



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. DOT¹ 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 Eugene-Springfield, and individual ITS projects proposed in the Implementation Plan, must conform to the National ITS Architecture and other federal ITS resolutions.

This chapter is intended as an accompaniment to the Turbo Architecture² database that was developed for Eugene-Springfield, as explained below. The following sections provide an overview of the National ITS Architecture, a description of the process used to select ITS Architecture market packages and architecture flows for the Eugene-Springfield area, and a discussion of potentially applicable ITS standards.

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 database was created for Eugene-Springfield. Turbo Architecture is a software application used as a tool for regional and project-level ITS Architecture development. In developing this database, the following steps were undertaken:

- **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.)

¹ *Intelligent Transportation System Architecture and Standards, Final Rule*. U.S. Department of Transportation, Federal Highway Administration. Jan. 8, 2001.
http://www.its.dot.gov/aconform/archrule_final_1.htm

² *Turbo Architecture Version 2.0*, developed by Iteris under contract to the U.S. Department of Transportation.

Appendix K 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 identified in Chapter 2.

- **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.
- **Steering Committee Input:** The project Steering Committee reviewed the ITS inventory and provided feedback on the appropriateness of the National ITS Architecture market packages that were selected for the region.
- **Architecture Flow 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 Northwest TOC and Eugene 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 M includes a table of the customized architecture flows from the Turbo Architecture database.

The Regional ITS Architecture development process is summarized in Figure 3-1.

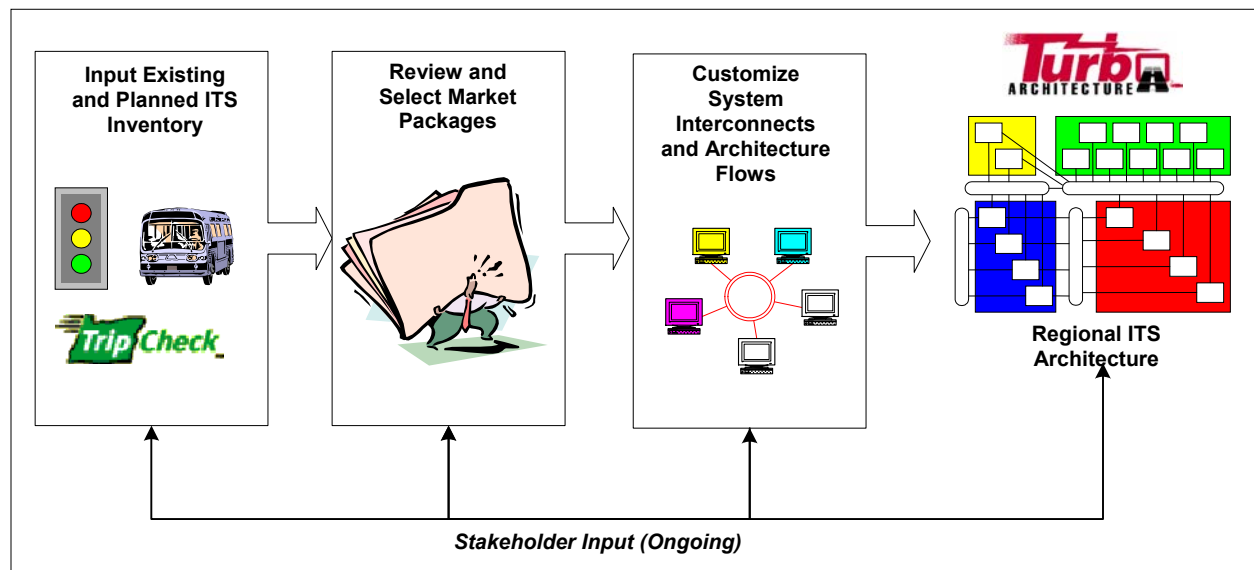


Figure 3-1. Regional ITS Architecture Development Process

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 process and set of associated tools, that reflect the contributions of a broad cross-section of the ITS community

(transportation practitioners, systems engineers, system developers, technology specialists, etc.). The architecture defines³:

- The functions (e.g., gather traffic information or request a route) that are required for ITS.
- 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.

Although the architecture is not technology-specific, it is function-specific. The architecture is employed to structure the planning and design process along with the general functions of ITS systems.

The purpose of developing a Regional ITS Architecture is to compose a guide for planning ITS projects and programs, and to ensure consistency with ITS strategies and projects contained in applicable transportation plans. Having developed a Regional ITS Architecture means that a regional framework for establishing institutional agreement and technical integration for the implementation of ITS projects is in place.

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 are grouped into “bundles” according to broad ITS focus areas. The following is a list of ITS Architecture user service bundles:

- Travel and Traffic Management
- Public Transportation Management
- Electronic Payment
- Commercial Vehicle Operations
- Emergency Management
- Advanced Vehicle Safety Systems
- Information Management
- Maintenance and Construction Management

3.2.2 Subsystems and the Physical Architecture

The physical elements of ITS, including cars, people, roadside devices, buses, computers, etc., are represented by subsystems in the physical architecture. Figure 3-2 is an illustration of a physical architecture provided by the U.S. DOT. This illustration is also known as a “sausage diagram” due to the sausage-like shapes used to represent communications mediums. Physical ITS elements are grouped by subsystem categories, which are functional categories that describe what their member physical entities (subsystems) do.

³ *National ITS Architecture User Services*. U.S. Department of Transportation. June 16, 2002.
<http://itsarch.iteris.com/itsarch/html/user/userserv.htm>

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).
- **Roadside Subsystems:** Systems or applications that process and provide vehicle system data (e.g., traffic signals).

The bubbles (or “sausages”) between the subsystem categories in Figure 3-2 represent the communications medium. For example, the Roadway subsystem (within the “Roadside” subsystem category) could potentially be communicating with the Vehicle, the Transit Vehicle, the Commercial Vehicle, the Maintenance & Construction Vehicle, and the Emergency Vehicle subsystems (within the “Vehicle” subsystem category) via short-range wireless links.

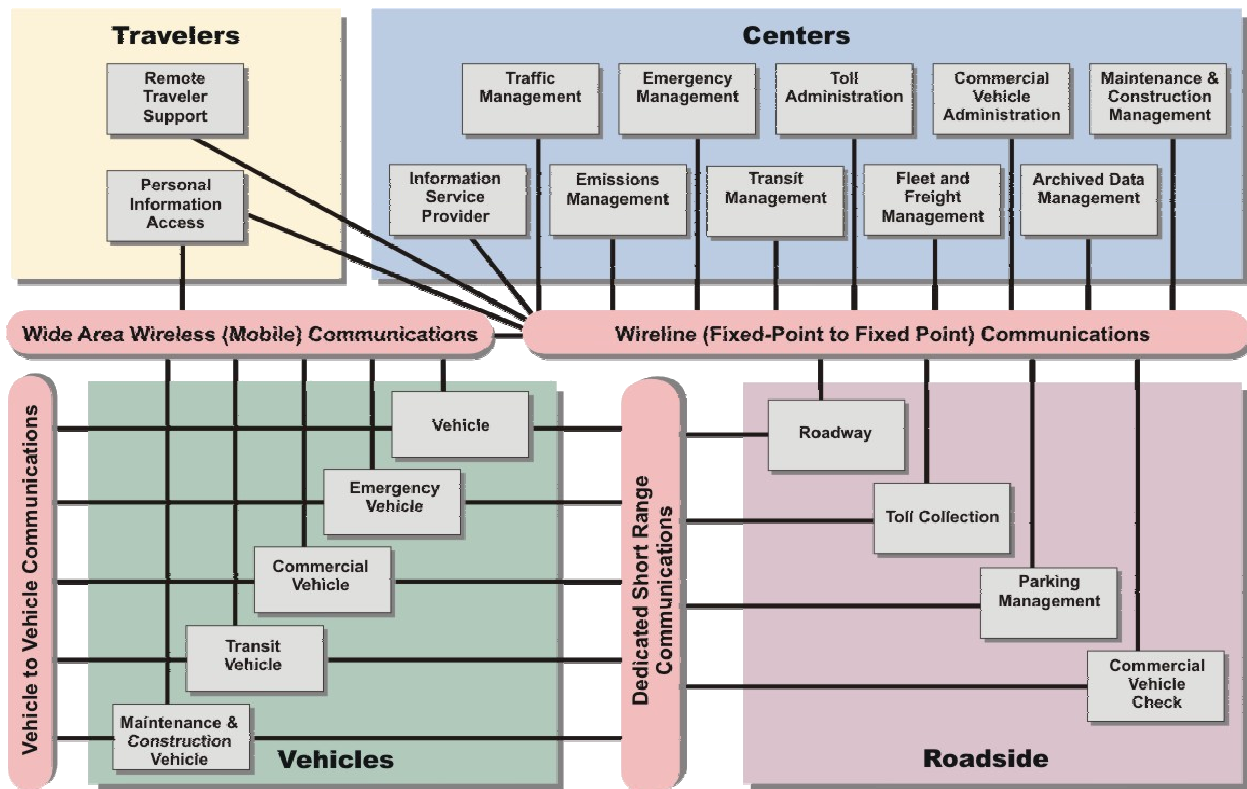


Figure 3-2. National ITS Architecture Physical Entities⁴

⁴ *National ITS Architecture Physical Entities*. U.S. Department of Transportation. June 16, 2002. <http://itsarch.iteris.com/itsarch/html/entity/paents.htm>

3.2.1.1 Terminators

Terminators are generally defined as people, systems and general environment that are outside the boundary 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, a subsystem that is out of the control of the entity's perspective is called a terminator. This is done to illustrate ownership/control of the proposed services.

3.2.1.2 Architecture Flows

Architecture flows are 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 the ITS Architecture be developed at a sufficient level of detail to show subsystems and architecture flows.

3.2.1.3 Market Packages

While the physical architecture components, such as subsystems and architecture flows, provide good tools for organizing the ITS design process, they are difficult to discuss with anyone who is not familiar with the National ITS Architecture. The market packages provide an accessible, deployment-oriented perspective to the ITS National Architecture. They are tailored to fit - separately or in combination - real world transportation problems and needs. Market packages utilize one or more equipment packages that must work together to deliver a given transportation service and the architecture flows that connect them and other important external systems. In other words, they identify the pieces of the physical architecture that are required to implement a particular transportation service. Equipment packages group similar processes of a particular subsystem together into an "implementable" package. The market packages also help in the design process by categorizing improvements and can serve as another check to make sure areas are not over or under covered.

As an example, the market package "Regional Traffic Control" is made up of the subsystems "Traffic Management" and "Roadway", as well as the terminator "Other Traffic Management", as shown in Figure 3-3. The service to be provided is regional traffic control. In order to do this, the entity must have control or access to processes under traffic management and roadway. The specific process needed is included in the equipment package "TMC Regional Traffic Control." This equipment package provides capabilities for analyzing, controlling, and optimizing area-wide traffic flow. These capabilities provide for wide area optimization, integrating control of a network signal system with control of freeway. These integrated systems consider current demand, as well as expected demand, with a goal of providing the capability for real-time traffic adaptive control while balancing inter-jurisdictional control issues to achieve regional solutions. The terminator "Other Traffic Management" shows that the information collected must be accessible by other traffic management centers. The architecture flows indicate that "traffic information coordination" and "traffic control coordination" will be exchanged between the "Traffic Management" subsystem and the "Other Traffic Management" terminator.

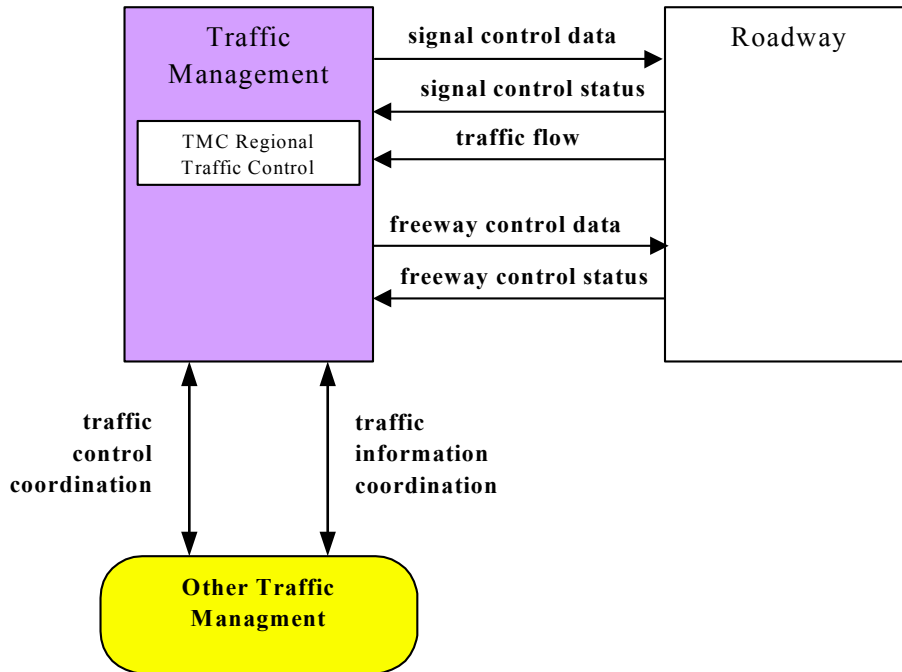


Figure 3-3. Regional Traffic Control Market Package

3.3 EUGENE-SPRINGFIELD REGIONAL ITS ARCHITECTURE

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

3.3.1 Eugene-Springfield 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 Eugene-Springfield metropolitan area:

- Travel and Traffic Management
- Public Transportation Management
- Electronic Payment
- 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.

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

	User Area Needs									
	Traffic Control & Operations	Parking Management	Special Events	Communications	Traveler Information	Maintenance & Construction Operations	Emergency Management Operations	Incident Response	Public Transportation	Information Management
Travel & Traffic Management										
Pre-Trip Traveler Information		√	√	√	√					
En-Route Driver Information			√	√	√					
Route Guidance			√		√				√	
Ride Matching & Reservation			√		√				√	
Traveler Services Information		√	√		√					
Traffic Control	√		√	√						√
Incident Management	√		√	√			√	√		
Travel Demand Management	√									
Highway-Rail Intersection	√									
Public Transportation Management										
Public Transportation Management			√						√	
En-Route Transit Information									√	
Personalized Public Transit					√				√	
Public Travel Security	√				√		√		√	
Electronic Payment										
Electronic Payment Services		√	√						√	
Emergency Management										
Emergency Notification & Personal Security				√			√	√		
Emergency Vehicle Management							√	√		
Information Management										
Archived Data Function	√									√
Maintenance & Construction Management										
Maintenance & Construction Operations			√		√	√		√		

3.3.2 Eugene-Springfield Physical Architecture Subsystems

Figure 3-4 is a version of Figure 3-1, customized for the Eugene-Springfield region. The intent is to show the subsystems involved in the Regional ITS Architecture, and the types of communications links between them.

— Existing *

- - - - Planned

* For some existing deployments, additional devices (cameras, system detectors, etc.) are planned.

** Center to Vehicle radio communications are represented by the link between Wireline and Wide Area Wireless communications

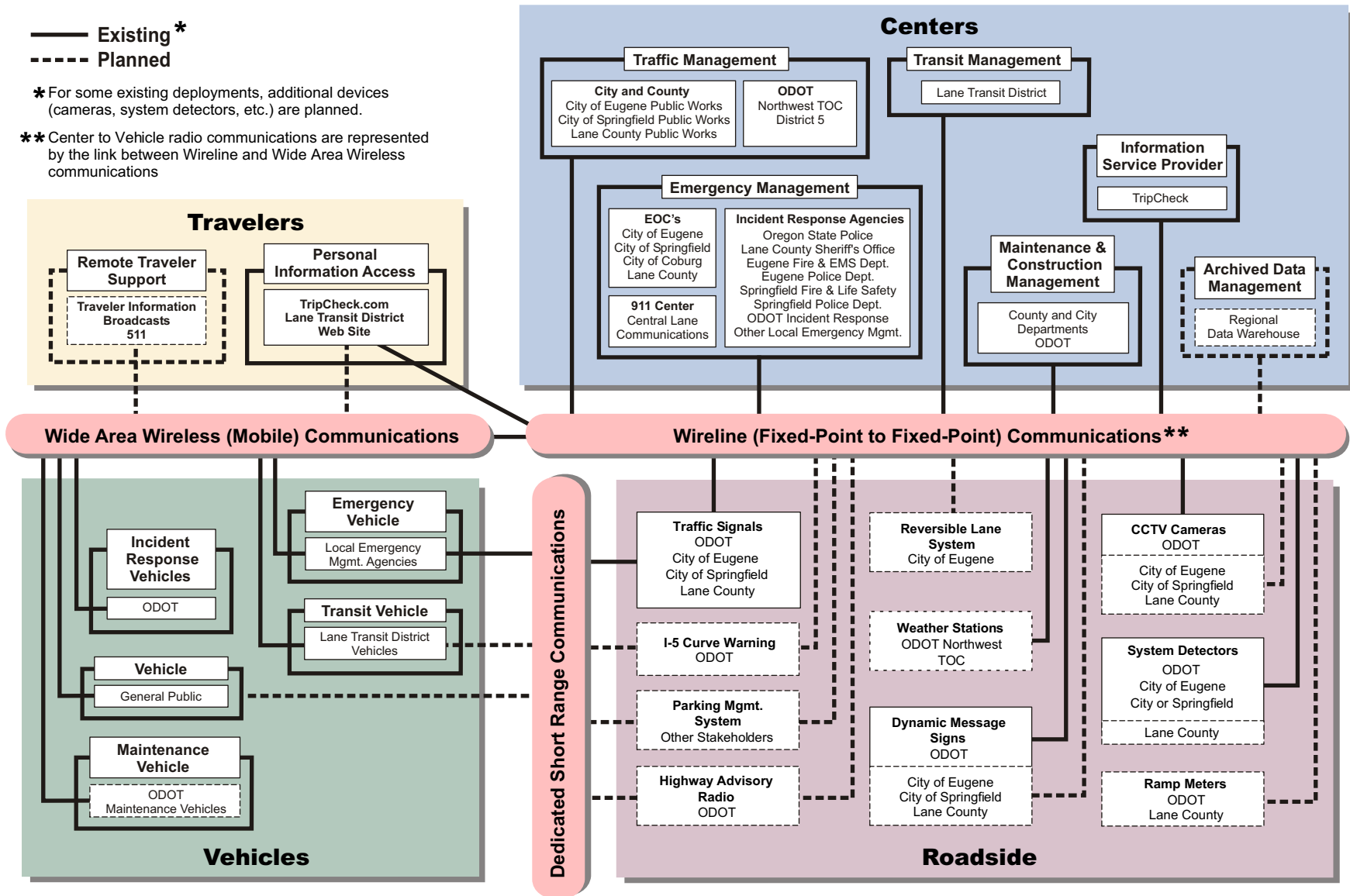


Figure 3-4
EUGENE-SPRINGFIELD
HIGH-LEVEL PHYSICAL ARCHITECTURE

3.3.3 Eugene-Springfield Market Packages

Table 3-2 lists all of the market packages, grouped by user service bundles, which are encompassed by the Eugene-Springfield 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. Appendix L 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 3-3) are provided as well.

Table 3-2. Eugene-Springfield Market Packages by Key Stakeholder

Market Package	ODOT	City of Eugene Public Works	City of Springfield Public Works	Lane County	Lane Transit District	Emergency Mgmt. Agencies	Lane Council of Governments
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 (E)					√	√	
Transit Maintenance (E)					√		
Multi-Modal Coordination (P)					√		
Transit Traveler Information (P)	√				√		
Travel and Traffic Management							
Broadcast Traveler Information (P)	√						
Interactive Traveler Information (E)	√						
In-Vehicle Signing (P)	√						
Network Surveillance (E)	√	√	√	√			
Probe Surveillance (P)		√	√		√		
Surface Street Control (E)		√	√	√			

Market Package	ODOT	City of Eugene Public Works	City of Springfield Public Works	Lane County	Lane Transit District	Emergency Mgmt. Agencies	Lane Council of Governments
Freeway Control (P)	√						
Traffic Information Dissemination (E)	√	√	√				
Regional Traffic Control (P)	√	√	√	√			
Incident Management System (P)	√	√	√	√		√	
Traffic Forecast and Demand Management (P)							√
Standard Railroad Grade Crossing (P)		√	√				
Railroad Operations Coordination (P)		√	√				
Parking Facility Management (P) ⁵							
Reversible Lane Management (P)		√	√				
Speed Monitoring (E)	√	√					
Emergency Management							
Emergency Response (E)	√					√	
Emergency Routing (P)		√	√			√	
Roadway Service Patrols (E)	√					√	
Maintenance and Construction Management							
Maintenance and Construction Vehicle Tracking (P)	√						
Road Weather Data Collection (P)	√						
Weather Information Processing and Distribution (E)	√	√	√	√	√	√	
Winter Maintenance (E)	√						
Roadway Maintenance and Construction (E)	√	√	√	√			
Work Zone Management (E)	√	√	√	√			
Work Zone Safety Monitoring (P)	√						
Maintenance and Construction Activity Coordination (E)	√	√	√	√	√	√	
(E) = Existing, (P) = Planned							

⁵ Some of the expanded stakeholders, (including the University of Oregon), have expressed the desire for advanced parking management systems, including electronic fee collection and monitoring, however, specific involvement of the key stakeholders has not been defined at this time.

3.4 ITS STANDARDS

This section presents some general information on common ITS standards that are relevant to the Eugene-Springfield 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 standards⁶. 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 U.S. 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 Common Standards

There are a series of standards that define terms, message sets and foundation standards that cut across many market packages. These standards form the basis for interoperability among systems by defining a common set of terms and 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.
- **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) (SDO's).
- **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

⁶ *ITS Standards*. U.S. Department of Transportation. May 25, 2003. <http://www.its-standards.net/> The standards web site includes a searchable database that provides a description and current status information for all standards under development.

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 EMC's:** 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.

3.4.2 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.⁷

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.⁸ Key C2F standards that should be adopted and used by regional jurisdictions are shown in Table 3-3.

⁷ Additional information on NTCIP standards is found at the NTCIP web site: <http://www.ntcip.org/index.html>.

⁸ *Intelligent Transportation Systems Standards Fact Sheet: National Transportation Communications for ITS Protocol (NTCIP) Overview*. AASHTO/ITE/NEMA TS 3.1. U.S. Department of Transportation, Federal Highway Administration. Oct. 1999.

Table 3-3. NTCIP Center-to-Field Standards⁹

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.
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.
NTCIP 1301	Message Set for Weather Reports	This standard defines messages used to exchange weather and pavement data between centers. An Environmental Sensor Station consists of both sensors and a microprocessor controller for communication with management centers. Environmental sensors include a wide array of sensors, including those that monitor weather, roadway surface, and air/water quality conditions.

⁹ *ITS Standards*. U.S. Department of Transportation. May 25, 2003. <http://www.its-standards.net/>

3.4.3 Transit Communications Interface Profiles

The Institute of Transportation Engineers (ITE), with funding from the U.S. 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.¹⁰

Lane Transit District will review compliance with TCIP standards as each advanced transit system is procured and deployed; however, most transit ITS vendors are currently not compliant with the draft standards.

¹⁰ Additional information on TCIP may be found at <http://www.tcip.org>.