Chapter 3: Regional ITS Architecture

3.1 INTRODUCTION

The National ITS Architecture is the defining resource for providing guidance to state and local jurisdictions that are planning and integrating intelligent transportation systems. This resource was developed on behalf of the U.S. Department of Transportation (U.S. DOT) to serve as a common framework for planning, defining, and integrating ITS. Final regulations issued by the U.S. DOT[1] require regions that are deploying ITS to develop a Regional ITS Architecture, in order to ensure institutional agreement as well as the technical integration of the implemented systems. All ITS projects that use federal highway trust funds are subject to this requirement. Thus, the Regional ITS Architecture developed for Deschutes County, and individual ITS projects proposed in the Implementation Plan, must conform to the National ITS Architecture and other federal ITS resolutions.

3.1.1 Regional ITS Architecture Development Approach

In order to deliver an ITS Architecture that is easy to update and maintain, a Turbo Architecture[2] database was created for the Deschutes County region. Turbo Architecture is a software application used as a tool for regional and project-level ITS Architecture development. The benefit of using Turbo Architecture to create and store a regional ITS Architecture is that the architecture is developed using a standard format that can be easily "handed off" from the original developer to a local agency that will be updating and maintaining the architecture. Regional ITS Architectures that are prepared outside of Turbo can be difficult to keep up-to-date, as they may include embedded diagrams or customized formatting that is not easily modified. For stakeholder review purposes, simple "reports" may be output from Turbo Architecture, just as with a typical database program.

Version 3.0 (the most recently released version at the time of this project) of the Turbo Architecture software was used to develop the Deschutes County Regional ITS Architecture. Version 3.0 was designed to be compatible with the most recent version of the National ITS Architecture, and provides greatly increased functionality over previous versions.

Although the ITS architecture file itself is a database format that may be opened with Microsoft Access™ , it is recommended that the agency taking ownership of the file[3] should acquire the Turbo Architecture application, which provides a graphical user interface for manipulating and entering data. Turbo Architecture may be purchased through the Mc*Trans* Software Center[4].

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[1] U.S. Department of Transportation, Federal Highway Administration. *ITS Architecture Final Rule.* January 8, 2001. http://www.its.dot.gov/aconform/archrule_final_1.htm

[2] *Turbo Architecture, Version 3.0*, developed by Iteris for the U.S. Department of Transportation, Federal Highway Administration, 2004.

[3] The ODOT Region 4 office will likely take ownership of the Turbo Architecture database.

[4] http://mctrans.ce.ufl.edu/store/description.asp?itemID=733

In developing this database, the following steps were conducted:

- **Initial Information:** A general description, time frame, and geographical scope of the region were entered into the Turbo Architecture database.

- **Inventory of Stakeholders:** A list of regional stakeholder agencies (both key and secondary) was compiled based upon input collected from attendees at the project kick-off meeting. At the Regional ITS Architecture project workshop held in October, attendees reviewed and provided comments on the list of stakeholders, which was then updated in Turbo. This report is included in Appendix G.

- **Inventory of Systems:** The region's existing and planned ITS inventory, as documented from stakeholder interviews and presented in Chapter 1, was used as input to the Turbo Architecture database. Relevant National ITS Architecture subsystem(s), terminator(s) and a primary stakeholder were assigned to each inventory element. (Section 3.2 provides an overview of the National ITS Architecture terminology.) Appendix G contains an inventory report from Turbo Architecture that lists the inventory elements, corresponding ITS Architecture components, and other information. This report was reviewed and revised based upon feedback from the key stakeholders at the Regional ITS Architecture workshop.

- **Selection of Market Packages:** Based upon this inventory, as well as information gathered from the user needs assessment, market packages from the National ITS Architecture were selected for inclusion in the Regional ITS Architecture and relevant ITS inventory elements assigned to each. The review of selected Market Packages was a key focus of the Regional ITS Architecture workshop.

- **Operational Concept Roles and Responsibilities:** One of the required elements of a Regional ITS Architecture is the Operational Concept that describes how stakeholder agencies will cooperate in the implementation and operation of ITS. Chapter 4 provides an operational concept for interagency relationships and information flows, however Turbo Architecture was also used to document specific roles and responsibilities for each agency in the regional deployment of ITS. The Roles and Responsibilities report from Turbo was provided as an Appendix to Chapter 4.

- **ITS Functionality:** ITS functional areas, related ITS elements, and general system functional requirements were selected in support of the existing and planned ITS in the region.

- **ITS Standards:** ITS Standards that could potentially support compatibility and interoperability among regional transportation systems were selected.

- **Agreements:** Interagency agreements needed to support the Operational Concept were documented.

- **Interconnects and Flows Customization:** As explained in Section 3.2, a Regional ITS Architecture defines flows of information that are exchanged between subsystems (for example, between the ODOT Region 4 TOC and Bend Public Works Traffic Management). A key task in Turbo Architecture is customizing the selection of flows between subsystems so that the appropriate flows are included as part of the architecture database. The architecture flows were also submitted for stakeholder review. Appendix H includes a table of the customized architecture flows from the Turbo Architecture database.

3.1.2 Compliance with Federal ITS Regulations

Effective on April 8, 2001, the Federal Highway Administration (FHWA) issued regulations and the Federal Transit Administration (FTA) issued a policy that requires that ITS projects funded through the Highway Trust Fund conform to the National ITS Architecture and applicable standards. Conformance with these federal ITS requirements included the development of a Regional ITS Architecture based upon the National ITS Architecture and the subsequent adherence of ITS projects to the Regional ITS Architecture and the completion of systems engineering analysis.

The purpose of the Regional ITS Architecture is to serve as a guide for the development of ITS projects and programs and be consistent with ITS strategies and projects contained in applicable transportation plans. The Regional ITS Architecture must include the following elements:

- Description of the Region: Included in Chapter 1 and in Turbo Architecture
- Identification of Stakeholders: In Turbo Architecture
- Operational Concept: In Turbo Architecture and Chapter 4
- Agreements: In Turbo Architecture
- System Functional Requirements: In Turbo Architecture
- Interface Requirements and Information Exchanges: In Turbo Architecture
- Identification of ITS Standards: In Turbo Architecture, and discussed in Section 3.4
- Sequence of Projects Required for Implementation: Presented in Implementation Plan (Chapter 6)

3.2 NATIONAL ITS ARCHITECTURE OVERVIEW

The National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. It is a mature product that reflects the contributions of a broad cross-section of the ITS community (transportation practitioners, systems engineers, system developers, technology specialists, etc.). The architecture defines:

- The functions (e.g., gather traffic information or request a route) that are required for ITS applications.
- The physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle).
- The information flows that connect these functions and physical subsystems together into an integrated system.[5]

[5] US DOT, National ITS Architecture, Version 5.0

Regional Architectures are not intended to specify the particular technologies that will be used in ITS deployments; they are instead used to define the functions that technologies must perform. The architecture provides structure for defining general ITS functional requirements during the planning and design process. Key terms and concepts that are specific to, and used extensively in, the National ITS Architecture are discussed below.

3.2.1 User Services

The National ITS Architecture utilizes "user services" to document what ITS should accomplish from a user's perspective; for example, "Provide pre-trip traveler information" or "Provide Transit Route Guidance". User services for a region can be selected by considering the needs and problems in the region and looking at how ITS can provide services to address these issues.

3.2.2 Physical Architecture

The physical architecture provides a framework for the physical elements of ITS systems. These elements include cars, people, computers, buses, trucks, etc. Figure 3-1: National ITS Architecture Subsystems, provides an illustration of the physical architecture. The physical elements are broken into large groups called subsystem categories. These are functional categories that describe what their member physical entities (subsystems) do.

The four major subsystem categories are:

- **Traveler Subsystems**: Systems or applications that provide information to travelers (e.g., traffic conditions).
- **Center Subsystems**: Systems or applications that process and use information to control the transportation network (e.g., signal timing).
- **Vehicle Subsystems**: Systems or applications that provide driver information and safety on vehicle platforms (e.g., in-vehicle signing).
- **Field Subsystems**: Systems or applications deployed in the field that collect transportation data and are ideally controlled from a center (e.g., traffic signals).

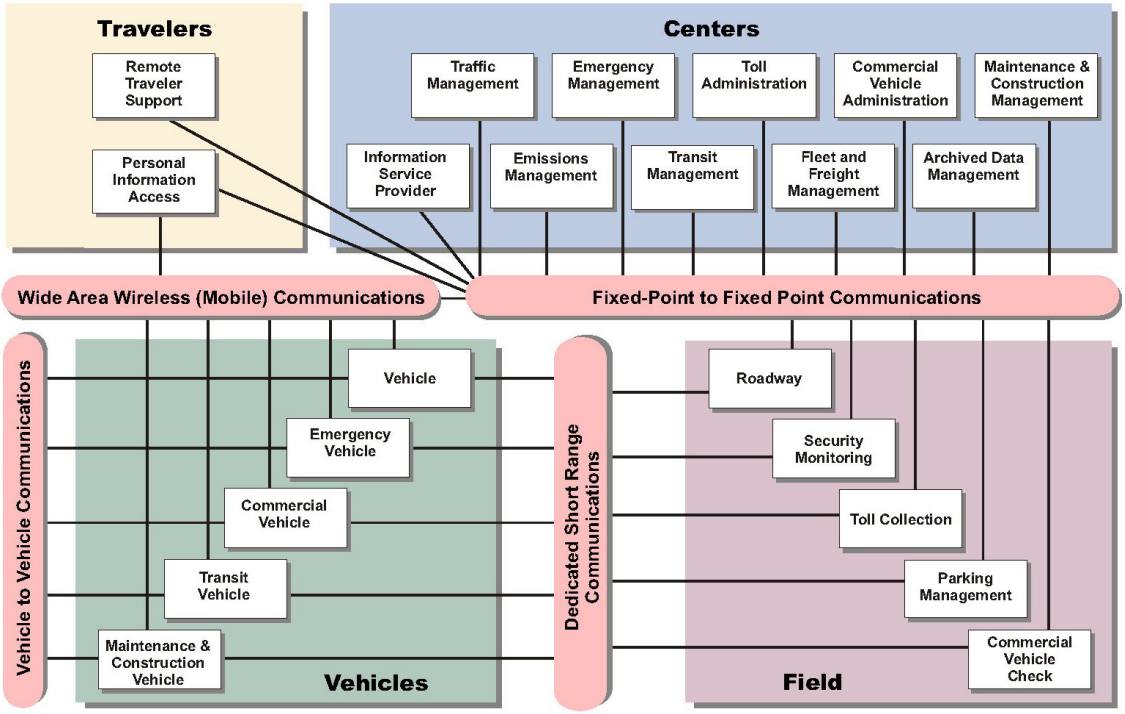


Figure 3-1: National ITS Architecture Subsystems

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, the Transit Vehicle, the Commercial Vehicle, and the Emergency Vehicle subsystems (within the "Vehicle" subsystem category) via short-range wireless links. Communications from the field devices to their respective center would be via fixed-point to fixed-point communications.

3.2.2.1 Equipment Packages

The subsystems generally provide a rich set of capabilities, more than would be implemented at any one place or time. Equipment Packages break up the subsystems into deployment-sized pieces. An example equipment package is Roadway Basic Surveillance, which is part of the Roadway subsystem, and includes fixed equipment used to monitor traffic conditions, including loop detectors and CCTV cameras.

3.2.2.2 Architecture Flows

An architecture flow is simply the information that is exchanged between subsystems and terminators in the Physical Architecture. These architecture flows and their communication requirements define the interfaces which form the basis for much of the ongoing standards work in the National ITS Architecture program. The current US DOT guidelines require that a Regional ITS Architecture be developed at a sufficient level of detail to show subsystems and architecture flows.

3.2.2.3 Terminators

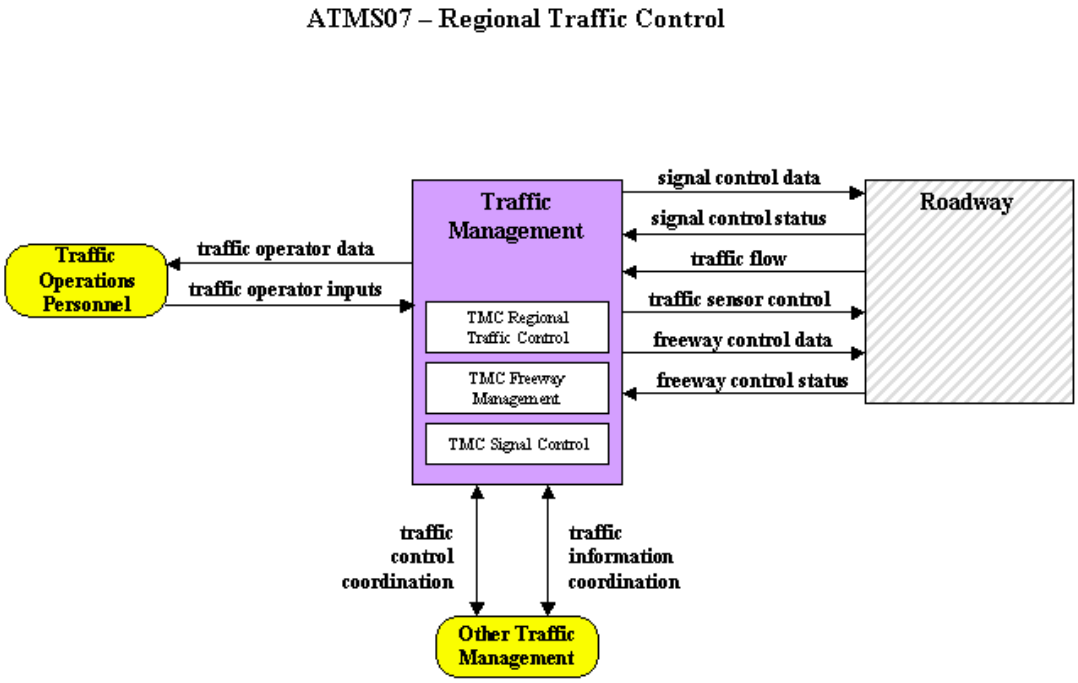
Terminators are generally defined as people, systems and general environment that are outside the boundary or control of ITS but still impact ITS systems. Interfaces between subsystems and terminators need to be defined, but there are no ITS-related functional requirements associated with terminators. Since regional architectures are usually developed from a specific agency(s) perspective, an entity that impacts ITS but is out of the bounds of the primary agency's perspective is called a terminator. This is done to illustrate ownership/ control of the proposed services. Examples of terminators include "Transit Vehicle Operator", "Other Traffic Management" (such as a traffic management center that is outside of the study area but that still interacts with entities within the study area), and "Financial Institution" (such as a bank that holds revenues from transit fares or toll collection).

3.2.2.4 Market Packages

Market Packages provide an accessible, deployment-oriented perspective to the National Architecture. Market Packages group various elements of the physical architecture (subsystems, equipment packages, architecture flows, and terminators) together to provide a specific ITS service. A key step in the Regional ITS Architecture development process is selecting which of the 85 National ITS Architecture market packages are applicable to the region and the status of deployment (existing or planned) of each. From that point, the Market Packages are reviewed individually to determine which physical architecture components in each are applicable to the region.

As stated in the previous paragraph, market packages are essentially a grouping of the physical ITS elements that are needed to provide a particular ITS service. For example, in the National ITS Architecture, the Market Package "Regional Traffic Control" is made up of the subsystems "Traffic Management" and "Roadway", as well as the terminator "Other TM" (see Figure 3-2 on the following page). The service to be provided is "regional traffic control". Key subsystems are Traffic Management and Roadway. The specific Equipment Package needed is "TMC Regional Traffic Control." This Equipment Package provides capabilities for analyzing, controlling, and optimizing area-wide traffic flow. These capabilities provide for integrating control of a network signal system with control of freeway devices, with the goal of providing the capability for real-time traffic adaptive control. The terminator "Other TM" shows that the information collected must be accessible by other traffic management centers. The architecture flow indicates that "traffic information coordination" and "traffic control coordination" will be exchanged between the "Traffic Management" subsystem and "Other TM" terminator.

Figure 3-2: ATMS07 – Regional Traffic Control



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

- **Advanced Traffic Management Systems (ATMS)**: Manage operation of the roadway network.
- **Advanced Traveler Information Systems (ATIS)**: Provide real-time information to travelers.
- **Advanced Public Transportation Systems (APTS):** Manage transit operations and make transit use more convenient and safer.
- **Emergency Management (EM)**: Manage emergency response operations.
- **Maintenance and Construction Management (MCM)**: Manage maintenance and construction activities and operations.
- **Commercial Vehicle Operations (CVO)**: Provides for the electronic monitoring of commercial vehicle safety assurance and regulation, and exchange of related information.
- **Archived Data Management (AD)**: Store and retrieve transportation system information for future analysis.
- **Advanced Vehicle Safety Systems (AVSS)**: Adds capability for improved safety to vehicles. Generally AVSS are private-sector industry initiatives.

Finally, Market Packages can be traced back to corresponding User Services to show how a given Market Package is relevant to a region.

3.2.3 National ITS Architecture Update: Version 5.0 Security Emphasis

Version 5.0 of the National ITS Architecture, released in 2003, is currently the most recent version of the Architecture. With this newest version, the US DOT has recognized the role of ITS in heightened national security, including both security uses for ITS devices that extend beyond transportation, as well as the need to protect those systems that are becoming more and more crucial to the performance of roadway networks. The following is a summary of security-related additions found in Version 5.0[6]:

- **Enhancement of Security Coverage**: The most significant Version 5.0 enhancement is the improvement of the coverage of transportation security in the National ITS Architecture. These improvements include updates to the physical architecture, market packages, logical architecture, and supporting documentation. Using ITS to Enhance Transportation Security is addressed in the following areas: Transit, Rail, Freight and Commercial Vehicle, Hazardous Materials (HAZMAT), Wide Area Alerts, Transportation Infrastructure, and Disaster Response and Evacuation. In addition, guidance is now offered on ways in which ITS can be made more secure. A new security document was created to define and present aspects to ITS-related surface transportation security and their applicability to the National ITS Architecture. It provides context and guidance for using the security-related parts of the National ITS Architecture when developing regional and project ITS architectures.
- **New Disaster Response and Evacuation User Service**: Disaster Response and Evacuation was added as the 33rd user service to the architecture. The new user service supports the activities and responsibilities for responding to and recovery efforts for a major disaster. It also supports evacuation and reentry activities. The inclusion of the new user service required additions to the physical architecture, the introduction of several new Market and Equipment Packages, and updating supporting architecture documentation.
- **New Security Monitoring Subsystem**: A new Security Monitoring Subsystem was added that includes surveillance and sensor equipment used to provide enhanced security and safety for transportation facilities or infrastructure.

[6] National ITS Architecture, "What's New" http://itsarch.iteris.com/itsarch/html/whatsnew/whatsnew.htm November 2003.

3.3 DESCHUTES COUNTY REGIONAL ITS ARCHITECTURE

This section is a further discussion of National ITS Architecture user services, subsystems, and market packages, as they apply to the Deschutes County region. Additional detail may be found in the Deschutes County Turbo Architecture database.

3.3.1 Deschutes County User Services

Based on the user needs assessment and the associated expanded stakeholder meeting (discussed in Chapter 2), the following user service bundles were selected to address the transportation system needs in the Deschutes County region:

- Travel and Traffic Management
- Public Transportation Management
- Emergency Management
- Information Management
- Maintenance and Construction Management

The full list of user service needs is included in Chapter 2. These needs were rolled up into major categories, and the user service bundles were selected by mapping the major categories of user needs to the National ITS Architecture user services. Table 3-1 presents this mapping.

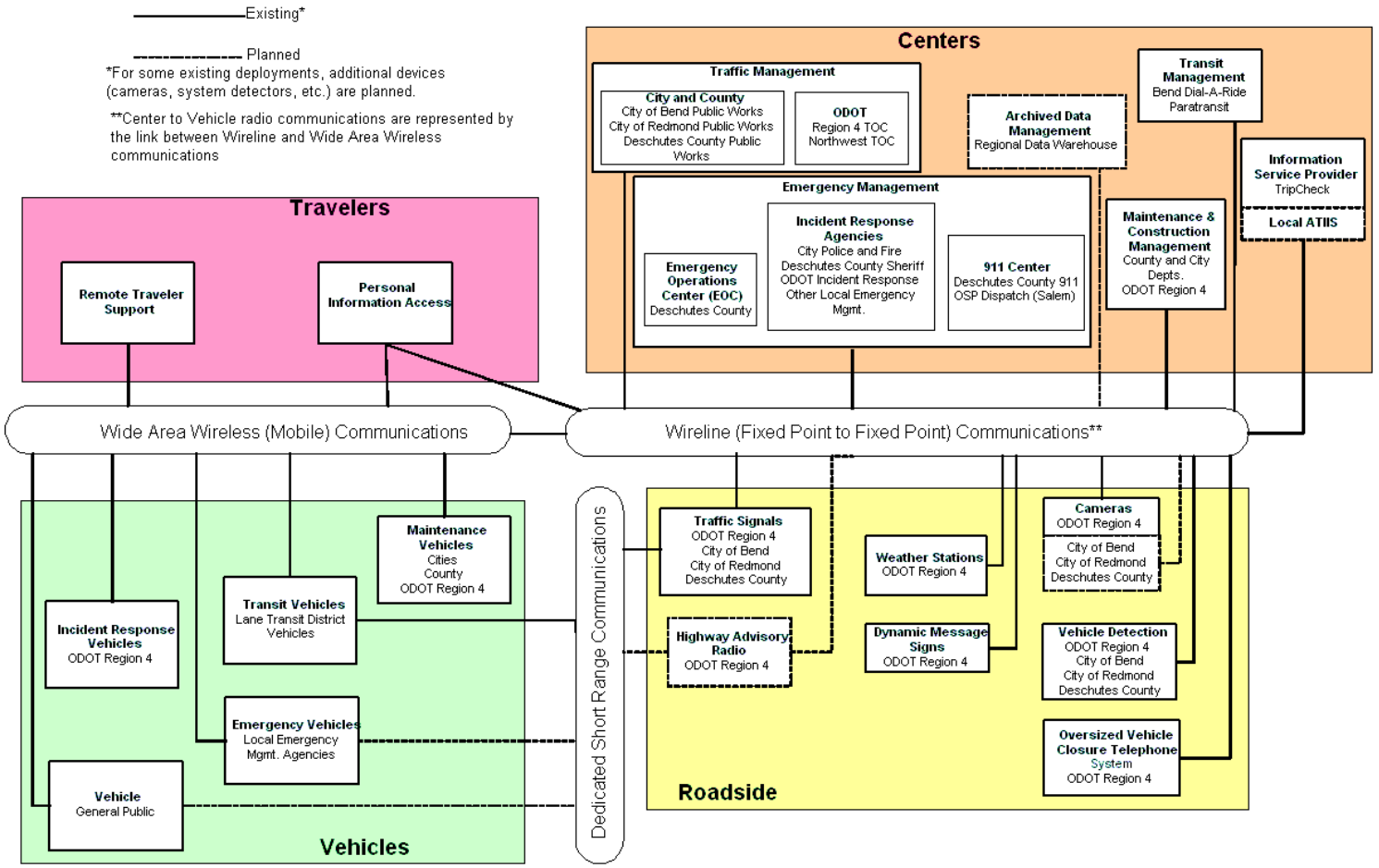
3.3.2 Deschutes County Physical Architecture Subsystems

Figure 3-3 is a version of Figure 3-1, customized for the Deschutes County region. The intent is to show the existing and planned subsystems in the region, and the types of communications links between them.

User Need Areas	Travel and Traffic Management										Public Transportation Mgmt.				Electronic Payment	Emergency Mgmt.			Information Mgmt.	Maintenance & Construction Mgmt.
	Pre-Trip Travel Info.	En-Route Driver Info.	Route Guidance	Ride Matching & Reservation	Traveler Services Info.	Traffic Control	Incident Mgmt.	Travel Demand Mgmt.	Emissions Testing & Mitigation	Highway-Rail Intersection	Public Transportation Mgmt.	En-Route Transit Info.	Personalized Public Transit	Public Travel Security	Electronic Payment Services	Emergency Notification & Personal Security	Emergency Vehicle Mgmt.	Disaster Response & Evacuation	Archived Data Function	Maintenance & Construction Operations
Traffic Operations & Management						√	√	√		√				√					√	
Special Events	√	√	√	√	√	√	√				√				√					√
Communications	√	√				√	√									√				
Traveler Information	√	√	√	√	√								√	√						√
Maintenance & Construction Management																				√
Emergency Management Operations							√							√		√	√			
Incident Management							√									√	√			√
Public Transportation Management			√	√							√	√	√	√	√					
Information Management						√													√	

Table 3-1. User Needs Mapped to ITS Architecture User Services

Figure 3-3: Deschutes County Physical Architecture



3.3.3 Deschutes County Market Packages

Table 3-2 lists all of the market packages, grouped by user service bundles, which are encompassed by the Deschutes County Regional ITS Architecture. The table includes key stakeholders associated with each market package. The selection of market packages was based upon existing and planned ITS projects, user needs, and on consultation with regional stakeholders regarding potential future ITS applications. An (E) by the market package name indicates that some systems included in that market package have already been deployed and the market package is considered existing. A (P) by the market package name indicates that the market package is intended for future deployment, and is considered planned. This information is also included in the Turbo Architecture database. Appendix I lists market package definitions from the National ITS Architecture for each existing and planned market package listed in Table 3-2. Several "example" market package diagrams (in the style of Figure 3-2) are provided as well.

Table 3-2. Deschutes County Market Packages by Key Stakeholder

Market Package	ODOT Region 4	City of Bend Public Works	City of Redmond Public Works	Deschutes County	Bend Dial-A-Ride	Emergency Mgmt. Agencies
Information Management						
ITS Data Mart (E)	√	√	√	√	√	√
ITS Data Warehouse (P)	√	√	√	√	√	√
ITS Virtual Data Warehouse (P)	√	√	√	√	√	√
Public Transportation Management						
Transit Vehicle Tracking (P)					√	
Transit Fixed Route Operations (P)					√	
Demand Response Transit Operations (E)					√	
Transit Passenger and Fare Management (P)					√	
Transit Security (P)					√	√
Transit Maintenance (E)					√	
Multi-Modal Coordination (P)					√	
Transit Traveler Information (P)					√	
Traveler Information						
Broadcast Traveler Information (E)	√					
Interactive Traveler Information (E)	√					
In-Vehicle Signing (P)	√					
Traffic Management						
Network Surveillance (E)	√	√	√	√		
Surface Street Control (E)		√	√	√		
Traffic Information Dissemination (E)	√	√	√			
Regional Traffic Control (P)	√	√	√	√		
Incident Management System (P)	√	√	√	√		√
Standard Railroad Grade Crossing (E)		√	√			
Advanced Railroad Grade Crossing (P)		√	√			

Market Package	ODOT Region 4	City of Bend Public Works	City of Redmond Public Works	Deschutes County	Bend Dial-A-Ride	Emergency Mgmt. Agencies
Parking Facility Management (P)		√				
Speed Monitoring (E)	√	√	√			
Roadway Closure Management (P)	√	√	√			√
Emergency Management						
Emergency Call Taking and Dispatch (E)						√
Emergency Routing (E)	√	√	√			√
Mayday Support (E)						√
Roadway Service Patrols (E)	√					√
Wide Area Alert (P)	√	√	√	√	√	√
Disaster Response and Recovery (P)	√	√	√	√	√	√
Evacuation and Reentry Management (P)	√	√	√	√	√	√
Maintenance and Construction Management						
Maintenance and Construction Vehicle Tracking (P)	√	√	√	√		
Road Weather Data Collection (P)	√					
Weather Information Processing and Distribution (E)	√	√	√	√	√	√
Roadway Automated Treatment (P)	√					
Winter Maintenance (E)	√					
Roadway Maintenance and Construction (E)	√	√	√	√		
Work Zone Management (P)	√	√	√	√		
Work Zone Safety Monitoring (P)	√					
Maintenance and Construction Activity Coordination (P)	√	√	√	√	√	√

3.4 ITS STANDARDS

This section presents some general information on common ITS standards that are relevant to the Deschutes County area. ITS standards are paving the way for interoperability and interchangeability of ITS equipment. The U.S. Department of Transportation maintains an up-to-date, online summary on the status of ITS standards[7]. This web site provides an explanation of key standards and provides additional contact information for more details. ITS standards are under active development; information is being updated regularly at the US DOT web site and should be consulted for the latest information.

In some cases, agencies may have already procured systems that were developed prior to the development of the ITS standards, or that conform to another set of standards. It should be noted that standards compliance is not federally mandated, assuming that an agency has determined, through their systems engineering analysis, that compliance with ITS standards is not feasible.

3.4.1 Standards and the National ITS Architecture

The National ITS Architecture links standards to market packages as a starting point for determining which ITS Standards may be applicable to a region. The Turbo Architecture database includes recommended/relevant standards for each architecture flow between elements. This information may be output as customized reports for specific architecture elements (such as, all of the potentially relevant standards for exchanging information between the ODOT Region 4 TOC and OSP CAD).

3.4.2 Common Standards

Although the standards development effort is very broad and many standards are still under development, there are a series of common standards that define terms, message sets and foundation standards and that cut across many market packages. These standards form the basis for interoperability among systems by defining a common set of terms and message sets. Key standards that should be adopted and used by regional jurisdictions in the development of ITS applications include:

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

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

[7] U.S. Department of Transportation. *ITS Standards*. May 25, 2003. http://www.standards.its.dot.gov/standards.htm The standards web site includes a searchable database that provides a description and current status information for all standards under development.

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

- **National Location Referencing Information Report**: A basis for location referencing standardization activities by various application communities and Standards Development Organization(s) (SDOs).

- **Standard for Common Incident Management Message Sets (IMMS) for use by Emergency Management Centers (EMC)**: Standards describing the form and content of the incident management messages sets for emergency management systems to traffic management systems (TMS) and from emergency management systems to the emergency telephone system (ETS) or Enhanced 911 (E-911).

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

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

- **Standard for Traffic Incident Management Message Sets for Use by EMCs**: Enables consistent standardized communications among incident management centers, fleet and freight management centers, information service providers, emergency management centers, planning subsystems, traffic/transportation management centers and transit management centers.

These key baseline standards are critical for the deployment of a wide range of market packages because they establish the common vocabulary that allows different systems to speak with each other.

3.4.3 National Transportation Communications for ITS Protocol

National Transportation Communications for ITS Protocol (NTCIP) provides a suite of communications protocols and data definitions for two different types of ITS communications. The first type of ITS communications is between two transportation management centers (or systems) and is called center-to-center (C2C). The second type is called center-to-field (C2F) and is the link from a transportation management system or center to a field device like a traffic signal or dynamic message sign.[8]

[8] Additional information on NTCIP standards is found at the NTCIP web site: http://www.ntcip.org/index.html.

For C2F applications, NTCIP offers the potential for interchangeability and interoperability of equipment from different suppliers on the same system. This family of standards provides both the rules for communicating (called protocols) and the vocabulary (called objects) necessary to allow electronic traffic control equipment from different manufacturers and transportation management centers to operate with each other as a system.[9] Key C2F standards that should be adopted and used by regional jurisdictions are shown in Table 3-3.

Table 3-3. NTCIP Center-to-Field Standards[10]

NTCIP STANDARD	NAME	DESCRIPTION
NTCIP 1201	Global Object Definitions	Provides the vocabulary—commands, responses and information—necessary for general device management, including those objects required for device identification, time-based schedule configuration, and event log configuration.
NTCIP 1203	Object Definitions for Dynamic Message Signs (DMS)	Defines data that is specific to dynamic message signs including all types of signs that can change state, such as blank- out signs, changeable signs, and variable signs.
NTCIP 1204	Object Definitions for Environmental Sensor Stations & Roadside Weather Information Systems	Defines those objects used to describe ambient conditions (including air pressure, wind, temperature, precipitation, sunlight, visibility, and air quality) and pavement conditions (including surface and subsurface temperature, moisture, treatment, etc.)
NTCIP 1205	Data Dictionary for Closed Circuit Television (CCTV)	A database for closed circuit television systems. The format of the database is identical to other NTCIP devices and uses Abstract Syntax Notation One (ASN. 1) representation. Targeted devices include cameras, lenses, video switches, and positioning controls for aiming and identification, such as videotext overlays.
NTCIP 1206	Data Collection and Monitoring Devices	Specifies object definitions that may be supported by data collection and monitoring devices, such as roadway loop detectors.
NTCIP 1207	Ramp Meter Controller Objects	Specifications for objects that are specific to ramp metering controller operations.
NTCIP 1208	Object Definitions for Video Switches	Deals with the data needed to control a video switch enabling multiple monitors to view multiple video feeds.

[9] U.S. Department of Transportation. *Intelligent Transportation Systems, Standards Fact Sheet.* October 1999, AASHTO/ITE/NEMA TS 3.1, National Transportation Communications for ITS Protocol (NTCIP) Overview.

[10] Source: U.S. Department of Transportation. *ITS Standards*. May 25, 2003.

NTCIP STANDARD	NAME	DESCRIPTION
NTCIP 1209	Transportation System Sensor Objects	Object definitions that are specific to and guide the data exchange content between advanced sensors and other devices in an NTCIP network. Advanced sensors include video-based detection sensors, inductive loop detectors, sonic detectors, infrared detectors, and microwave/radar detectors.
NTCIP 1210	Objects for Signal Systems Master	Defines the objects necessary to manage a field master.
NTCIP 1211	Objects for Signal Control Priority	Defines the management information base for Signal Control and Prioritization (SCP) Systems. It defines individual parameters that represent the configuration, status, and control information that is unique to an SCP and also defines specific groupings of these parameters and others to address the operational configuration, monitoring, and control of the device/entity in a baseline system configuration.

3.4.4 Transit Communications Interface Profiles

The Institute of Transportation Engineers (ITE), with funding from the US Department of Transportation's Joint Program Office for ITS, is managing the Transit Communications Interface Profiles (TCIP) Project. The U.S. DOT defines TCIP as a suite of data interface standards for the transit industry, and states that TCIP standards define the information and information-transfer requirements among public transportation vehicles, transit management centers, other transit facilities, and ITS centers. TCIP standards also identify mechanical and electrical interfaces (physical layer) and methods for ensuring data integrity (data-link layer), specify required message sets, and provide a common set of conformance requirements. A new version, Version 2.4, has recently been released for review and comment[11].

Compliance with TCIP may or may not a consideration for future advanced transit systems procured by Bend Dial-A-Ride (such as AVL).

[11] Information on the latest TCIP efforts may be found at http://www.standards.its.dot.gov/tcip.htm