ITS Data Warehouse	ITS Virtual Data Warehouse
CDOT ITS	E		P
CDOT DTD	E		
CDOT Region 4	E		
DRCOG	E	P	
NFRMPO	E		
ETPR	E		
UFR TPR	E		
Emergency Management	E		
Law Enforcement	E		
Fort Collins	E		
Greeley	E		
Loveland	E		
Local Jurisdictions	E		
Transfort	E		
GET	E		
COLT	E		

B. Advanced Public Transportation Systems

There are several transit agencies that operate in CDOT Region 4. Three primary transit agencies within the Region include: 1) Transfort, 2) COLT, and 3) GET. The primary transit agencies have deployed or plan to deploy many of the Advanced Public Transportation Systems Market Packages: Transit Vehicle Tracking, Transit Fixed Route Operations, Transit Security, Multi-Modal Coordination and Transit Traveler Information. Also, other Market Packages have been planned or considered for deployment. Table 2 lists the Advanced Public Transportation Systems Market Packages.

Table 2: Advanced Public Transportation Systems Market Packages Summary

Market Package	APTS01	APTS02	APTS03	APTS04	APTS05	APTS06	APTS07	APTS08	APTS09	APTS10
Jurisdiction	Transit Vehicle Tracking	Transit Fixed-Route Operations	Demand Response Transit Operations	Transit Fare Collection Management	Transit Security	Transit Fleet Management	Multi-Modal Coordination	Transit Traveler Information	Transit Signal Priority	Transit Passenger Counting
CDOT ITS							E	P		
DRCOG							E	P		
NFRMPO							E	E		
ETPR							E			
UFR TPR							E			
Law Enforcement					E					
Fort Collins							E		E	
Greeley							E			
Loveland							E			
Town of Estes Park							E	E		
Transfort	E	E	E	E	E	E	E	E	E	P
GET	E	E	E	P	E	E	E	E		P
COLT	E	E	E	E	E	E	E	E		P

C. 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 email 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, Highway Advisory Radio (HAR), CDOT GovDelivery, and CDOT 511 phone system. Table 3 lists the Advanced Traveler Information Systems Market Packages.

Table 3: Advanced Traveler Information Systems Market Packages Summary

Market Package	ATIS01	ATIS02	ATIS03	ATIS04
Jurisdiction	Broadcast Traveler Information	Interactive Traveler Information	Transportation Operations Data Sharing	Dynamic Ridesharing
CDOT ITS	E	E	P	
DRCOG				P
NFRMPO				E
Fort Collins	E	E		
Greeley	P	P		
Loveland	E	P		
Town of Estes Park	E	P		
RMNP	E	P		
Local Jurisdictions	E			

D. Advanced Traffic Management Systems

Many ATMS Market Packages are already in deployment in the Region either by CDOT or other stakeholders. There are several locations where Automatic Traffic Recorders (ATRs) or Weigh-in-Motion (WIM) scales are in use along I-25 and other major highways. Several jurisdictions in the Region use video cameras for surveillance and detection. All major jurisdictions in the Region operate traffic signal systems; several with traffic signal and railroad signal coordinated grade crossings (Standard Railroad Grade Crossing). Dynamic Message Signs and Highway Advisory Radio are used to provide traveler

information. CDOT and local jurisdictions provide incident management along I-25 and US 36 within the Region. Table 4 lists the Advanced Traffic Management Systems Market Packages.

Table 4: Advanced Traffic Management Systems Market Packages Summary

Market Package	ATMS01	ATMS02	ATMS03	ATMS04	ATMS05	ATMS06	ATMS07	ATMS08	ATMS13	ATMS16	ATMS17	ATMS19	ATMS21
Jurisdiction	Network Surveillance	Traffic Probe Surveillance	Surface Street Control	Freeway Control	HOV Lane Management	Traffic Information Dissemination	Regional Traffic Control	Traffic Incident Management System	Standard Railroad Grade Crossing	Parking Facility Management	Regional Parking Management	Speed Monitoring	Roadway Closure Management
CDOT ITS	E	P				E	P	E			P	P	P
CDOT DTD	E												
CDOT Region 4	E		E	E	P			E	E			P	P
Emergency Management								E					
Law Enforcement								E				P	P
Fort Collins	E		E						E				
Greeley	E		E						E				
Loveland	E		E						E				
Town of Estes Park	E		E							P	P		
RMNP										P	P		
Local Jurisdictions	E		E						E				

E. Advanced Vehicle Safety Systems

Advanced Vehicle Safety Systems (AVSS) is not included in the CDOT Region 4 Architecture. Market Packages for AVSS include systems which are primarily in the vehicle and monitor driver condition, vehicle position, and warn the driver when a collision may be imminent. AVSS may also take control of the vehicle in the latter case. AVSS technology is rapidly evolving and changing as manufacturers continue to improve the technology and the safety of these systems. In the future AVSS may come into more widespread use and become more applicable in the regional ITS. Currently, they do not require

direct interface with the ITS infrastructure in CDOT Region 4. It is anticipated that this trend will continue; however, it is important to note that the Vehicle Infrastructure Integration (VII) initiative, which is a cooperative effort between Federal and State DOTs and automobile manufacturers, is working to provide the capability for cars and the transportation network to communicate with each other. As VII and the AVSS systems develop, AVSS Market Packages may be reevaluated for subsequent revisions of the Region 4 ITS Architecture.

F. Commercial Vehicle Operations

The role of ITS in commercial vehicle operations is to support existing efforts to improve the safety and efficiency of commercial vehicle operations. Currently, the main element implemented in CDOT Region 4 is an electronic clearance (PrePass) system at the Ports of Entry fixed locations. In the National ITS Architecture, there are several Market Packages identified to improve the safety of commercial vehicle operations, which may require technology improvements and coordination between stakeholders. Table 5 lists the Commercial Vehicle Operations Market Packages.

Table 5: Commercial Vehicle Operations Market Packages Summary

Market Package	CVO03	CVO04	CVO06	CVO07	CVO08	CVO10	CVO12	CVO13
Jurisdiction	Electronic Clearance	CV Administrative Process	Weigh-in-Motion	Roadside CVO Safety	On-Board CVO and Freight Safety and Security	HAZMAT Management	CV Driver Security Authentication	Freight Assignment Tracking
CDOT ITS			E					
Colorado Department of Revenue – Port of Entry	E	E	E					
Colorado Department of Public Health						E		
Colorado State Patrol				E		E		
Pre-pass	E							
Trucking Companies					P		P	P

G. 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 law enforcement 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 ITS devices are monitored and controlled. Table 6 lists the Emergency Management Market Packages.

Table 6: Emergency Management Market Packages Summary

Market Package	EM01	EM04	EM05	EM06	EM08	EM09	EM10
Jurisdiction	Emergency Call-Taking and Dispatch	Roadway Service Patrols	Transportation Infrastructure Protection	Wide-Area Alert	Disaster Response and Recovery	Evacuations and Reentry Management	Disaster Traveler Information
CDOT ITS		P	P	E			
CDOT Region 4		P	P				
Emergency Management	E				E	E	E
Law Enforcement	E		P	E	E		
Fort Collins	E						
Greeley	E						
Loveland	E						
Town of Estes Park	E						
Local Jurisdictions	E						

H. Maintenance and Construction Management

Market Packages in this service area may be linked to issues and needs concerning maintenance vehicles, work zones, and collecting/distributing weather and road conditions data. Currently, CDOT Region 4 has an extensive deployment of MDSS and weather stations that are interconnected and share data. CDOT has also 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 that is provided to CDOT maintenance. Several local agencies have also deployed weather stations, but very little coordination exists with the state system with respect to sharing data. CDOT Region 4 is instrumenting maintenance vehicles to collect real-time road

condition data and to dispatch maintenance vehicles in a more timely manner. CDOT Region 4 intends to deploy additional automatic bridge-deicing systems. Table 7 lists the Maintenance and Construction Market Packages.

Table 7: Maintenance and Construction Market Packages Summary

Market Package	MC01	MC03	MC04	MC05	MC06	MC07	MC08	MC10
Jurisdiction	M&C Vehicle and Equipment Tracking	Road Weather Data Collection	Weather Information Processing and Distribution	Roadway Automated Treatment	Winter Maintenance	Roadway Maintenance and Construction	Work Zone Management	M&C Activity Coordination
CDOT ITS		E	E					
CDOT Region 4	E	E	E	E	E	E	P	P
Fort Collins				E				
Greeley		E						
Loveland		E						
Local Jurisdictions		E						

IV. OPERATIONAL CONCEPT

The Operational Concept identifies the stakeholders that will be responsible for implementing transportation services and their roles and responsibilities regarding those services. A detailed list of the stakeholders and their roles and responsibilities was developed in Turbo Architecture.

This section provides a summary of stakeholder roles and responsibilities and their status (existing and planned) within four functional areas, if applicable, based on TSA and its associated Market Packages. The four functional areas are as follows:

- Implementation – specific ITS elements already existing and identified for deployment
- Maintenance – specific elements for maintenance of the existing ITS infrastructure
- Management – planning and coordination activities
- Operations – related to operating the ITS infrastructure

A. Regional Traveler Information

Associated Market Packages for this Transportation Service Area

AMS01: Network Surveillance	ATIS1: Broadcast Traveler Information
ATMS06: Traffic Information Dissemination	ATIS2: Interactive Traveler Information
MC03: Road Weather Data Collection	ATIS8: Dynamic Ridesharing
MC04: Weather Information Processing and Distribution	EM06: Wide-Area Alert
MC10: Maintenance and Construction Activity Coordination	EM10: Disaster Traveler Information
APTS8: Transit Traveler Information	

1. CDOT ITS Branch

Implementation:	Status
Deploy traveler information on all high priority corridors	Planned
Deploy traffic monitoring systems elements on all high priority corridors for traveler information	Planned
Deploy weather monitoring systems elements on all corridors	Existing
Access to MDSS and traffic video for other agencies	Planned
Integrate future travel information systems into the CoTrip/511 system/GovDelivery	Planned
Provide links to multi-modal information on CoTrip	Planned
Develop iPhone and Droid traveler information/road condition Apps	Planned
Support traveler information needs for Estes Park/RMNP on CoTrip/511 System/GovDelivery	Planned
Maintenance:	Status
Maintain field monitoring systems	Existing
Maintain CoTrip/511 system/GovDelivery	Existing
Management:	Status
Establish and promote standards and protocols for CoTrip/511 system/GovDelivery	Existing
Assist in the promotion of the CoTrip/511 system/GovDelivery with other agencies and	Planned



CDOT Region 4 ITS Architecture

traveling public	
Support development of system elements by other entities that are compatible with the CoTrip/511 system/GovDelivery	Planned
Develop RFP regarding feasibility of allowing advertising and for sponsorship on the CoTrip website to generate funds to offset costs	Existing
Operations:	Status
Serve as the regional ISP, a clearinghouse for traveler information. This will mainly be achieved through the CoTrip/511 system/GovDelivery, which will be automatically or manually updated by local agencies	Planned
Provide traveller information to private information service providers (ISP)	Existing
Coordinate with Public Safety the wide area alert messaging (i.e. existing Amber alert and evacuation messaging)	Existing

2. CDOT Region 4

Implementation:	Status
Deploy traffic monitoring systems elements on all corridors with high priority for traveler information	Planned
Deploy weather monitoring systems elements on all corridors	Existing
Maintenance:	Status
Maintain field monitoring systems	Existing
Management:	Status
Assist in the promotion of the CoTrip/511 system/GovDelivery with other agencies and traveling public	Planned
Support traveler information needs on corridors for Estes Park/RMNP	Planned

3. NFRMPO

Implementation:	Status
Add static transit route information to Google	Planned
Develop requirements for on-line trip planning services SmartTrips.org website (multi-modal planner)	Planned
Develop on-line trip planning services SmartTrips.org website (multi-modal planner)	Planned
Maintenance:	Status
Maintain SmartTrips.org website	Existing
Maintain static transit route information on Google	Planned
Maintain on-line trip planning services SmartTrips.org website	Planned
Management:	Status
Support website linkage between CDOT and transit traveler information	Planned

4. DRCOG

Implementation:	Status
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Deploy rideshare and telework services (RideArrangers)	Existing
Prepare bicycle and pedestrian traveler information resources	Existing
Develop and deploy alternative travel options educational and promotional material	Existing
Maintenance:	Status
Maintain RideArrangers telephone number and website	Existing
Management:	Status
Support public promotion of the CoTrip/511 system/GovDelivery regionally	Planned
Operations:	Status
Operate Ride Arrangers services	Existing
Coordinate access to RideArrangers services through 511 system	Planned

5. Local Jurisdictions

Implementation:	Status
Deploy traffic monitoring systems elements on corridors	Planned
Deploy weather monitoring systems elements	Existing
Deploy arterial conditions map & tie to CoTrip	Planned
Maintenance:	Status
Maintain field monitoring systems	Existing
Maintain TMC operations	Planned
Maintain communications with the CTMC and CoTrip/511 system	Planned
Management:	Status
Support CDOT standards and protocols for use of the CoTrip/511 system/GovDelivery	Planned
Operations:	Status
Monitor field monitoring systems and detect transportation system issues	Planned

6. Public Safety

Operations:	Status
Coordinate with CDOT ITS for wide area alert messaging to be included in CoTrip/511 system/GovDelivery	Existing
Coordinate with CDOT ITS on CSP campaigns	Existing

7. Transit Agencies

Implementation:	Status
Assist in adding static transit route information to Google	Planned
Assist in developing requirements for on-line trip planning services website (multi-modal planner)	Planned
Assist in developing on-line trip planning services website (multi-modal planner)	Planned
Deploy bus arrival/departure application at transit centers, PNRs and key bus stops	Planned
Maintenance:	Status
Maintain equipment and software supporting the real-time bus arrival system	Planned



Operations:	Status
Operate real-time bus arrival time system	Planned

B. Regional Operations and Management

Associated Market Packages for this Transportation Service Area

ATMS01: Network Surveillance	ATMS13: Standard Railroad Grade Crossing
ATMS02: Probe Surveillance	ATMS19: Speed Monitoring
ATMS03: Surface Street Control	ATMS21: Roadway Closure Management
ATMS04: Freeway Control	APTS7: Multi-modal Coordination
ATMS05: HOV Lane Management	EM05: Transportation Infrastructure Protection
ATMS07: Regional Traffic Control	EM06: Wide-Area Alert

1. CDOT ITS Branch

Implementation:	Status
Deploy traffic monitoring system elements on freeways and major state highways	Existing
Deploy travel time monitoring system elements on freeways and major state highways	Existing
Deploy traffic information dissemination system elements on freeways and major state highways	Existing
Expand CCTM to include other traffic agencies	Planned
Deploy backbone communications infrastructure	Planned
Maintenance:	Status
Maintain ITS equipment	Existing
Maintain CTMC	Existing
Maintain CCTM	Existing
Maintain backbone communications system connecting with other agencies	Planned
Operations:	Status
Monitor corridor operations including both congestion and traffic incident detection	Existing
Use DMS to post messages	Existing
Post other operations information to DMS upon request from local agencies	Existing
Serve as concentration point for Regional Traffic Control, consolidating links from other traffic management centers in the Region and presenting a regional view for both traffic conditions and system health - the CCTM	Planned

2. CDOT Region 4

Implementation:	Status
Deploy traffic monitoring system elements on state highways	Planned
Deploy ramp metering system elements on freeways	Existing
Deploy interconnected traffic signal system elements along state highways	Existing
Develop signal timing plans for major corridors	Existing
Deploy traffic responsive/traffic adaptive control on select corridors	Existing
Maintenance:	Status
Maintain field system elements.	Existing
Maintain communications to CTMC	Existing
Management:	Status
Develop deployment plan for ramp meters	Existing



Assist HPTE in development of a plan for management and operations of managed lanes.	Planned
Operations:	Status
Monitor and operate ramp meter system	Existing
Monitor and operate traffic signal system	Existing
Feed system health and traffic conditions data to CCTM	Planned

3. DRCOG

Implementation:	Status
Develop signal timing plans for major corridors	Existing
Lead development of a plan for performance monitoring of regional system operations	Planned

4. Local Jurisdictions

Implementation:	Status
Deploy interconnected traffic signal system elements on corridors.	Existing
Deploy traffic monitoring system elements on corridors.	Existing
Develop signal timing for corridors	Existing
Maintenance:	Status
Maintain traffic signal system	Existing
Maintain traffic monitoring system	Existing
Operations:	Status
Implement signal timing plans for corridors	Existing
Monitor traffic signal system health and traffic conditions on the local network	Planned
Feed system health and traffic conditions data to CCTM	Planned

5. Public Safety

Maintenance:	Status
Dispatch emergency vehicles based on information available from the CCTM	Planned
Feed emergency routing information to the CCTM	Planned

C. Regional Traffic Incident Management

Associated Market Packages for This Transportation Service Area

ATMS01: Network Surveillance	ATMS08: Traffic Incident Management System
ATMS02: Probe Surveillance	ATIS1: Broadcast Traveler Information
ATMS03: Surface Street Control	ATIS2: Interactive Traveler Information
ATMS04: Freeway Control	EM01: Emergency Call-Taking and Dispatch
ATMS06: Traffic Information Dissemination	2M02: Emergency Routing
ATMS07: Regional Traffic Control	EM04: Roadway Service Patrols

1. CDOT ITS Branch

Implementation:	Status
Deploy incident detection on freeway corridors	Existing
Interface public safety CAD display at CTMC	Existing
Maintenance:	Status
Maintain incident detection and verification systems.	Existing
Maintain contact list related to traffic incident management plans	Existing

Management:	Status
Improve ties to public safety agencies	Planned
Operations:	Status
Contact other CDOT resources required to respond to the incident	Existing
Implement alternate routes as determined by traffic incident management plan	Existing
Notify jurisdictions impacted by alternate route	Existing

2. CDOT Region 4

Implementation:	Status
Develop TIMP for US-85	Planned
Update TIMP for I-25 and US-36	Planned
Courtesy patrol on designated segments of I-25	Planned
Maintenance:	Status
Maintain a ready stock of incident management equipment	Planned
Management:	Status
Manage courtesy patrol	Planned
Operations:	Status
Region Maintenance assists in incident response and clearance	Existing

3. Local Jurisdictions

Operations:	Status
Review alternate routes to ensure they are clear of any maintenance/construction activities prior to rerouting traffic	Planned
Implement signal timing plan that supports the alternate routes	Planned

4. Public Safety

Implementation:	Status
Support interface of CAD display at CTMC	Existing
Maintenance:	Status
Maintain Resource Ordering and Status System (ROSS) database that tracks the availability of incident management equipment and resources	Existing
Maintain CAD system	Existing
Management:	Status
Assist in the development and updates of TIMPs	Planned
Operations:	Status
Dispatch updates to the CAD system	Existing

D. Regional Transit Operations & Management

Associated Market Packages for This Transportation Service Area

ATMS02: Probe Surveillance	APTS4: Transit Passenger and Fare Management
ATMS03: Surface Street Control	APTS5: Transit Security
APTS1: Transit Vehicle Tracking	APTS6: Transit Maintenance
APTS2: Transit Fixed-Route Operations	APTS7: Multi-modal Coordination
APTS3: Demand Response Transit Operations	APTS8: Transit Traveler Information



1. Transit Agencies

Implementation:	Status
Deploy transit passenger counting system	Planned
Deploy automated fare collection system for GET	Planned
Deploy fare collection kiosks	Planned
Maintenance:	Status
Maintain CAD/AVL systems	Existing
Maintain fleet maintenance systems	Existing
Maintain transit signal priority for Transfort	Existing
Maintain transit security communications	Existing
Management:	Status
Define integration of transit with other multi-modal options	Planned
Operations:	Status
Monitor transit system operations	Existing

2. NFRMPO

Management:	Status
Develop a plan to integrate multi-modal services at PNRs	Planned

3. CDOT Region 4

Management:	Status
Coordination with NFRMPO on providing multi-modal access to PNR's	Planned

E. Maintenance and Construction

Associated Market Packages for This Transportation Service Area:

ATMS01: Network Surveillance	MC04: Weather Information Processing and Distribution
ATMS02: Probe Surveillance	MC05: Roadway Automated Treatment
ATMS21: Roadway Closure Management	MC06: Winter Maintenance
MC01: Maintenance and Construction Vehicle and Equipment Tracking	MC08: Work Zone Management
MC02: Maintenance and Construction Vehicle Maintenance	MC10: Maintenance and Construction Activity Coordination
MC03: Road Weather Data Collection	

1. CDOT ITS Branch

Implementation:	Status
Deploy central weather data processing system elements.	Existing
Deploy field equipment	Existing
Deploy Maintenance Decisions Support System (MDSS) roadside elements	Planned
Maintenance:	Status
Maintain field equipment	Existing
Operations:	Status
Collect and process weather data and send to traveler information system	Existing

2. CDOT Region 4



Implementation:	Status
Deploy MDSS elements on maintenance fleet	Existing
Deploy weather stations	Existing
Maintenance:	Status
Maintain MDSS server and software	Existing
Maintain MDSS elements on maintenance fleet	Existing
Operations:	Status
Coordinate maintenance operations with MDSS program	Existing
MDSS information to coordinate roadway maintenance and construction closures and restrictions	Planned
Share roadway maintenance and construction activities information with traveler information system	Planned

3. DRCOG

Management:	Status
Coordinate deployment of weather stations within the Region	Planned

4. Local Jurisdictions

Implementation:	Status
Deploy weather stations	Existing
Deploy central weather data processing system elements	Planned
Interface with CDOT MDSS	Planned
Maintenance:	Status
Maintain weather stations	Existing

F. Regional Parking Management

Associated Market Packages for This Transportation Service Area

ATMS06: Traffic Information Dissemination	ATMS17: Regional Parking Management
ATMS07: Regional Traffic Control	APTS8: Transit Traveler Information
ATMS10: Electronic Toll Collection	ATIS1: Broadcast Traveler Information
ATMS16: Parking Facility Management	ATIS2: Interactive Traveler Information

1. CDOT Region 4

Implementation:	Status
Deploy CCTV at PNRs	Existing
Maintenance:	Status
Maintain CCTV at PNRs	Existing
Management:	Status
Assist NFRMPO in efforts to integrate PNRs with other multi-modal operations	Planned

2. Town of Estes Park

Implementation:	Status
Deploy parking conditions monitoring systems at transit hubs	Planned
Deploy kiosks or video wall at Town Visitor center	Planned
Support interfaces with CoTrip/511 system	Planned
Maintenance:	Status
Maintain parking conditions monitoring systems at transit hubs	Planned



Maintain kiosks or video wall at Town Visitor center	Planned
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3. CDOT ITS Branch

Management:	
Coordination with Estes Park in determining traveler information needs	Planned

G. Regional Data Management

Associated Market Packages for This Transportation Service Area

AD1: ITS Data Mart	AD3: Virtual ITS Data Warehouse
AD2: ITS Data Warehouse	

1. CDOT ITS

Implementation:	Status
Lead development of a plan defining data needs, including: location, type of data, format for data storage, data quality and data reliability requirements	Planned
Lead the development and procurement of a regional data warehouse	Planned
Lead procurement of a web-based software that can access existing database and compute and report regional performance data for planning, operations and research	Existing
Maintenance:	Status
Maintain the regional data warehouse database and hardware that supports it	Planned
Management:	Status
Lead the development of data management requirements	Planned
Lead the development of the standards and agreements required to define the virtual data warehouse	Planned

H. Regional Emergency Management

Associated Market Packages for This Transportation Service Area

ATMS01: Network Surveillance	EM08: Disaster Response and Recovery
MC04: Weather Information Processing and Distribution	EM09: Evacuation and Reentry Management
EM06: Wide-Area Alert	EM10: Disaster Traveler Information

1. CDOT ITS Branch

Implementation:	Status
Deploy communications link to State EMC	Existing
Deploy information	Existing
Maintenance:	Status
Maintain transportation system infrastructure	Existing
Management:	Status
Support emergency planning exercises	Planned
Operations:	Status
Operate transportation system infrastructure	Existing
Disseminate traveler information as directed by state EMC during emergency events	Existing
Share transportation conditions data with EOC, as appropriate	Existing



2. CDOT Region 4

Implementation:	Status
Deploy portable DMS for use during evacuation	Existing

3. Local Jurisdictions

Implementation:	Status
Deploy communications link to local EOC	Planned
Infrastructure to support emergency planning	Planned
Deploy communications link to State EMC	Planned
Maintenance:	Status
Maintain transportation system infrastructure	Existing
Management:	Status
Support emergency planning exercises. Support evacuation planning	Planned
Operations:	Status
Disseminate traveler information as directed by public safety during emergency events	Planned
Respond to requests for traffic control support during emergency	Existing

4. Public Safety

Management:	Status
Support emergency planning exercises	Existing
Support evacuation planning	Planned
Operations:	Status
Respond to evacuation order	Existing
Coordinate communications between public safety field staff and transportation operations	Planned

I. Commercial Vehicle Operations

Associated Market Packages for This Transportation Service Area

ATMS06: Traffic Information Dissemination	CVO10: HAZMAT Management
CVO03: Electronic Clearance	CVO12: CV Driver Security Authentication
CVO04: CV Administrative Processes	CVO13: Freight Assignment Tracking
CVO06: Weigh-In-Motion	

1. CDOR Motor Carrier Services Division – Ports of Entry

Implementation:	Status
Deploy port-of-entry bypass system elements	Existing
Deploy DMS at ports-of-entry	Existing
Deploy portable monitoring systems for mobile size and weight enforcement for load deficient structures	Planned
Deploy traveler information kiosks/access to MDSS	Planned
Maintenance:	Status
Maintain equipment at Ports-of-Entry that support traveler information (i.e. DMS, kiosks, communications link)	Planned
Maintain the portable monitoring systems	Planned
Management:	Status
Develop a plan to upgrade and integrate existing business systems	Planned

2. CDOT ITS Branch

Implementation:	Status
Deploy commercial vehicle operations safety systems – pull out areas	Planned
Deploy kiosks at ports-of-entry	Planned
Maintenance:	Status
Maintain commercial vehicle operations safety systems	Planned
Management:	Status
Coordinate with Colorado State Patrol regarding safety issues determined by safety systems	Planned
Coordinate with CDOR to allow traveler information to be posted on Port-of-Entry DMS, on kiosks, and other means	Planned
Operations:	Status
Monitor the status of safety systems and send driver and traveler information to Port-of-Entry	Planned

3. CDOT Permitting

Implementation:	Status
Link the permitting system to the traveler information system including closure and weather information, travel and weight restrictions	Planned
Management:	Status
Coordinate with CDOR to include annual and one-trip permitting information in the PrePass program	Planned
Continue to work on an automated routing program for permitting	Planned
Support the development of a plan to upgrade and integrate business systems	Planned

4. CDOT Region 4

Implementation:	Status
Assist in the deployment of Port-of-Entry bypass system elements	Existing
Deploy commercial vehicle operations safety systems – pull out areas	Planned
Maintenance:	Status
Maintain commercial vehicle operations safety systems	Planned
Management:	Status
Coordinate with CSP regarding safety issues determined by safety systems	Planned
Operations:	Status
Monitor status of safety systems	Planned

5. Colorado Dept. of Public Health and Environment (CDPHE)

Management:	Status
Develop system to share HAZMAT travel information with public safety, port operations, traffic operations, and other entities that may benefit from the information	Planned
Operations:	Status
Issue Permits for HAZMAT travel	Existing

6. Public Safety

Operations:	Status
Perform motor carrier safety inspections	Existing

7. Trucking Companies

Implementation:	Status
Install port-of-entry bypass system elements on commercial vehicles	Existing
Install other safety-related electronic equipment as required by CSP	Planned
Maintenance:	Status
Maintain equipment on commercial vehicles	Existing
Operations:	Status
Maintain appropriate credentialing information	Existing

V. AGREEMENTS

The operational concept in the previous section identified the agencies notes and responsibilities within Purchased areas for each TSA. In order to fully accomplish the operational concept, formal agreements are necessary to define the roles and responsibilities of the agencies involved including such items as performance requirements, funding arrangements, data sharing arrangements, etc. This section discusses existing, planned and potential agreements within each TSA.

Regional Traveler Information: The Federal Communications Commission (FCC) has designated 511 as the nationwide telephone number for traveler information. CDOT implemented a statewide 511 phone access information system and website (www.cotrip.org) over a decade. CDOT ITS has formal agreements with several local wireless communications companies to provide 511 related telephony services statewide. In general, for regional traveler information, there are some informal agreements in place between local jurisdictions to share information within the Region. CDOT ITS also has many formal agreements to exchange video images and website information with private information providers and news media organizations. As local agencies deploy additional ITS elements within their jurisdictions and centralize operations by building dedicated TMC facilities, additional information sharing agreements will need to be formalized with CDOT. Agreements between NFRMPO and transit agencies will be needed to support multi-modal traveler information needs within the Region. CDOT, Town of Estes Park and RMNP need to finalize traveler information needs and develop an agreement to support traveler information to out-of-town visitors.

Regional Operations and Management: As the network of ITS implementations grow along each of the highway corridors and across the Region, many agencies will be responsible for operation and maintenance of additional ITS devices such as traffic signals, vehicle detectors, CCTV cameras, DMS and Road Weather Information Systems (RWIS) stations. Agreements that detail ownership, performance or level-of-service requirements, priorities for shared operation, roles and responsibilities regarding maintenance and other operations and liability will be necessary to share current and future ITS implementations.

There is no significant need currently for center-to-center coordination between local agencies. However, in order to implement center-to-center coordination, formal agreements between the agencies with control centers would need to be developed to define a plan for compliance with the NTCIP standards for center-to-center communications. The CTMC is involved in a number of such agreements, which may serve as the basis for agreements in CDOT Region 4.

Regional Traffic Incident Management: No formal agreements are currently in place for cooperation on incident response plans for major freeways in CDOT Region 4. I-25 and US-36 have Traffic Incident Management Plans. These Plans define the roles of key agencies in responding to incidents along the freeways based on the incident location and severity. With the implementation of on-call courtesy patrol on I-25, there will be need for an agreement between CDOT and CSP regarding operational responsibilities. The sharing of ITS devices can be critical as some local incidents have Region-wide effects. Agreements should be considered to address device availability as well as the means by which control conflicts (i.e. competing messages on a DMS) can be resolved.

Regional Transit Operations and Management: The major transit agencies within CDOT Region 4 should coordinate with each other on new deployment of ITS. No agreements are anticipated at this time.

In the future, there may be opportunities for agreements with other regional stakeholders (i.e. traffic management agencies) on infrastructure and information sharing or multi-modal coordination.

Maintenance and Construction: The agencies within CDOT Region 4 have a great desire to improve the availability of information to assist the public in transportation decisions and to facilitate efficient application of maintenance resources. Of specific interest is weather station information and access to MDSS system, but the agreements for sharing other traveler information follow the same concept. Agreements will need to be developed that define maintenance responsibilities and the means and format by which information will be shared, and coordination of existing and future information sources. The agreements should also detail how it will be distributed to the public. In the future, formal agreements should address access to communications infrastructure, franchise agreements and responsibilities for maintenance to field elements.

Regional Parking Management: CDOT, Town of Estes Park and RMNP should coordinate and work together to determine traveler information needs in the area. Based upon the needs and agreed upon ITS implementations, there may be a need for agreements between the agencies.

Regional Data Management: The basis for data sharing in the Region is a regional communications backbone. As the communication networks in CDOT Region 4 grow, there will be additional opportunities for sharing of communications infrastructure and information. The purpose of the agreements is to define the ownership, standards, responsibilities for maintenance, and repair of networks. Provision in these agreements should be made to accommodate new participants as the network grows. In the Denver Region, CDOT ITS currently has many agreements in place to integrate communications infrastructure and share fiber capacity.

Regional Emergency Management: No formal agreements have been identified. Future coordination between the public safety community and the transportation community may require mutual agreements (as are common in the public safety community).

Commercial Vehicle Operations: The Colorado Department of Revenue (DOR) is primarily responsible for Commercial Vehicle operation of the State's Ports of Entry. Agreements between CDOR and CDOT and the PrePass electronic screening equipment vendor exist. Current agreements define operational guidelines, responsibilities for maintenance, and conditions relevant to access and handling of data. Additional agreements between CDOT and CDOR to enhance information and infrastructure sharing and coordination will be needed to improve efficiency and expand services as CDOR's IT capabilities and technology are improved.

VI. FUNCTIONAL REQUIREMENTS

The definition of functional requirements is a mandatory component of a regional ITS architecture as identified in the FHWA/FTA rules and policies. Functional requirements identify the tasks or activities that are, or will be, performed by each system or subsystem in the region. Detailed functional requirements are generally best left to project architectures or individual project designs. At the regional architecture level, these functional requirements are high-level descriptions of the tasks derived from the operational concept. In the context of the National ITS Architecture, functional requirements can be stated in terms of Equipment Packages and implementable groupings of processes within a given subsystem. Equipment Packages are the building blocks of the physical architecture subsystems and group similar processes of a particular subsystem together into an “implementable” package.

The major physical entities in the Region 4 ITS Architecture and the Equipment Packages that define the functional requirements are identified in Table 8.

Table 8: Equipment Packages By Entities

Equipment Packages	CDOT ITS Branch	Colorado Transportation Management Center	CDOT Region 4 Traffic Operations	CDOT Region 4 Maintenance	CDOT Maintenance Vehicles	CDOT Roadside Devices	NFRMPO	Denver Regional Council of Governments	Greeley, Fort Collins & Loveland TMC	CSP, City & County Emergency Operations Center (EMC)	Transfort, GET & COLT
Collect Traffic Surveillance		X							X		
Emergency Call-Taking										X	
Emergency Data Collection										X	
Emergency Dispatch										X	
Emergency Early Warning System										X	
Emergency Evacuation Support										X	
Emergency Response Management										X	
Government Reporting System Support	X										
Incident Command										X	
Infrastructure Provided Dynamic Ridesharing							X		X		
Infrastructure Provided Trip Planning							X				
ISP Data Collection		X						X			

Equipment Packages	CDOT ITS Branch	Colorado Transportation Management Center	CDOT Region 4 Traffic Operations	CDOT Region 4 Maintenance	CDOT Maintenance Vehicles	CDOT Roadside Devices	NFRMPO	Denver Regional Council of Governments	Greeley, Fort Collins & Loveland TMC	CSP, City & County Emergency Operations Center (EMC)	Transport, GET & COLT
ISP Emergency Traveler Information		X									
ISP Traveler Data Collection		X						X			
ITS Data Repository		X						X			
MCM Automated Treatment System Control				X							
MCM Data Collection				X							
MCM Environmental Information Collection				X							
MCM Incident Management				X							
MCM Vehicle & Equipment Maintenance Management				X							
MCM Vehicle Tracking				X							
MCM Work Activity Coordination		X		X					X		
MCM Work Zone Management				X							
MCV Environmental Monitoring					X						
MCV Vehicle Location Tracking					X						
On-board Transit Signal Priority											X

Equipment Packages	CDOT ITS Branch	Colorado Transportation Management Center	CDOT Region 4 Traffic Operations	CDOT Region 4 Maintenance	CDOT Maintenance Vehicles	CDOT Roadside Devices	NFRMPO	Denver Regional Council of Governments	Greeley, Fort Collins & Loveland TMC	CSP, City & County Emergency Operations Center (EMC)	Transport, GET & COLT
Roadway Basic Surveillance						X			X		
Roadway Data Collection						X			X		
Roadway Equipment Coordination						X			X		
Roadway Freeway Control						X					
Roadway Signal Controls						X			X		
Roadway Speed Monitoring						X					
Roadway Traffic Information Dissemination						X					
Standard Railroad Crossing			X								
TMC Environmental Monitoring		X							X		
TMC Evacuation Support		X							X		
TMC Freeway Management		X									
TMC Incident Detection		X							X		
TMC Incident Dispatch Coordination/Communication		X							X		
TMC Multimodal Coordination									X		
TMC Regional Traffic			X						X		



CDOT Region 4 ITS Architecture

Equipment Packages	CDOT ITS Branch	Colorado Transportation Management Center	CDOT Region 4 Traffic Operations	CDOT Region 4 Maintenance	CDOT Maintenance Vehicles	CDOT Roadside Devices	NFRMPO	Denver Regional Council of Governments	Greeley, Fort Collins & Loveland TMC	CSP, City & County Emergency Operations Center (EMC)	Transfort, GET & COLT
Management											
TMC Signal Control			X						X		
TMC Speed Monitoring		X							X		
TMC Traffic Information Dissemination		X							X		
TMC Work Zone Traffic Management			X								
Traffic & Roadside Data Archival	X										
Traffic Data Collection		X						X	X		
Traffic Maintenance		X							X		
Transit Center Fixed-Route Operation											X
Transit Center Information Services											X
Transit Center Multimodal Coordination											X
Transit Center Vehicle Tracking											X
Transit Data Collection											X

Equipment Packages	CDOT ITS Branch	Colorado Transportation Management Center	CDOT Region 4 Traffic Operations	CDOT Region 4 Maintenance	CDOT Maintenance Vehicles	CDOT Roadside Devices	NFRMPO	Denver Regional Council of Governments	Greeley, Fort Collins & Loveland TMC	CSP, City & County Emergency Operations Center (EMC)	Transport, GET & COLT
Transit Environmental Monitoring											X
Transit Evacuation Support											X
Traveler Telephone Information		X									

The following equipment packages were selected for CDOT Region 4:

- **Collect Traffic Surveillance-** This equipment package remotely monitors and controls traffic sensors and surveillance (e.g., CCTV) equipment, and collects, processes and stores the collected traffic data. Current traffic information and other real-time transportation information are also collected from other centers. The collected information is provided to traffic operations personnel and made available to other centers.
- **Emergency Call-Taking-**This equipment package supports the emergency call-taker, collecting available information about the caller and the reported emergency, and forwarding this information to other equipment packages that formulate and manage the emergency response. This equipment package receives 9-1-1, 7-digit local access, and motorist call-box calls and interfaces to other agencies to assist in the verification and assessment of the emergency and to forward the emergency information to the appropriate response agency.
- **Emergency Data Collection-**This equipment package collects and stores emergency information that is collected in the course of operations by the Emergency Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.
- **Emergency Dispatch-**This equipment package tracks the location and status of emergency vehicles and dispatches these vehicles to incidents. Pertinent incident information is gathered from the public and other public safety agencies (see the Emergency Call-Taking equipment package) and relayed to the responding units. Incident status and the status of the responding units are tracked so that additional units can be dispatched and/or unit status can be returned to available when the incident is cleared and closed.
- **Emergency Early Warning System-**This equipment package monitors alerting and advisory systems, information collected by ITS surveillance and sensors, and reports from other agencies and uses this information to identify potential, imminent, or inprogress major incidents or disasters. Notification is provided to other equipment packages that provide the emergency response, including public notification using ITS traveler information systems, where appropriate.
- **Emergency Evacuation Support-**This equipment package coordinates evacuation plans among allied agencies and manages evacuation and reentry of a population in the vicinity of a disaster or other emergency that poses a risk to public safety. Where appropriate, the affected population is evacuated in shifts, using more than one evacuation route, and including several evacuation destinations to spread demand and thereby expedite the evacuation. All affected jurisdictions (e.g., states and counties) at the evacuation origin, evacuation destination, and along the evacuation route are informed of the plan. The public is provided with real-time evacuation guidance including basic information to assist potential evacuees in determining whether evacuation is necessary. Resource requirements are forecast based on the evacuation plans and the necessary resources are located, shared between agencies if necessary, and deployed at the right locations at the appropriate times. The evacuation and reentry status are monitored and used to refine the plan and resource allocations during the evacuation and subsequent reentry. This equipment package communicates with public health systems to develop evacuation plans and recommended strategies for disasters and evacuation scenarios involving biological or other medical hazards.
- **Emergency Response Management-**This equipment package provides the strategic emergency response capabilities and broad inter-agency interfaces that are implemented for extraordinary incidents and disasters that require response from outside the local community. It provides the

functional capabilities and interfaces commonly associated with Emergency Operations Centers. This equipment package develops and stores emergency response plans and manages overall coordinated response to emergencies. It monitors real-time information on the state of the regional transportation system including current traffic and road conditions, weather conditions, special event and incident information. It tracks the availability of resources and assists in the appropriate allocation of these resources for a particular emergency response. This equipment package provides coordination between multiple allied agencies before and during emergencies to implement emergency response plans and track progress through the incident. It also coordinates with the public through the Emergency Telecommunication Systems (e.g., Reverse 911). This equipment package coordinates with public health systems to provide the most appropriate response for emergencies involving biological or other medical hazards.

- **Government Reporting System Support** - This equipment package selects and formats data residing in an ITS archive to facilitate local, state, and federal government data reporting requirements.
- **Incident Command**-The equipment package provides tactical decision support, resource coordination, and communications integration for Incident Commands that are Establish by first responders at or near the incident scene to support local management of an incident. The equipment package supports communications with public safety, emergency management, transportation, and other allied response agency centers, tracks and maintains resource information, action plans, and the incident command organization itself. Information is shared with agency centers including resource deployment status, hazardous material information, traffic, road, and weather conditions, evacuation advice, and other information that enables emergency or maintenance personnel in the field to implement an effective, safe incident response. This equipment package supports the functions and interfaces commonly supported by a mobile command center.
- **Infrastructure Provided Dynamic Ridesharing** - This equipment package provides dynamic rideshare matches for eligible travelers, connecting riders and drivers for specific trips based on preferences. This ridesharing/ride matching capability also arranges connections to transit or other multimodal services for portions of a multi-segment trip that includes ridesharing. Reservations and advanced payment are also supported so that each segment of the trip may be confirmed.
- **Infrastructure Provided Trip Planning** -This equipment package provides pre-trip and en-route trip planning services for travelers. It receives origin, destination, constraints, and preferences and returns trip plan(s) that meet the supplied criteria. Trip plans may be based on current traffic and road conditions, transit schedule information, and other real-time traveler information. Candidate trip plans are multimodal and may include vehicle, transit, and alternate mode segments (e.g., rail, ferry, bicycle routes, and walkways) based on traveler preferences. This equipment package also confirms the trip plan for the traveler and supports reservations and advanced payment for portions of the trip. The trip plan includes specific routing information and instructions for each segment of the trip and may also include information and reservations for additional services (e.g., parking) along the route.
- **ISP Data Collection**- This equipment package collects and stores traveler information that is collected in the course of operation of the ISP subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.
- **ISP Emergency Traveler Information**-This equipment package provides emergency information to the public, including wide-area alerts and evacuation information. It provides

emergency alerts, information on evacuation zones and evacuation requirements, evacuation destinations and shelter information, available transportation modes, and traffic and road conditions at the origin, destination, and along the evacuation routes. In addition to general evacuation information, personalized information including tailored evacuation routes, service information, and estimated travel times is also provided based on traveler specified origin, destination, and route parameters. Updated information is provided throughout the evacuation and subsequent reentry as status changes and plans are adapted.

- **ISP Traveler Data Collection-** This equipment package collects traveler-related data from other centers, consolidates, verifies, and refines the collected data, and makes this data available in a consistent format to applications that deliver traveler information. A broad range of traveler-related data is collected including traffic and road conditions, transit data, emergency information and advisories, weather data, special event information, traveler services, parking, multimodal data, and toll/pricing data. This equipment package also shares data with other information service providers.
- **ITS Data Repository-**This equipment package collects data and data catalogs from one or more data sources and stores the data in a focused repository that is suited to a particular set of ITS data users. This equipment package includes capabilities for performing quality checks on the incoming data, error notification, and archive to archive coordination. This equipment package supports a broad range of implementations, ranging from simple data marts that collect a focused set of data and serve a particular user community to large-scale data warehouses that collect, integrate, and summarize transportation data from multiple sources and serve a broad array of users within a region.
- **MCM Automated Treatment System Control-**This equipment package remotely monitors and controls automated road treatment systems that disperse anti-icing chemicals or otherwise treat a road segment. The automated treatment system may be remotely activated by this equipment package or it may include environmental sensors that activate the system automatically based on sensed environmental conditions. This equipment package monitors treatment system operation, sets operating parameters, and directly controls system activation if necessary.
- **MCM Data Collection-**This equipment package collects and stores maintenance and construction information that is collected in the course of operations by the Maintenance and Construction Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.
- **MCM Environmental Information Collection-**This equipment package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. In addition to fixed sensor stations at the roadside, this equipment package also collects environmental information from sensor systems located on Maintenance and Construction Vehicles as well as the broader population of vehicle probes. It also collects current and forecast environmental conditions information that is made available by other systems. The equipment package aggregates the sensor system data and provides it, along with data attributes to meteorological systems.
- **MCM Incident Management-**This equipment package supports maintenance and construction participation in coordinated incident response. Incident notifications are shared, incident response resources are managed, and the overall incident situation and incident response status is coordinated among allied response organizations.

- **MCM Vehicle and Equipment Maintenance Management**-This equipment package monitors vehicle and equipment condition, tracks maintenance history, and schedules routine and corrective maintenance based on vehicle utilization and availability schedules.
- **MCM Vehicle Tracking**-This equipment package tracks the location of maintenance and construction vehicles and other equipment. Vehicle location and associated information is presented to the operator.
- **MCM Work Activity Coordination** -This equipment package disseminates work activity schedules and current asset restrictions to other agencies. Work schedules are coordinated with operating agencies, factoring in the needs and activities of other agencies and adjacent jurisdictions. Work schedules are also distributed to Information Service Providers for dissemination to the traveling public.
- **MCM Work Zone Management**-This equipment package remotely monitors and supports work zone activities, controlling traffic through dynamic message signs (DMS), Highway Advisory Radio (HAR), gates and barriers, and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds, and delays, and closures are provided to the motorist prior to the work zones. This equipment package provides control of field equipment in all maintenance areas, including fixed and portable field equipment supporting both stationary and mobile work zones.
- **MCV Environmental Monitoring**-This on-board equipment package collects current road and surface weather conditions from sensors on-board the maintenance and construction vehicle or by querying fixed sensors on or near the roadway. Environmental information including road surface temperature, air temperature, and wind speed is measured and spatially located and time stamped, and reported back to a center.
- **MCV Vehicle Location Tracking**-This on-board equipment package tracks vehicle location and reports the position and timestamp information to a dispatch center.
- **On-board Transit Signal Priority**-This on-board equipment package provides the capability for transit vehicles to request signal priority at signalized intersections, ramps, and interchanges through short range communication directly with traffic control equipment at the roadside.
- **Roadway Basic Surveillance**-This equipment package monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
- **Roadway Data Collection**-This equipment package collects traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications where data quality and completeness take precedence over real-time performance. This equipment package includes the sensors, supporting roadside infrastructure, and communications equipment that collects and transfers information to a center for archival.
- **Roadway Equipment Coordination**-This equipment package supports direct communications between field equipment. It includes field elements that control and send data to other field elements. This includes coordination between remote sensors and field devices (e.g., Dynamic Message Signs) and coordination between the field devices themselves (e.g., direct coordination between traffic controllers that are controlling adjacent intersections.).
- **Roadway Freeway Control**-This equipment package includes the field equipment used to control traffic on freeways including ramp meters, interchange connector meters, mainline meters, and lane control signals.

- **Roadway Signal Controls**-This equipment package includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, signal heads, detectors, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. This equipment package represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians.
- **Roadway Speed Monitoring**-This equipment package includes the field elements that monitor vehicle speeds. If the speed is determined to be excessive, then roadside equipment can suggest a safe driving speed. Environmental conditions may be monitored and factored into the safe speed advisories that are provided to the motorist. The operational status (state of the device, configuration, and fault data) is provided to the center. This equipment package can also provide an enforcement function, reporting speed violations to an enforcement agency.
- **Roadway Traffic Information Dissemination**-This equipment package includes field elements that provide information to drivers, including dynamic message signs and highway advisory radio.
- **Standard Railroad Crossing**-This equipment package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Either passive (e.g., the cross buck sign) or active warning systems (e.g., flashing lights and gates) are supported depending on the specific requirements for each intersection. These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification of an approaching train by interfaced wayside equipment. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported through interfaces to the wayside interface equipment and the traffic management subsystem.
- **TMC Environmental Monitoring**- This equipment package assimilates current and forecast road conditions and surface weather information using a combination of weather service provider information, information collected by other centers such as the Maintenance and Construction Management Subsystem, and data collected from environmental sensors deployed on and about the roadway. The collected environmental information is monitored and presented to the operator. This information can be used to issue general traveler advisories and support location specific warnings to drivers. Other equipment packages process the collected information and provide decision support.
- **TMC Evacuation Support**- This equipment package supports development, coordination, and execution of special traffic management strategies during evacuation and subsequent reentry of a population in the vicinity of a disaster or major emergency. A traffic management strategy is developed based on anticipated demand, the capacity of the road network including access to and from the evacuation routes, and existing and forecast conditions. The strategy supports efficient evacuation and also protects and optimizes movement of response vehicles and other resources that are responding to the emergency. This equipment package coordinates the evacuation with the Traffic Management Subsystem (representing centers in other affected jurisdictions) and the Emergency Management Subsystem.

- **TMC Freeway Management-** This equipment package provides center monitoring and control of freeway traffic control systems including ramp control, interchange control, and mainline lane control systems. Approaches covered include ramp metering, interchange connector metering, overhead lane control signals, freeway mainline metering, and variable speed control systems.
- **TMC Incident Detection-** This equipment package identifies and reports incidents to Traffic Operations Personnel. It remotely monitors and controls traffic sensor and surveillance systems that support incident detection and verification. It analyzes and reduces the collected sensor and surveillance data, external alerting and advisory and incident reporting systems, anticipated demand information from intermodal freight depots, border crossings, special event information, and identifies and reports incidents and hazardous conditions.
- **TMC Incident Dispatch Coordination/Communication-** This equipment package formulates and manages an incident response that takes into account the incident potential, incident impacts, and/or resources required for incident management including proposing and facilitating the dispatch of emergency response and service vehicles as well as coordinating response with all appropriate cooperating agencies.
- **TMC Multimodal Coordination-** This equipment package supports center-to-center coordination between the Traffic Management and Transit Management Subsystems. It monitors transit operations and provides traffic signal priority for transit vehicles on request from the Transit Management Subsystem.
- **TMC Regional Traffic Management-** This equipment package supports coordination between traffic management centers in order to share traffic information between centers as well as control of traffic management field equipment. This coordination supports wide area optimization and regional coordination that spans jurisdictional boundaries; for example, coordinated signal control in a metropolitan area or coordination between freeway operations and arterial signal control within a corridor.
- **TMC Signal Control-** This equipment package provides the capability for traffic managers to monitor and manage the traffic flow at signalized intersections. This capability includes analyzing and reducing the collected data from traffic surveillance equipment and developing and implementing control plans for signalized intersections. Control plans may be developed and implemented that coordinate signals at many intersections under the domain of a single traffic management subsystem and are responsive to traffic conditions and adapt to support incidents, preemption and priority requests, pedestrian crossing calls, etc.
- **TMC Speed Monitoring-** This equipment package remotely monitors and controls speed monitoring and speed warning systems. It remotely monitors vehicle speeds and presents this information to traffic operations personnel. It configures and controls the speed monitoring and warning equipment that provides safe speed advisories to the motorist. This equipment package can also notify an enforcement agency if excessive speeds are identified.
- **TMC Traffic Information Dissemination-** This equipment package disseminates traffic and road conditions, closure and detour information, incident information, driver advisories, and other traffic-related data to other centers, the media, and driver information systems. It monitors and controls driver information system field equipment including dynamic message signs and highway advisory radio, managing dissemination of driver information through these systems.
- **TMC Work Zone Traffic Management-** This equipment package coordinates work plans with maintenance systems so that work zones are established that have minimum traffic impact. Traffic control strategies are implemented to further mitigate traffic impacts associated with work

zones that are established, providing work zone information on driver information systems such as dynamic message signs.

- **Traffic and Roadside Data Archival-** This equipment package collects and archives traffic, roadway, and environmental information for use in off-line planning, research, and analysis. The equipment package controls and collects information directly from equipment at the roadside, reflecting the deployment of traffic detectors that are used primarily for traffic monitoring and planning purposes rather than for traffic management.
- **Traffic Data Collection-** This equipment package collects and stores traffic information that is collected in the course of traffic operations performed by the Traffic Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.
- **Traffic Maintenance-** This equipment package monitors the operational status of field equipment and detects failures. It presents field equipment status to Traffic Operations Personnel and reports failures to the Maintenance and Construction Management Subsystem. The equipment package tracks the repair or replacement of the failed equipment. The entire range of ITS field equipment may be monitored by this equipment package including sensors (traffic, infrastructure, environmental, security, speed, etc.) and devices (highway advisory radio, dynamic message signs, automated roadway treatment systems, barrier and safeguard systems, cameras, traffic signals and override equipment, ramp meters, beacons, security surveillance equipment, etc.).
- **Transit Center Fixed-Route Operation-**This equipment package manages fixed route transit operations. It supports creation of schedules, blocks and runs for fixed and flexible route transit services. The package allows fixed-route and flexible-route transit services to disseminate schedules and automatically updates customer service operator systems with the most current schedule information. This equipment package also supports automated dispatch of transit vehicles. Current vehicle schedule adherence and optimum scenarios for schedule adjustment are also provided. This equipment package also receives and processes transit vehicle loading data.
- **Transit Center Information Services-**This equipment package collects the latest available information for a transit service and makes it available to transit customers and to Information Service Providers for further distribution. Customers are provided information at transit stops and other public transportation areas before they embark and on-board the transit vehicle once they are enroute. Information provided can include the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents, weather conditions, yellow pages, and special events. In addition to general service information, tailored information (e.g., itineraries) is provided to individual transit users.
- **Transit Center Multimodal Coordination-**The equipment package supports transit service coordination between transit properties and coordinates with other surface and air transportation modes. As part of service coordination, this equipment package shares schedule and trip information, as well as transit transfer cluster (a collection of stop points, stations, or terminals where transfers can be made conveniently) and transfer point information between Multimodal Transportation Service Providers, Transit Agencies, and ISPs. An interface to Traffic Management also supports travel demand management strategies.
- **Transit Center Vehicle Tracking-**This equipment package monitors transit vehicle location. The location information is collected via a data communication link between the transit vehicles and the transit center. The location information is presented to the transit operator on a digitized map of the transit service area. The location data may be used to determine real time schedule

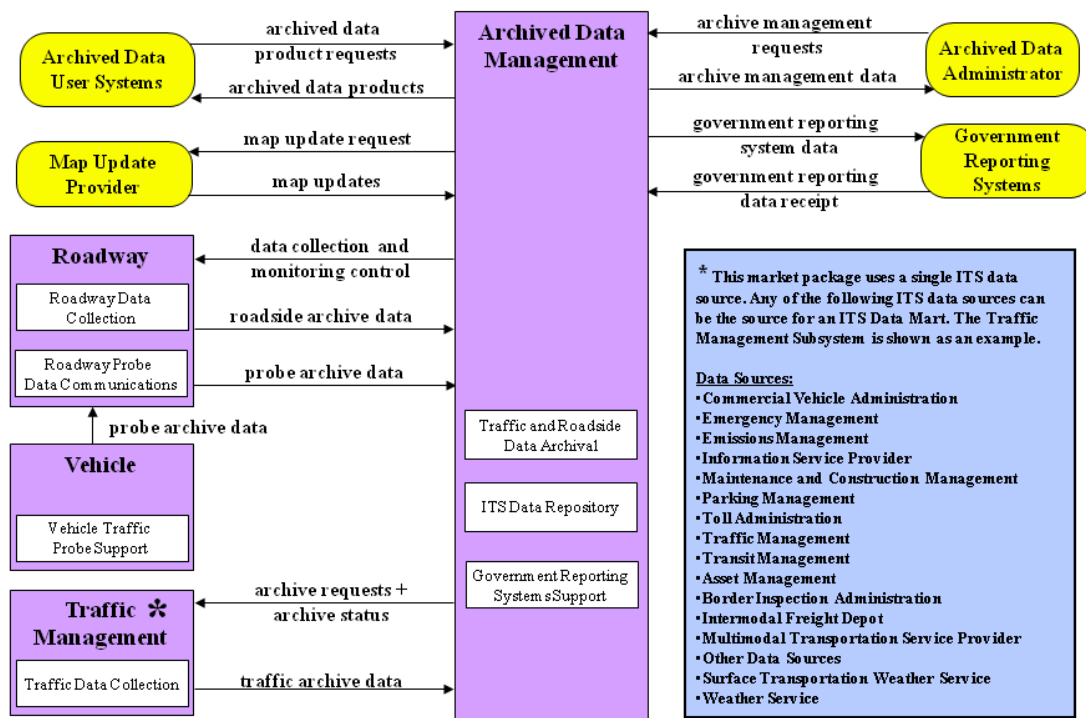
adherence and update the transit system's schedule in real-time. The real-time schedule information is provided to Information Service Providers and the Transit Center Information Services equipment package, which furnish the information to travelers.

- **Transit Data Collection**-This equipment package collects and stores transit information that is collected in the course of transit operations performed by the Transit Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region.
- **Transit Environmental Monitoring**-This equipment package assimilates current and forecast road conditions and surface weather information from a variety of sources, including both weather service providers and vehicle probes. The collected environmental information is monitored and forwarded to other agencies to more effectively manage transit operations.
- **Transit Evacuation Support**-This equipment package manages transit resources to support evacuation and subsequent reentry of a population in the vicinity of a disaster or other emergency. It supports coordination of regional evacuation plans, identifying the transit role in a regional evacuation and identifying transit resources that would be used. During an evacuation, this equipment package coordinates the use of transit and school bus fleets, supporting evacuation of those with special needs and the general population. Transit service and fare schedules are adjusted and updated service and fare information is made available through traveler information systems. This equipment package coordinates the functions in other Transit equipment packages to support these requirements.
- **Traveler Telephone Information**- This equipment package services voice-based traveler requests for information that supports traveler telephone information systems like 511. The equipment package takes requests for traveler information, which could be voice-formatted traveler requests, dual-tone multi-frequency (DTMF)-based requests, or a simple traveler information request, and returns the requested traveler information in the proper format. In addition to servicing requests for traveler information, this equipment package also collects and forwards alerts and advisories to traveler telephone information systems.

VII. INTERFACE REQUIREMENTS

The Federal Rule requires that interface requirements and information exchanges be addressed within the context of a regional architecture. The National ITS Architecture defines information exchange or flow and architecture flow as terms that are used interchangeably regarding information that is exchanged between subsystems and terminators in the physical view of the National ITS Architecture. The architecture flows are the primary tool that is used to define the regional ITS architecture interfaces. It would be impractical to show every relevant interface requirement and architecture flow in this Region 4 ITS Architecture associated with each agency's respective identified Market Packages and Equipment Packages; however, they are available in the Turbo Architecture software package. As an example, Figure 3 illustrates the interface requirements and data flows for the Market Package ITS Data Mart (AD1) and associated Equipment Packages. The Turbo Architecture database for CDOT Region 4 is available at <http://www.cotrip.org/its/arch.htm>.

Figure 3: ITS Data Mart Architecture Flow Chart
AD1 - ITS Data Mart



VIII. ITS STANDARDS

ITS Standards facilitate interoperability and integration of ITS devices and systems

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

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

In addition, the federal regulations require that ITS projects funded with federal funds must use USDOT federally-adopted ITS standards:

“All ITS projects funded with highway trust funds shall use applicable ITS standards and interoperability tests that have been officially adopted through rulemaking by the DOT.”

To date, none of the ITS standards have been adopted by the USDOT, but it behooves the Region to prepare for that action. This does not, however, suggest that the Region will immediately migrate to all available standards, only that the region understand the impact of adoption of standards within the deployment cycle for an ITS system. For example, choosing to use a standard related to systems not yet deployed will potentially be less of an impact than for systems that are already deployed with equipment and communications that do not conform to the standard.

The ITS standards govern communications between the interfaces listed in Table 9 and between various ITS subsystems as defined in the National ITS Architecture. The ITS standards are grouped into 21 application areas of which only two (Rail Coordination and Lighting Management) are not applicable in the Region 4 ITS Architecture.

Table 9: Standards Application Areas Table

National ITS Architecture Interface Class	Standards Application Areas
<p>Center to Center – This class of application areas includes interfaces between transportation management centers.</p>	<p>Data Archival Incident Management Rail Coordination Traffic Management Transit Management Traveler Information</p>

National ITS Architecture Interface Class	Standards Application Areas
<p>Center to Field – This class of application areas includes interfaces between a management center and its field equipment (e.g., traffic monitoring, traffic control, environmental monitoring, driver information, security monitoring, and lighting control).</p>	<p>Data Collection/Monitoring Dynamic Message Signs Environmental Monitoring Lighting Management Ramp Metering Traffic Signals Vehicle Sensors Video Surveillance</p>
<p>Center to Vehicle/Traveler – This class of application areas includes interfaces between a center and the devices used by drivers or travelers. It includes interfaces with motorists and travelers for exchange of traveler and emergency information as well as interfaces between management centers and fleet vehicles to support vehicle fleet management.</p>	<p>Mayday Transit Vehicle Communications Traveler Information</p>
<p>Field to Field – This class of application areas includes interfaces between field equipment, such as between wayside equipment and signal equipment at a highway rail intersection.</p>	<p>Highway Rail Intersection (HRI)</p>
<p>Field to Vehicle – This class of application areas includes wireless communication interfaces between field equipment and vehicles on the road.</p>	<p>Probe Surveillance Signal Priority Toll/Fee Collection</p>

Several of the data flows between subsystems identified in the National ITS Architecture are associated with appropriate ITS standards. For example, the DMS sign controller software developed for CDOT is compliant with the standard “National Transportation Communications for ITS Protocol (NTCIP) 1203 – Object Definitions for Dynamic Message Signs”. Use of this standard enables one software driver to communicate with NTCIP-compliant DMS signs from different vendors.

In Table 10, candidate standards, or standards that may be applicable to this Region 4 ITS Architecture have been identified. The Table also lists candidate standards that have been identified in the *Colorado ITS Standards Plan – Statewide (Version 0.1)* as standards adopted for use by the state that will impact CDOT Region 4 directly. The standards currently in use are also identified. Finally, a priority is assigned to each of the candidate standards. The priority indicates the level of consideration to be applied to the standard during ITS project development in the region. The priority ranking was developed based on the following general guidance:

H – High

- highest strategic priority for subsystem interconnection related to standard
- communications link does not yet exist and no standards in the region have been established, which is an opportunity to consider the standard for use before development begins
- involves interagency communications

M – Medium

- not the highest strategic priority for subsystem interconnection related to standard
- a (non-conforming) standard may already be established in the region
- involves interagency communications

L – Low

- lowest strategic priority for subsystem interconnection related to standard
- a (non-conforming) standard may already be established in the region
- does not involve interagency communications

N/A – Not Applicable

- standard not applicable to this architecture at this time

The regional stakeholders will carry forward ITS deployment while tracking the status of the candidate standards. When potentially applicable to an ITS project, stakeholders will evaluate the feasibility and suitability of adopting use of the standards. This is the initial step in an on-going process to identify and adopt ITS standards. The next complete update of the architecture will further define the process in a specific standards plan that will identify:

- An assessment of current standards use – this will be an inventory of the use of each standard both in the region and statewide.
- An assessment of the potential standards use – this will be an assessment of the applicability of each standard to the architecture. Also, it will include an assessment of the “maturity” of the standard. Maturity will be defined by factors such as the level of adoption by vendors and other users, standard testing results, pending adoption by the USDOT, and the stability of the Version of the standard (i.e. are significant amendments anticipated?)
- A migration strategy – the migration strategy will define the new standards that will be adopted and deployed and it will define the transition plan to new standards for existing system; Several factors will be considered in the development of the migration strategy, including: migration strategy of standards at the state level, standard maturity, cost implications of standard adoption (or not adopting), and project sequencing.

Table 10: CDOT Region 4 Candidate ITS Standards

Standard	Status	Ver.	Title	In Use State Region	Candidate State Region	Priority
ANSI TS284	Published	1.0	Commercial Vehicle Safety Reports		X	L
ANSI TS285	Published	1.0	Commercial Vehicle Safety and Credentials Information Exchange		X	L
ANSI TS286	Published	1.0	Commercial Vehicle Credentials		X	L
APTA TCIP-S-001 3.0.0	Published	1.0	Standard for Transit Communications Interface Profiles		X	L
ASTM E2213-03	Published	2.0	Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems - 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications			N/A
ASTM E2259-03	Published	1.0	Standard Guide for Archiving and Retrieving ITSGenerated Data		X	M
ASTM E2468-05	Published	1.0	Standard Practice for Metadata to Support Archived Data Management Systems		X	M
ASTM E2265-C8	Published	1.0	Standard Specifications for Archiving ITS Generated Traffic Monitoring Data		X	M
EIA 794	Published	1.0	Data Radio Channel (DARC) System			N/A
EIA 795	Published	1.0	Subcarrier Traffic Information Channel (STIC) System			N/A
IEEE 1455-1999	Published	1.0	Standard for Message Sets for Vehicle/Roadside Communications		X	M
IEEE 1512 - 2006	Published	2.0	Standard for Common Incident Management Message Sets for use by Emergency Management Centers		X X	H
IEEE	Published	1.0	The Survey and Analysis of Existing Standards		X	N/A



CDOT Region 4 ITS Architecture

Standard	Status	Ver.	Title	In Use State Region	Candidate State Region	Priority
SH94633- SH94638			and those Under Development Applicable to the Needs of the Intelligent Transportation System (ITS) Short Range and Wide Area Wireless and Wireline Technologies			
ITE ATC PI	Published	2.0	Application Programming Interface (API) Standard for the Advanced Transportation Controller (ATC)		X	L
ITE ATC Controller 5.2	Published	1.0	Advanced Transportation Controller (ATC)		X	L
ITE ATC Type 2070	Approved Development	1.0 2.0	Advanced Transportation Controller (ATC) Standard Specification for the Type 2070 Controller		X	L
ITE ITS Cabinet	Published Development	1.0 2.0	ITS Standard Specification for Roadside Cabinets		X	L
ITE TM 1.03	Approved Development	1.0 1.1	Standard for Functional Level Traffic Management Data Dictionary (TMDD)	X	X	H
ITE TM 2.01	Approved	1.0	Message Sets for External TMC Communication (MS/ETMCC)	X	X	H
ITE TMDD 2.1	Published	2.0	Traffic Management Data Dictionary and Message Sets for External TMC Communication (TMDD and MS/ETMCC)		X X	H
ITE TMDD Guide	Published	2.1	TMDD & MS/ETMCC Guide Standard for Functional Level Traffic Management Data Dictionary (TMDD) and Message Sets for External Traffic Management Center Communications			N/A
NTCIP 1101	Published	1.1	Simple Transportation Management Framework (STMF)		X X	H
NTCIP 1102	Published	1.0	Octet Encoding Rules (OER) Base Protocol		X X	H
NTCIP 1103	Approved Development	1.0 2.0	Transportation Management Protocols (TMP)	X	X	H
NTCIP 1104	Published	1.0	Center-to-Center Naming Convention		X X	H

Standard	Status	Ver.	Title	In Use State Region	Candidate State Region	Priority
			Specification			
NTCIP 1201	Published	3.0	Global Object Definitions	X	X	H
NTCIP 1202	Published Development	2.0 3.0	Object Definitions for Actuated Traffic Signal Controller (ASC) Units		X	L
NTCIP 1203	Published Approved Development	1.0 1.1 2.0	Object Definitions for Dynamic Message Signs (DMS)	X	X	M
NTCIP 1204	Published	3.0	Object Definitions for Environmental Sensor Stations (ESS)		X X	M
NTCIP 1205	Published Ballot	1.0 1.1	Object Definitions for Closed Circuit Television (CCTV) Camera Control		X X	M
NTCIP 1206	Published	1.0	Object Definitions for Data Collection and Monitoring (DCM) Devices		X X	L
NTCIP 1207	Published Development	1.0 2.0	Object Definitions for Ramp Meter Control (RMC) Units		X	M
NTCIP 1208	Published	1.0	Object Definitions for Closed Circuit Television (CCTV) Switching		X X	M
NTCIP 1209	Published Development	1.0 2.0	Data Element Definitions for Transportation Sensor Systems (TSS)		X X	M
NTCIP 1210	Development	1.0	Field Management Stations (FMS) - Part 1: Object Definitions for Signal System Masters			N/A
NTCIP 1211	Published Development	1.0 2.0	Object Definitions for Signal Control and Prioritization (SCP)		X	L
NTCIP 1213	Approved	2.0	Object Definitions for Electrical and Lighting Management Systems (ELMS)			N/A
NTCIP 1400	Published Ballot	1.0 1.1	TCIP Framework Standard			N/A
NTCIP 1401	Published Ballot	1.0 1.1	TCIP Common Public Transportation (CPT) Objects		X	L
NTCIP 1402	Published Ballot	1.0 1.1	TCIP Incident Management (IM) Objects		X	N/A
NTCIP 1403	Published Ballot	1.0 1.1	TCIP Passenger Information (PI) Objects		X	L



CDOT Region 4 ITS Architecture

Standard	Status	Ver.	Title	In Use State Region	Candidate State Region	Priority
NTCIP 1404	Published Ballot	1.0 1.1	TCIP Scheduling/Runcutting (SCH) Objects		X	L
NTCIP 1405	Published Ballot	1.0 1.1	TCIP Spatial Representation (SP) Objects		X	L
NTCIP 1406	Published Ballot	1.0 1.1	TCIP On-Board (OB) Objects		X	L
NTCIP 1407	Published Ballot	1.0 1.1	TCIP Control Center (CC) Objects		X	L
NTCIP 1408	Published Ballot	1.0 1.1	TCIP Fare Collection (FC) Business Area Objects		X	L
NTCIP 2001	Published	1.0	Class B Profile			N/A
NTCIP 2101	Published	1.0	Point to Multi-Point Protocol Using RS-232 Subnetwork Profile		X X	H
NTCIP 2102	Published	1.0	Point to Multi-Point Protocol Using FSK Modem Subnetwork Profile		X	H
NTCIP 2103	Published	2.0	Point-to-Point Protocol Over RS-232 Subnetwork Profile	X	X	H
NTCIP 2104	Published	1.0	Ethernet Subnetwork Profile		X X	H
NTCIP 2201	Published	1.0	Transportation Transport Profile		X X	H
NTCIP 2202	Published	1.0	Internet (TCP/IP and UDP/IP) Transport Profile	X	X	H
NTCIP 2301	Published	2.0	Simple Transportation Management Framework (STMF) Application Profile		X X	H
NTCIP 2302	Published	1.0	Trivial File Transfer Protocol (TFTP) Application Profile		X X	H
NTCIP 2303	Published	1.0	File Transfer Protocol (FTP) Application Profile		X X	H
NTCIP 2304	Published	1.0	Application Profile for DATEX-ASN (APDATEX)		X	H
NTCIP 2306	Published	1.0	Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML)		X X	H
NTCIP 8003	Published	1.0	Profile Framework		X X	H
NTCIP 8004	Published	1.0 2.0	Structure and Identification of Management Information			N/A

Standard	Status	Ver.	Title	In Use State Region	Candidate State Region	Priority
NTCIP 8007	Published	1.0	Testing and Conformity Assessment Documentation within NTCIP Standards Publications			N/A
NTCIP 9001	Published Development	3.0 4.0	NTCIP Guide	X		N/A
NTCIP 9010	Published	1.0	XML in ITS Center-to-Center Communications		X	N/A
NTCIP 9012	Development	1.0	Testing Guide for Users			N/A
SAE J1663	Published	1.0	Truth-in-Labeling Standard for Navigation Map Databases			N/A
SAE J1708	Published	1.0	Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications			N/A
SAE J1746	Published	1.0	ISP-Vehicle Location Referencing Standard		X X	H
SAE J1757	Published	1.0	Standard Metrology for Vehicular Displays			N/A
SAE J1760	Published	1.0	ITS Data Bus Data Security Services			N/A
SAE J2266	Published	1.0	Location Referencing Message Specification (LRMS)		X X	H
SAE J2313	Published	1.0	On-Board Land Vehicle Mayday Reporting Interface			N/A
SAE J2352	Published	1.0	Mayday Industry Survey Information Report			N/A
SAE J2354	Published Development	2.0 3.0	Message Set for Advanced Traveler Information System (ATIS)		X X	H
SAE J2355	Published	1.0	ITS Data Bus Architecture Reference Model Information Report			N/A
SAE J2365	Published	1.0	Calculation of the Time to Complete In-Vehicle Navigation and Route Guidance Tasks			N/A
SAE J2366/1	Published	1.0	ITS Data Bus - IDB-C Physical Layer			N/A
SAE J2366/1L	Published	1.0	ITS Data Bus - Low Impedance Stereo Audio			N/A
SAE J2366/2	Published	1.0	ITS Data Bus - Link Layer			N/A
SAE	Published	1.0	ITS Data Bus - Thin Transport Layer			N/A



CDOT Region 4 ITS Architecture

Standard	Status	Ver.	Title	In Use State Region	Candidate State Region	Priority
J2366/4						
SAE J2366/7	Published	1.0	ITS Data Bus - Application Message Layer			N/A
SAE J2369	Published	1.0	Standard for ATIS Message Sets Delivered Over Reduced Bandwidth Media		X X	H
SAE J2372	Published	1.0	Field Test Analysis Information Report			N/A
SAE J2373	Published	1.0	Stakeholders Workshop Information Report			N/A
SAE J2395	Published	1.0	ITS In-Vehicle Message Priority			N/A
SAE J2396	Published	1.0	Definitions and Experimental Measures Related to the Specification of Driver Visual Behavior Using Video Based Techniques			N/A
SAE J2399	Published	1.0	Adaptive Cruise Control (ACC) Operating Characteristics and User Interface			N/A
SAE J2400	Published	1.0	Human Factors in Forward Collision Warning Systems: Operating Characteristics and User Interface Requirements			N/A
SAE J2539	Published	1.0	Comparison of GATS Messages to SAE ATIS Standards Information Report			N/A
SAE J2540	Published	1.0	Messages for Handling Strings and Look-Up Tables in ATIS Standards		X X	H
SAE J2540/1	Published	1.0	RDS (Radio Data System) Phrase Lists			N/A
SAE J2540/2	Published	1.0	ITIS (International Traveler Information Systems) Phrase Lists			N/A
SAE J2540/3	Published	1.0	National Names Phrase List		X X	H
SAE J2630	Published	1.0	Converting ATIS Message Standards from ASN.1 to XML		X X	H
SAE J2735	Published	2.0 2.0	Dedicated Short Range Communications (DSRC) Message Set Dictionary			N/A

IX. ITS DEPLOYMENT STRATEGIES FOR REGION 4

This section identifies the Regional strategies regarding ITS deployment including specific recommendations concerning each ITS deployment.

A. *Recommended ITS Strategies for Region 4*

Strategy #1- Implement ITS Deployments that Provides Benefits on interstates, state highways and regionally significant corridors.

These corridors carry the highest traffic volumes within the Region and would receive the greatest benefits from ITS implementation, and they would be able to demonstrate greater overall mobility and safety benefits. It should be noted that local agencies are not precluded from deploying ITS on their local street and roadways that serve local needs; however, deployment should be considered in terms of technical integration and jurisdiction coordination with the Regional ITS network. ITS deployments for Strategy #1 include:

- **Communication Infrastructure (Fiber Optic Cable & Network Equipment)** – Implement communication coverage to corridors or corridor segments where no coverage exists, and to increase the connectivity, reliability and integration of all ITS devices.

CTMC is migrating from a SONNET based fiber optic communications to an Ethernet-based fiber optic communications to expand bandwidth capacity to support its ITS devices. Greeley is in the process of implementing an Ethernet based fiber optic communications system within the City to support traffic signals, weather stations, CCTV and ATR. Ethernet based fiber optic communications is recommended for the urban area within the Region, which is defined by the following boundaries: US-287 on the west, US-85 on the east, SH-7 on the south and SH-14 on the north. Cellular wireless communications has shown increased improvements in reliability and bandwidth and, therefore, is recommended for isolated ITS deployments in rural areas where it would be cost prohibitive to install fiber communications to support few ITS devices. Regardless, CDOT and local agencies should take advantage of opportunities such as partnerships between agencies, partnerships with private companies, with new development, during construction, etc. to install fiber optic communications along the corridors where possible.

- **Traveler Information** – It is recommended that traveler information be implemented on the I-25 corridor and on all corridors that have received the highest priorities for traveler information.
- **Colorado Transportation Management Center (CTMC) & Urban Traffic Operation/Management Centers (TOC/TMC)** – CTMC and the urban centers collect traffic conditions information based on overall operational and maintenance responsibility for the corridor. CTMC will continue to serve as the primary center for dissemination of statewide traveler information within the Region through the COTrip website, 511 and GovDelivery system. The 511 automated phone systems has the capability to transfer to local 511 automated phone systems. The GovDelivery system provides text and email alerts for incidents, maintenance and construction. Local agencies that collect traveler information on their corridors can disseminate the information on agency websites and coordinate with CTMC to display the information on the COTrip website.
- **Traffic Incident Management Plan (TIMP)** – Improves coordination between agencies and identifies operational roles and responsibilities, protocols, and alternative routes when responding

to incidents. A TIMP exists for the I-25 and US-36 corridors. A TIMP is recommended for US-85 (Denver to Greeley). The development of the TIMP should be coordinated between CDOT Regions 4 and 6. These plans should be updated on a regular basis to address changing conditions.

- **Courtesy Patrol/Tow Vehicles** – Assists law enforcement to utilize resources more effectively when incidents occur during severe weather conditions. On-call courtesy patrol is recommended along I-25 within the Region. Private tow vehicles would tow the impacted vehicle to a designated safe zone and be available to assist with other incidents.
- **Traffic Responsive/Traffic Adaptive Control** – Time-Of-Day (TOD) plans are sufficient to meet the needs of normal traffic conditions. These plans typically need to be updated every 3-5 years. A traffic adaptive pilot project is being implemented along 10th Street (US 34 Business) in Greeley. The results will be used to determine other potential future installations within the Region. Corridors such as SH-119 (Foothills Parkway to I-25), SH-7 West (Estes Park to Lyons) and SH-52 (SH-119 to US-85) could benefit from the implementation of traffic responsive control, i.e., pre-designed timing plans based on traffic condition thresholds to maximize corridor efficiency that responds to changing traffic conditions. Traffic responsive control would also apply for traffic signals along event and incident routes.
- **Dynamic Message Signs** – These signs can provide real-time traveler information to drivers along corridors. In addition, they can be used to support CSP safety campaigns, promotion of COTrip, 511 and alternative modal options. The signs are recommended at major decision points.
- **Ramp Meters** – Ramp meters exist on US-36. It is recommended that ramp meters be installed on I-25 from Loveland to Fort Collins based on traffic volumes and indicated levels of congestion. The installation of ramp meters will reduce the friction between freeway traffic and the traffic merging from the ramps resulting in a smoother operation. However, it should be noted that a ramp meter warrant study needs to be conducted prior to ramp meters being deployed.
- **Closed Circuit Television Cameras (CCTV)** – Increase real-time observation coverage along corridors. CCTV is recommended at major signalized intersections or intersections of highways. The images from the CCTV should be made available on the COTrip website,
- **Weather Stations** – Expand the deployment of weather stations and pavement sensors on corridors to assist maintenance personnel and provide information to the travelling public. Given the extensive geographical area, microclimate and significant impacts of weather conditions across the Region, deployment of weather stations is recommended on each corridor.

Strategy #2 - Increase transit ridership and demand by integration and coordination with alternative travel modes.

Transit, vanpool, carpool, bicycle and PNR modal options should be integrated to foster usage of alternative modes of travel. ITS deployments for Strategy #2 include:

- **Add Static/Transit Route Information to Google** – This site provides transit agencies a platform to post transit route information. Currently, there are over 400 agencies that provide transit information on the site. Within the Region, it is recommended that transit route information from all transit agencies be posted on the site. This is an interim solution until the on-line planning services website is developed.

- **On-line Trip Planning Services Website** – Integrating travel mode options will assist in generating interest and increased usage. It is recommended that the SmartTrips.org website be rebranded as a multi-modal trip planning web application and be integrated to include transit, vanpool, carpool, bicycle and PNR. The site currently supports ridesharing for carpools and vanpools, and contains information for bicyclists and pedestrians. It also shows transit routes and bus information but does not dynamically report bus availability.
- **Automated Fare Collection System** – It is recommended that an automated fare collection system be implemented for GET to increase transit usage and to improve operational efficiency. Automated fare collection systems exist for Transfort and COLT.
- **Transit Passenger Counting System** - It is recommended that a passenger count system be implemented for GET and Transfort. Automated system exists for COLT.
- **Transit Services to PNR Locations** – It is recommended that transit services be provided to these locations as it would promote usage of transit and the PNR lots.
- **NextBus Application** – It is recommended that real-time transit information be provided at transit centers, PNRs and key bus stops.
- **Fare Collection Kiosks** – Fare collection kiosks should be implemented after transit services and associated improvements at PNR are completed. In addition, these kiosks should also be implemented at transit centers.

It should be noted that a study is planned to examine the feasibility of forming a Regional transit agency for North Central Colorado. The study is anticipated to be completed by December 2012. The potential formation of a Regional transit agency could have a significant impact on transit ITS within the Region. Operationally, there will be existing systems for dispatch, maintenance, scheduling, etc. that are being used by transit agencies that may not be compatible with each other. Currently, these existing systems support transit ITS.

Strategy #3- Implement and promote Regional projects that increase cooperation and coordination within and between agencies.

ITS deployments for Strategy #3 include:

- **Access to MDSS and Traffic Video for Agencies** – It is recommended that local law enforcement, local transportation agencies and POE be provided access to the information. At POEs, traveler information kiosks should be installed to allow dissemination of information to commercial vehicle drivers.
- **Regional Guidelines for Arterial Conditions Display and Sharing with CDOT** – Fort Collins provides arterial condition information on its City website. As more agencies provide arterial condition information, it is critical information is displayed consistently across the Region so that the travelling public is not confused. Within the DRCOG area, Guidelines are being developed for arterial condition information. It is recommended that Region 4 consider using these guidelines. It is important to achieve consistency across the Region and the Front Range to display information on the COTrip website.
- **Performance Monitoring for Corridors** – There is a significant interest and value in reporting performance measures of corridor operations. The infrastructure needed to collect performance measurements are better served if done in conjunction with ITS deployment for traveler information. As corridors are instrumented for traveler information, they will be integrated with CTMS. CTMC is currently considering a reporting tool that interfaces with the CTMS database

to report performance measures. Within the DRGOG area, agencies have identified several key performance measures and indices. For CDOT Region 4, it is recommended to also consider using the measures along with those adopted in the NFRMPO Congestion Management Process in 2010. Similar to the Regional Guidelines for Arterial Conditions Display, it is important to achieve consistency across the Region and Front Range regarding corridor performance measures.

- **Traveler information for Estes Park/RMNP** – It is recommended that interfaces with 511 and COTrip be developed to provide traveler information. This would include traffic condition information on US-34, US-36 and I-25 for outbound traffic leaving RMNP or Estes Park and parking availability information for the parking hub and satellite lots. RMNP should install cameras on Bear Lake Road to provide traffic and parking conditions information. Also, all of this information could be provided at the Estes Park Transit Hub (Town Visitor Center) via kiosk or a video wall. There is a need to provide incident information on US-34 so that travelers entering Big Thompson Canyon have the opportunity to turnaround if the roadway ahead is closed, particularly during winter months when snow forces closures on Cameron Pass.
- **CDOT Maintenance Vehicles with AVL/Camera and In-Vehicle Interface Device** – It is recommended that all CDOT maintenance vehicles be equipped with AVL/Camera and In-Vehicle interface devices to allow maintenance personnel to report back on the work conditions.
- **Expansion of MDSS System** – The deployment of additional weather stations will provide more granular information. Additional routes will need to be added to MDSS and will require integration and revised forecast models. Also, given the demand for MDSS, additional users will need to be added to provide access to the information. This would require proper licensing and network management functions.
- **Event Management Plans** – It is recommended that event management plans be developed to meet the event traffic demands in Greeley and Larimer County. The plan would also include traffic responsive plans for impacted traffic signals to support event traffic.
- **Expansion of CCTM Application for Traffic Agencies** – Within the DRCOG area, CDOT has developed the CCTM application that allows users to access traffic data such as the locations of traffic signals, secure weather data and contract information for planned construction and maintenance projects. The performance measures will be accessible on the CCTM also. It is recommended that this application be provided to CDOT Region 4 as more ITS deployment occurs. Again, this will also ensure consistency within the Region and along the Front Range.
- **Expand CTMS Functionality for Maintenance and Construction Activity Information** – This would allow local agencies the ability to add maintenance and construction activity information so that it is available on COTrip, 511 and GovDelivery. Specific requirements need to be developed.
- **Portable Monitoring System for Load Deficient Structures for Size and Weight Enforcement** – This would implement the system at high priority locations within the Region. Specific requirements need to be developed.

X. ARCHITECTURE MAINTENANCE PROCESS

Federal regulations require the preparation of a regional ITS architecture and also define procedures and processes to maintain the architecture as needs and conditions evolve in the region. As ITS projects are implemented, the regional needs and priorities may change and evolve and new ITS projects that were not be reflected in the regional ITS architecture may be identified. This section describes the procedures and processes to maintain the *Region 4 ITS Architecture*.

The *Region 4 ITS Architecture Area* consists of two items:

- Turbo Architecture Database Version 5.0: The Turbo Architecture database is the key element describing the ITS architecture.
- ITS Architecture Document: The document entitled *CDOT Region 4 ITS Architecture Plan (August 2011)* reflects the information contained in Turbo Architecture Database Version 5.0 in a more user-friendly textual format.

ITS Architecture Update Process – As needed

As identified in the Region 4 ITS Plan, Region 4 will establish an ITS working group committee and conduct committee meetings every six months to review ITS implementations, identify and document changes and revisions that need to be made to the Plan. The Plan will then be updated every three years. With regard to the Region 4 ITS Architecture, Region 4 will update Turbo Architecture as projects are implemented, and update the Region 4 ITS Architecture every three years in conjunction with the Region 4 ITS Plan update.

The architecture maintenance process will coincide with the Region 4 ITS Plan update process, performing has two types of updates as described below: annual administrative updates and full document updates.

As needed Administrative Update Process

The annual administrative update process involves relatively minor updates to the regional ITS architecture (i.e. a agency identifies a project involving ITS that is not reflected in the regional ITS architecture). These updates will recorded only in the Turbo Architecture database – the ITS architecture document will not be updated.

Full Document Update Process

A full document update involves the complete review and potential update of all elements of the Region 4 ITS Architecture including both the Turbo Architecture database and the *CDOT Region 4 ITS Architecture Regional Area* document should be completed and in conjunction with Region 4 ITS Plan every 3 years.

Appendix A: Market Package Analysis for Region 4

	Market Package	Brief Description	Existing Applicability	Future Applicability
Archived Data (AD)				
AD1	ITS Data Mart	Collect data for future analysis for one agency only	CTMS collects travel time, speed, device logs, etc. Existing weather forecast and pavement condition information in CDOT MDSS. Existing traffic count data at cities, counties and CDOT DTD. Transit ridership, vanpool/carpool usage, PNR usage at various agencies	As more real-time conditions data is collected and stored, performance measures reporting at an individual agency level would be enabled
AD2	ITS Data Warehouse	Store data for multiple agencies	Does not exist	All historical traffic counts available at CDOT DTD
AD3	ITS Virtual Data Warehouse	Supports networked access to data archives for multiple agencies	Does not exist	Historical performance “traffic conditions” data made available on CCTM on corridors that support “real-time” conditions through an on-line reporting tool and is also available on COTrip
Advanced Public Transit Systems (APTS)				
APTS 01	Transit Vehicle Tracking	Provide automatic vehicle location (AVL) to track transit vehicles	Transfort and COLT have AVL. Planned AVL in Greeley	None
APTS 02	Transit Fixed-Route	Performs automatic driver assignment and	Computer Aided Dispatch (CAD) and two-way	None

	Market Package	Brief Description	Existing Applicability	Future Applicability
	Operations	monitoring, as well as vehicle routing and scheduling for fixed-route services	communications exist	
APTS 03	Demand Responsive Transit Operations	Performs automatic driver assignment and monitoring as well as vehicle routing and scheduling for demand responsive transit services	Computer Aided Dispatch (CAD) and AVL exist; scheduling systems exist	None
APTS 04	Transit Passenger and Fare Management	Allows for the management of passenger loading and fare payments on-board vehicles using electronic means	Automated fare collection exists for Transfort and COLT. Magnetic strip exists for Transfort and allows use of smartcard for CSU students. Magnetic strip and smartcard planned for COLT	Possibly automated fare collection for GET
APTS 05	Transit Security	Provides for the physical security of transit passengers	Two-way communications and panic buttons exist; video monitoring in buses and transit center for Transfort; GET planning to install cameras on buses soon; transit security is not integrated with local law enforcement agencies	None

	Market Package	Brief Description	Existing Applicability	Future Applicability
APTS 06	Transit Maintenance	Supports automatic maintenance scheduling and monitoring	Maintenance systems exist. Transfort upgrading existing system	None
APTS 07	Multi-modal Coordination	Establishes two-way communications between multiple transit and traffic agencies	Coordination between transit and traffic agencies exists regarding implementation of new routes and new stops. Fare collection coordination between COLT and Transfort. Regional route coordination on FLEX between Transfort, COLT and RTD	Transit, vanpool/carpool, bicycle and PNR working together to promote multi-modal options. More coordination required if other Regional bus routes are implemented
APTS 08	Transit Traveler Information	Provides customized or real-time transit Information	Static transit routes and schedules exist locally for Town of Estes Park and RMNP. Static shuttle system information exists locally on websites	Need for consolidated on-line trip planning services
APTS 09	Transit Signal Priority		TSP exists at Prospect Road and Stover	None
APTS 10	Transit Passenger Counting		Exists for COLT	Possibly for GET & Transfort
Advanced Traveler Information Systems (ATIS)				
ATIS01	Broadcast	Dissemination of	Existing radio station (KEZ	Possibly use agency website to show traffic

	Market Package	Brief Description	Existing Applicability	Future Applicability
	Traveler Information	information over a wide area through existing infrastructures and low cost user equipment	1410) broadcasts weather and travel information in Estes Park. Existing Loveland HAR on 1610 AM, posts traffic information online and sends out weekly emails. Existing DMS provides information. CDOT's GovDelivery system exists for email and text alerts	conditions within the city. Provide traffic video images on city channel
ATIS02	Interactive Traveler Information	Provides tailored information in response to a traveler request. Includes dynamic web pages and 511 telephone information	CDOT COTrip web site, GovDelivery and 511 system exists	Possibly Estes Park city traveler information web site and kiosks. Kiosks at POE
ATIS03	Autonomous Route Guidance	In-vehicle or handheld electronic devices used to provide trip planning information and directions	This service is generally not provided by public sector agencies	CDOT data available for use by private ISPs
ATIS04	Dynamic Route Guidance	Builds on Autonomous Route Guidance to factor in real-time conditions information. Again, this Market Package is generally	This service is generally not provided by public sector agencies	CDOT data available for use by private ISPs

	Market Package	Brief Description	Existing Applicability	Future Applicability
		more of a private-sector initiative		
ATIS05	ISP (Information Service Provider) Based Route Guidance	Trip planning and directions information that is provided by a service, and does not require a specific user device – “MapQuest” web site would be an example	This service is generally not provided by public sector agencies	CDOT data available for use by private ISPs
ATIS06	Integrated Transportation Management/ Route Guidance	Ties in with route guidance systems to optimize traffic control strategies along anticipated vehicle routes	Does not exist	None
ATIS07	Yellow Pages and Reservation	Provides “Yellow pages” business listings and the capacity to make reservations	This service is generally not provided by public sector agencies	Not applicable
ATIS08	Dynamic Ridesharing	Provides dynamic ridesharing/ride matching capability in real time. Some large companies provide this service	Static vanpool/carpool matching exists	None

	Market Package	Brief Description	Existing Applicability	Future Applicability
ATIS09	In-Vehicle Signing	Supports distribution of information, such as travel advisories, to drivers through in-vehicle devices	This service is generally not provided by public sector agencies	CDOT data available for use by private ISPs
ATIS10	VII Traveler Information	Distributes real-time information to vehicles via Vehicle Infrastructure Integration (VII)	This service is generally not provided by public sector agencies	Not applicable
Advanced Traffic Management Systems (ATMS)				
ATMS01	Network Surveillance	Collects information from field devices (detectors, CCTV, etc.) for monitoring of roadway conditions	Cameras exist in Fort Collins, Greeley and Loveland, and at CDOT PNR	More deployment needed to support real-time information
ATMS02	Probe Surveillance	Use toll transponder equipped vehicles, volunteers, buses, anonymous cellular phone tracking or other technology to monitor traffic conditions	None available	Use of transponders anticipated Fort Collins South and Greeley South. Van and maintenance vehicles are an additional option
ATMS03	Surface Street Control	Provide traffic signal control	TOD synchronization exists. Most urban area signals under	Traffic responsive control as needed, Upgrading to fiber communication as needed

	Market Package	Brief Description	Existing Applicability	Future Applicability
			system control. Traffic adaptive planned for 10 th Street in Greeley	
ATMS04	Freeway Control	Control of devices installed along freeways, including control of cameras and dynamic message signs	Ramp meters exist on US-36	Additional ramp meter deployment on I-25
ATMS05	HOV Lane Management	Manages HOV lanes by coordinating freeway ramp meters and connector signals with HOV lane usage signals	None	Future HOV/HOT on I-25 at south end of study area. HOV/HOT lanes are being considered on I-25 from 84 th Avenue to SH-14 and US-36 from I-25 to Boulder
ATMS06	Traffic Information Dissemination	Supports Dynamic Message Signs and Highway Advisory Radio	HARS and DMS exist	More deployment needed
ATMS07	Regional Traffic Control	Provides for the sharing of traffic information and control among traffic management centers to support a Regional control strategy	None	Dependent on fiber connectivity

	Market Package	Brief Description	Existing Applicability	Future Applicability
ATMS08	Incident Management System	Detects incidents and provides links between transportation and emergency management centers to exchange information	Existing I-25 and US-36 Incident Management Plans	Need US-85 TIMP. Need for incident management and event planning at Larimer County Event Center and for Island Grove Park. Congestion and routing an issue for special events in Fort Collins
ATMS09	Traffic Forecast and Demand Management	Use of historical traffic data to predict future demand	None	None
ATMS10	Electronic Toll Collection	Use of electronic “tags” to collect tolls and process violations without requiring motorists to stop	None	None
ATMS11	Emissions Monitoring and Management	Monitors individual vehicle emissions and provides general air quality monitoring using distributed sensors to collect the data	Existing emissions check stations	None
ATMS12	Roadside lighting system control.	Manage lighting system along roadside	Not applicable	Not applicable

	Market Package	Brief Description	Existing Applicability	Future Applicability
ATMS13	Standard Railroad Grade Crossing	Manages highway traffic at highway-rail intersections where rail operational speeds are less than 80 miles per hour	Existing rail signal pre-emption in Fort Collins	Possibly query clearance system
ATMS14	Advanced Railroad Grade Crossing	Same as Standard, but for intersections with trains traveling in excess of 80 miles per hour	Not applicable	Not applicable
ATMS15	Railroad Operations Coordination	Provides an information link between rail operations and traffic management centers and emergency dispatch	None	None
ATMS16	Parking Facility Management	Provides monitoring and management of parking facilities	Parking exists at transit hub (Town of Estes Park visitor center) and Stanley satellite hub on US-36. More satellite hubs planned	Need for parking lot monitoring in downtown Estes Park and at Rocky Mountain National Park
ATMS17	Regional Parking Management	Supports coordination between parking facilities to enable Regional parking management strategies	None	Possible future coordination in Estes Park, RMNP and CDOT

	Market Package	Brief Description	Existing Applicability	Future Applicability
ATMS18	Reversible Lane Management	Provides for the control of reversible lane facilities	Not applicable	Not applicable
ATMS19	Speed Monitoring	Monitors speeds of vehicles on roadways. DMS can then be used to post a safe speed reminder	None	Specific locations
ATMS20	Drawbridge Management	Drawbridge control systems – gates, warning lights, DMS, etc.	Not applicable	Not applicable
ATMS21	Roadway Closure Management	Support for remotely controlled gates or barriers that close off roads in unsafe conditions, plus camera surveillance and traveler information	None	Specific locations
Commercial Vehicle Operations				
CVO01	Fleet Administration	Electronic routing of commercial vehicle fleets	Not applicable	Not applicable
CVO02	Freight Administration	Electronic tracking of cargo movements from	Not applicable	Not applicable

	Market Package	Brief Description	Existing Applicability	Future Applicability
		source to destination, including whether the shipment has been tampered with		
CVO03	Electronic Clearance	Provides for pre-registered commercial vehicles to pass through check stations without pulling over	PrePass and Automatic Vehicle Identification equipment exists	None
CVO04	CV Administrative Processes	Provides for electronic information sharing and automation of a number of commercial vehicle administration tasks, such as fee collection, credentialing, and tax filing	Separate databases at various agencies	Electronic sharing of information between agencies
CVO05	International Border Electronic Clearance	Expands the Electronic Clearance Market Package to include border crossings	Not applicable	Not applicable
CVO06	Weigh-In-Motion	Includes systems that allow commercial vehicles to be weighed by equipment installed on the roadside,	WIM exists at Fort Collins and Ft. Morgan POEs	Install WIM at Ft. Lupton

	Market Package	Brief Description	Existing Applicability	Future Applicability
		allowing the vehicle to bypass traditional weigh stations		
CVO07	Roadside CVO Safety	Provides for automated roadside safety monitoring and reporting	Limited pullout roadside check locations	More pullout locations needed
CVO08	On-board CVO Safety	Provides for on-board commercial vehicle safety monitoring and reporting	Generally a private sector initiative	None
CVO09	CVO Fleet Maintenance	On-board monitoring and maintenance system	Generally a private sector initiative	None
CVO10	HAZMAT Management	Integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents	Not applicable	Not applicable
CVO11	Roadside HAZMAT Security Detection and Mitigation	Uses roadside equipment to detect HAZMAT cargo, then checks the vehicle's credentials to ensure that	Not applicable	Not applicable

	Market Package	Brief Description	Existing Applicability	Future Applicability
		the cargo and driver are properly authorized		
CVO12	CV Driver Security Authentication	Uses onboard security to detect unauthorized CV drivers, and if detected, disables the vehicle	Generally a private sector initiative	None
CVO13	Freight Assignment Tracking	Registration and tracking of the vehicle, cargo shipment, and driver	Not applicable	Not applicable
Emergency Management				
EM01	Emergency Response	Provides computer-aided dispatch Systems	Weld County emergency services dispatch and 911. Larimer County Sheriff dispatch. Fort Collins emergency department. Loveland emergency response. CSP dispatch	None
EM02	Emergency Routing	Automatic Vehicle Location and dynamic routing for emergency vehicles	Existing CAD for emergency vehicles in Estes Park. Trains block emergency vehicle access in La Salle. Existing signal pre-emption in Greeley, Loveland, and Fort Collins.	None

	Market Package	Brief Description	Existing Applicability	Future Applicability
EM03	Mayday Support	Supports response to requests for help from in-vehicle or call-box type systems	Existing in-vehicle systems	None
EM04	Roadway Service Patrols	Service trucks that respond to reports of disabled vehicles and help to clear them, in order to reduce the impact on the traffic flow	None	On call tow services during severe incidents and inclement weather for I-25
EM05	Transportation Infrastructure Protection	Uses surveillance cameras and sensors to monitor critical infrastructure such as bridges, tunnels, etc.	None	Monitoring bridges, PNRs and DMS to deter graffiti and vandalism
EM06	Wide-Area Alert	Facilitates the use of ITS driver information devices (such as DMS and HAR) to spread emergency alert Messages – example would be Amber Alerts	CDOT ITS currently places DMS messages on request of R4, State Patrol, and HQ. This includes Amber Alerts and Silver Alerts	None
EM07	Early Warning System	Uses various types of sensors and monitors to facilitate early detection	Stream level monitoring in Loveland, Fort Collins, and Estes Park. Some linked to	None

	Market Package	Brief Description	Existing Applicability	Future Applicability
		and warning of emergencies, including weather emergencies and terrorist attacks	emergency operations centers. Estes Park has a SCADA system with alarm capabilities. Existing stream monitoring on US 85, but not linked to any centers	
EM08	Disaster Response and Recovery	Supports the overall coordinated response to emergencies by transportation, emergency response, and maintenance personnel	Existing emergency management plans	None
EM09	Evacuation and Reentry Management	Supports coordination of evacuation plans by transportation and safety agencies as well as the subsequent return to the evacuation area	Existing emergency management plans	None
EM10	Disaster Traveler Information	Augments existing traveler information systems to provide emergency traveler information, such as evacuation routes, etc., in the event of a disaster	Existing emergency management plans	None

	Market Package	Brief Description	Existing Applicability	Future Applicability
Maintenance and Construction				
MC01	Maintenance and Construction Vehicle and Equipment Tracking	Tracks the location of maintenance and construction vehicles and other equipment	Data communications and GPS systems on CDOT snow plows exist	More deployment anticipated
MC02	Maintenance and Construction Vehicle Maintenance	On-board diagnostics that provide maintenance and repair information for snowplows, trucks, etc.	None	None
MC03	Road Weather Data Collection	Collection of weather and road conditions data using sensors installed near the roadway	Weather stations in Fort Collins, Windsor, Loveland, Greeley, and CDOT R4	More deployment needed
MC04	Weather Information Processing and Distribution	Processing and dissemination of road/weather conditions information to travelers, maintenance workers, etc.	CDOT MDSS system exists	Expansion of MDSS
MC05	Roadway Automated Treatment	Automated anti-icing systems for bridges and roadways	City of Fort Collins Timberline Bridge de-icing system	Specific locations

	Market Package	Brief Description	Existing Applicability	Future Applicability
MC06	Winter Maintenance	Supports winter road maintenance including snowplow operations, roadway treatments (i.e., salt spraying, etc.)	Existing winter maintenance operations and MDSS	None
MC07	Roadway Maintenance and Construction	Supports scheduled and unscheduled maintenance and construction of ITS and non-ITS equipment	Existing maintenance and construction operations	None
MC08	Work Zone Management	Enables construction delay and routing information to be provided en-route to drivers, and also facilitates providing this information to other agencies	None	As needed
MC09	Work Zone Safety Monitoring	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	None	None

	Market Package	Brief Description	Existing Applicability	Future Applicability
		workers		
MC10	Maintenance and Construction Activity Coordination	Coordination of maintenance and construction activities between various agencies for improved operations	Most agencies post scheduled road closures to web sites	Need consolidation of all sources
MC11	Environmental Probe Surveillance	Collects environmental data from on-board vehicle sensors	Not applicable	Not applicable
MC12	Infrastructure Monitoring	Monitors infrastructure via both fixed and vehicle-based sensors	Not applicable	Not applicable