WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

WASHINGTON STATE INTELLIGENT TRANSPORTATION SYSTEMS ARCHITECTURE

FINAL REPORT

Prepared by

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1. INTRODUCTION

1.1 OVERVIEW

The Washington State Department of Transportation (WSDOT) has long been a leader in the deployment of Intelligent Transportation Systems (ITS). Stemming from projects intended to address the severe traffic congestion in the Puget Sound region, WSDOT's ITS program has grown to include many regional projects outside of the Puget Sound region and several statewide deployments. Traffic surveillance and control, winter maintenance, and traveler information are some of the areas where WSDOT's ITS efforts have recently had a positive impact in addressing Washington's transportation issues. The development of a statewide ITS Architecture will provide a framework to link the separate projects and provide a path to integrate ITS applications across the state.

The Washington Statewide ITS Architecture meets the US DOT's Final Regulations[1] regarding the development of regional ITS Architectures. All jurisdictions using federal highway trust funds for projects are required to have a regional ITS Architecture. While many individual localities and regions in Washington have already adopted a regional ITS Architecture, the state did not yet have a comprehensive document that defined WSDOT's role as a multi-modal transportation agency, a technical framework for systems integration, or an institutional framework for operational integration with local agencies. This statewide ITS Architecture is intended to meet all of these needs, while ensuring that WSDOT is in compliance with the Federal Regulations.

1.2 PROJECT APPROACH

Before the outset of this project, most urban areas in Washington had already developed their own regional ITS Architectures, including:

- Puget Sound
- Thurston County
- Spokane Region (Eastern Region)
- Vancouver Area Smart Trek (Southwest Washington)
- Whatcom County (underway)

These previous efforts provided the basis for the development of the statewide ITS Architecture. However, missing from previous efforts was an examination of ITS requirements in the central portion of the state. To fill in this gap, ITS architectures were developed for two WSDOT regions that encompass this area – North Central and South Central.

The previous work undertaken in developing regional ITS Architectures for Washington encouraged a bottom-up approach to developing this statewide Architecture. An important project task was reviewing and compiling past work, and applying a WSDOT perspective to each regional architecture.

[1] January 8, 2001, U.S. Department of Transportation, Federal Highway Administration, 23 CFR Part 940, FHWA Docket No. FHWA-99-5899 (http://www.its.dot.gov/aconform/archrule_final_1.htm)

Additional project tasks included:

- **Identification of Stakeholders**: Stakeholders were identified by determining those agencies with which an operational link to WSDOT is needed in order to share information.
- **Operational Concept Development**: The operational concept lays the groundwork for interagency communication and coordination, indicating where and how WSDOT will work with other transportation and safety agencies.

Taken together with several statewide ITS initiatives, the statewide ITS Architecture was developed from these current and past efforts.

1.3 ORGANIZATION OF THE REPORT

Following this introduction, this report is divided into nine sections as follows:

Section 2 – Introduction to the National ITS Architecture: This section provides information on the context of ITS Architecture development.

Section 3 – Description of Region: This section provides a description of Washington State, WSDOT as an agency, transportation needs facing Washington, and existing and planned ITS projects.

Section 4 – Identification of Stakeholders: WSDOT's organizational structure, identification of statewide and regional stakeholders.

Section 5 – Operational Concept: The operational concept presents WSDOT's relationship with other transportation and safety agencies in each region, as well as a high-level representational diagram for various ITS program areas.

Section 6 – Agreements between Organizations: Existing and proposed interagency cooperative agreements, plus considerations for developing these agreements.

Section 7 - System Functional Requirements, Interface Requirements, and Information Exchanges: Introduction to the approach of developing physical ITS architecture diagrams from a WSDOT perspective, and detailed description of the elements included in the diagrams. These diagrams are again developed for various ITS program areas, but are shown from a statewide perspective.

Section 8 - Identification of ITS Standards: Introduction to the standards development effort and identification of standards based on the selected Market Packages.

Section 9 - Sequence of Projects Required for Implementation: Identifies any projects that must have precedence over others in order to implement the overall ITS vision for the region.

2. NATIONAL ITS ARCHITECTURE

2.1 INTRODUCTION

This section provides background information on the National ITS Architecture and the final FHWA rulemaking regarding the development of regional ITS Architectures.

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.
- 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.[2]

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 architecture further defines these functions into two categories: physical and logical.

2.2 PHYSICAL ARCHITECTURE

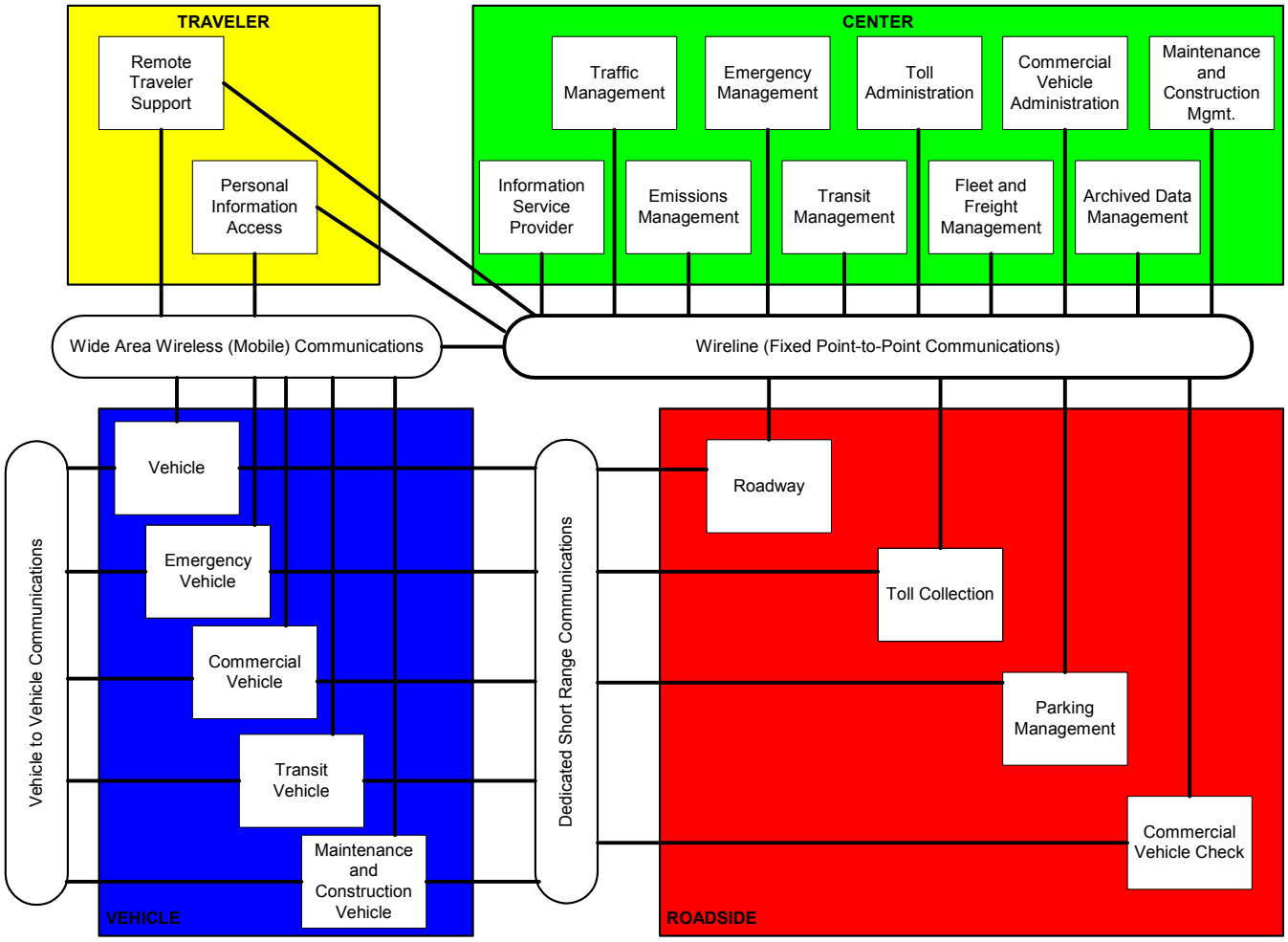
The physical architecture provides a framework for the physical elements of ITS systems. These elements include cars, people, computers, buses, trucks, etc. Figure 1, National ITS Architecture Subsystems, provides an illustration of the physical architecture. The physical elements are broken into large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

The four major subsystem categories are:

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

[2] US DOT, National ITS Architecture, Version 4.0

Figure 1: National Architecture "Sausage" Diagram



The bubbles (or "sausages") between the subsystem categories 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, and the Emergency Vehicle subsystems (within the "Vehicle" subsystem category) via short-range wireless links.

2.2.1 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 or control of the proposed services.

2.2.2 Architecture Flows

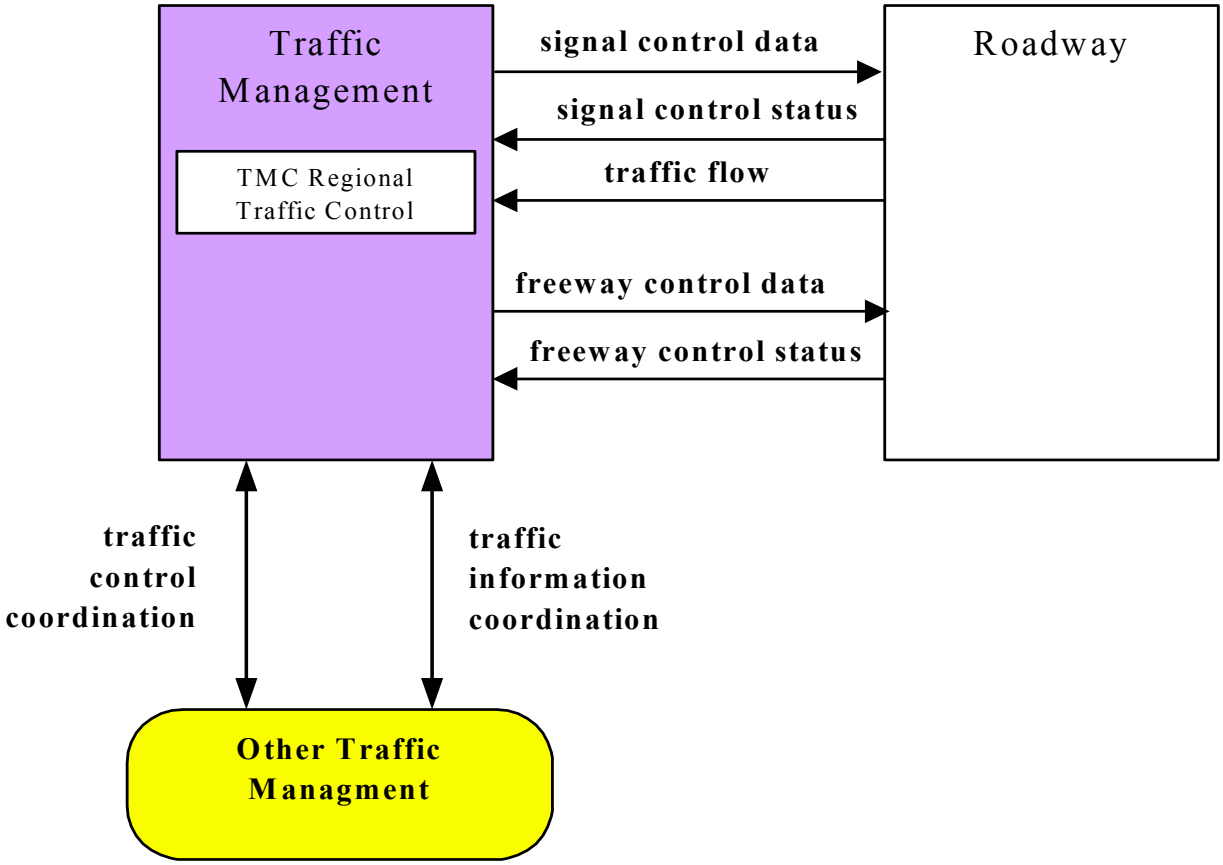
An architecture flow is simply the information that is exchanged between subsystems and terminators in the Physical Architecture. Each architecture flow contains one or more data flows from the Logical Architecture. These architecture flows and their communication requirements define the interfaces which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

2.2.3 Market Packages

While the physical architecture components, such as subsystems and architecture flows, provide a good tool 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 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 like 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.

For example, 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 2). The service to be provided is regional traffic control. In order to do this, the entity must have control or access to physical equipment and processes under the traffic management and roadway subsystems. 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, considering current demand as well as expected demand. The goal is to provide the capability for real-time traffic adaptive control while balancing inter-jurisdictional control issues to achieve regional solutions. 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 2: Regional Traffic Control



Architecture flows represent the information flows between subsystems and terminators. These flows can be broken down further into data-flows and process specifications. This breakdown defines more and more detailed information exchanges between the subsystems and terminators. This level of detail becomes more useful in the project design and implementation stages.

2.3 FEDERAL HIGHWAY ADMINISTRATION (FHWA) REGULATIONS

FHWA has issued a final rulemaking to implement section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21). This section required ITS projects funded through the highway trust fund to conform to the National ITS Architecture and applicable standards. Conformance with the National ITS Architecture is defined as development of a Regional[3] ITS Architecture and the subsequent adherence of ITS projects to the Regional ITS Architecture. The Regional ITS Architecture is based on the National ITS Architecture and consists of several parts including the system functional requirements and information exchanges with planned and existing systems and subsystems along with identification of

[3] The size of the region should reflect the breadth of the integrations effort and is left to the discretion of the cooperating organizations. Thus, a region may be a city, county, state or other defined geographical region where ITS is cooperatively deployed.

applicable standards. The Regional ITS Architecture would be tailored to address the local situation and ITS investment needs.[4] The rule became effective on April 8, 2001.

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. Having developed a regional ITS Architecture means that a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects is in place.

The regional ITS Architecture must include the following elements:[5]

- Description of the Region or Project
- Identification of Stakeholders
- Operational Concept
- Agreements
- System Functional Requirements
- Interface Requirements and Information Exchanges
- Identification of ITS Standards
- Sequence of Projects Required for Implementation

Each of these areas is covered in subsequent sections of this report.

2.4 IMPLICATIONS

The final rule making by FHWA provides the guidance for the development of a regional or statewide ITS Architecture. The individual ITS projects that exist or are planned for the state must all be integrated into an overall regional ITS Architecture. This statewide architecture provides the technical and institutional framework for incorporating existing and planned projects into a larger vision for Washington. The statewide architecture will provide this greater vision for interoperability and collaboration between WSDOT and other state, county and local agencies for the deployment of ITS applications.

[4] January 8, 2001, U.S. Department of Transportation, Federal Highway Administration, 23 CFR Part 940, FHWA Docket No. FHWA-99-5899 (http://www.its.dot.gov/aconform/archrule_final_1.htm)

[5] IBID

3. DESCRIPTION OF WASHINGTON STATE

3.1 GEOGRAPHY AND DEMOGRAPHICS

Washington is a diverse state whose individual regions each present challenges and requirements with respect to the statewide transportation system. For example the Puget Sound area, in addition to its hilly landscape, is home to numerous inlets and islands that add to the cost of road construction while limiting available land. Mountain passes dividing the Eastern and Western sides of the state incur difficult traveling conditions as a result of severe winter weather. National safety concerns require Washington's international border crossings to develop new enforcement programs.

Having an area of 66,582 square miles, Washington is the 20th largest state in the county.[6] As determined by the Census Bureau, the state is home to over 5.8 million residents. The Puget Sound area, with a population of over 3 million, is the densest and most congested region. The state economy includes major industries such as freight, tourism, agriculture, manufacturing, forestry, fishing, technology, and trade. Each economic sector places demand on the state's transportation infrastructure. Thus, Washington's diverse geography, growth rate, and industry require the state to tailor transportation solutions to several regions.

3.2 TRANSPORTATION ISSUES

Washington's transportation system consists of facilities that include state and local roadways, ferries, passenger rail, inter-modal terminals, freight, a navigable river system, and marine ports. The state's cities and towns are linked with a roadway system comprised of over 80,000 centerline miles of state and local roads. WSDOT maintains over 3,000 bridges, 34 tunnels, 43 rest areas, and 97,000 acres of roadside land.[7] The state's ferry system operates 23 ferries from 20 ports of call, providing transportation to over 23 million passengers every year.[8] In line with Washington's explosive population growth and extensive infrastructure, substantial transportation issues have emerged. It is expected that solutions to many of these issues lie within expanded ITS planning and deployment. These issues that have an ITS component are listed below:

- **Extensive Traffic Congestion**: The Puget Sound region has severe traffic congestion affecting many major routes. A regional plan has been developed to address this congestion over the long term, however the region needs additional funds to fully implement the plan.
- **Urban and Rural Environments**: Washington's sharp division between eastern and western halves also translates to a division between the transportation needs of the more rural eastern half with the heavily urban western half.
- **Harsh Winter Weather Conditions**: Washington's eastern region and mountain ranges experience heavy snowfall and freezing rain during the winter season. Winter maintenance is a considerable issue for WSDOT. Winter weather preparation activities include testing new technology such as "smart" snowplows, investing in advanced weather forecasting models, and maintaining communications to remote maintenance stations.

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[6] WSDOT, Washington State Highway System Plan, 2003-2022, February 2002

[7] IBID

[8] Go Northwest! web site, www.gonorthwest.com/washington/wavisitor.htm

- **International Border Security**: WSDOT is working to define their role in developing and enforcing border security policies that will not slow the flow of goods between the United States and Canada.
- **Limited Interstate Crossing with Oregon**: Both the I-5 and I-205 bridges between Vancouver, Washington and Portland, Oregon are frequently congested.
- **Incidents and Closures on Mountain Passes**: As mentioned above, severe winter weather conditions have a considerable impact on WSDOT's mountain pass maintenance, as well as making incident response more difficult. In the event of a closure, WSDOT must get the information out as efficiently as possible.
- **Strong export dependency**: Washington's economy is heavily dependent on exports and trade. This dependency requires good relations and cooperation between WSDOT and the air and seaports.
- **Interstate corridors**: Long distance travelers along the I-90 and I-5 corridors need WSDOT to provide coordinated traveler information dissemination procedures. Maintenance and construction efforts must also be coordinated between regions.

3.3 SUMMARY OF ITS DEPLOYMENTS

Numerous ITS projects have been or will be deployed on a statewide basis. General summaries of these deployments are listed below.

- **WSDOT Traveler Information Website**: WSDOT's statewide traveler information web site provides CCTV camera images, weather conditions, and a traffic flow map for all parts of the state.
- **511 Traveler Information Telephone**: 511 has been designated the national phone number to reach location-specific traveler information. Various state and local agencies, as well as cellular providers, have been working together to bring 511 capabilities to Washington. Currently, 511 for traveler information is available only over the Cingular Wireless network.
- **Statewide Highway Advisory Radio (HAR)**: Currently, manual posting and updating of HAR messages to multiple locations is very time-consuming. WSDOT is planning to network their HARs so that changes may be made to multiple sites at one time.
- **Linking Transportation Management Centers (TMCs)**: Several of the existing regional ITS Architectures have identified the need for a communications link between WSDOT regional TMCs and local city and county TMCs. A state wide initiative would link the various WSDOT TMCs together. Linking all of the WSDOT regional TMCs would enable coordinated responses to incidents along cross-state highways that affect travelers in multiple regions.
- **Link to Washington State Patrol (WSP) Computer Aided Dispatch (CAD) System**: This streamlining of operations will open up an electronic information-sharing link between the WSP CAD system and the WSDOT regional TMCs. The State Patrol dispatchers will also be entering incident information into WSDOT's CARS (Conditions Acquisition and Reporting System) where TMC and maintenance personnel can access it.

- **WSDOT Communications Network Infrastructure**: WSDOT has available significant communications infrastructure, including owned fiber optic cable, wireless microwave and radio networks, and leased wireless and landline services. New additions are being planned.
- **Commercial Vehicle Regulatory Compliance**: The Commercial Vehicle Information Systems and Networks program (CVISN) enhances efficiency and safety for truck-drivers, state staff, and the traveling public. Key deployments include Weigh-In-Motion and expedited freight tracking and border clearance.
- **Transit Management**: Transit operations within the state include public transit, state ferries, and passenger rail, plus the potential for future light-rail and monorail systems. Equipment and systems designed to improve service and efficiency for these operations include Transit Signal Priority (TSP) installations, inter-agency multi-modal coordination efforts, and better traveler information and security for ferry passengers.
- **Security Management**: WSDOT is currently defining its role within the newly formed Homeland Security operations. Beginning with the identification of critical infrastructure such as bridges, ports, and borders, the state looks to implement equipment and systems for monitoring and improving communication and coordination between federal, state, and local agencies.
- **Statewide Transportation Operations Center (STOC)**: The Statewide Transportation Operations Center will serve as a clearinghouse for statewide traveler, traffic, and weather information gathered from WSDOT systems, other transportation agencies, and non-transportation agencies such as the media and weather services. This function will enable statewide monitoring of real-time conditions from one location. A second potential function of the STOC will be to develop applications that will make use of other types of transportation data that are not currently being used for traveler information or operations.

4. IDENTIFICATION OF STAKEHOLDERS

ITS stakeholders are those who will plan, deploy, use, and benefit from the development of transportation technologies. All successful ITS projects require stakeholder identification and buy-in. As this regional ITS Architecture focuses on WSDOT's role as a statewide agency, stakeholders may be determined by considering the organizational structure of WSDOT (and selecting the offices that fit the above stakeholder definition) and also by looking at those agencies with which WSDOT interacts in planning and deploying ITS.

4.1 WSDOT ORGANIZATIONAL STRUCTURE

WSDOT is organized into executive staff, five service centers, three modal divisions, and six regional organizations.[9] Appendix A shows WSDOT's organizational chart. The Secretary of Transportation is appointed by the state Transportation Commission and is the executive for WSDOT. Primary WSDOT organizational branches directly impacting ITS include the following:[10]

- **Engineering and Regional Operations**: Includes all of the regional offices, as well as the Environmental & Engineering, Urban Corridors & Northwest Coordination, Maintenance & Operations, and Planning & Capitol Program Management programs.
- **Washington State Ferries**: All aspects of ferry operation and management including maintenance, finance, engineering and information technology.

4.2 REGIONAL ARCHTECTURE STAKEHOLDERS

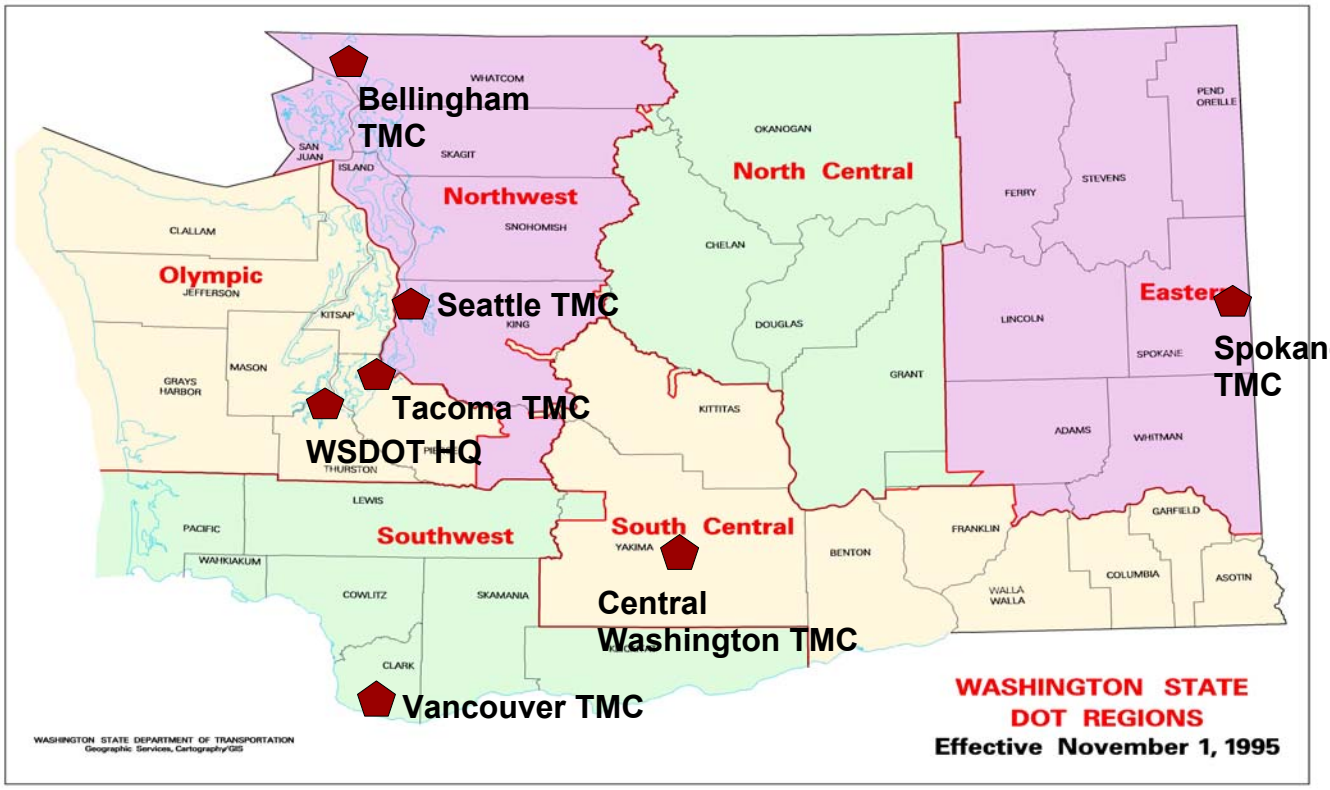
The regional TMCs are the concentration points of transportation management activities for WSDOT. The TMCs are charged with control of ITS equipment, monitoring of roadway conditions, and detection of incidents within WSDOT's regional jurisdictions[11]. The overall goal of the regional TMCs is to maximize the use of the existing transportation network within that jurisdiction. The information collected and disseminated by the TMCs helps motorists to make better trip planning decisions; resulting in reduced congestion, fewer secondary collisions, and improved air quality. Figure 3 shows the locations of WSDOT TMCs across the state.

[9] Source: WSDOT Key Facts, January 2001

[10] Source: WSDOT Table of Organization, http://www.wsdot.wa.gov/SiteIndex/ExecOrgChart.htm

[11] The Spokane TMC in the Eastern Region is a special case, whereby it is an equal partnership of WSDOT, the City of Spokane, Spokane Regional Transportation Council, and Spokane County.

Figure 3: WSDOT Regional TMCs



In addition to the WSDOT regional TMCs, key stakeholders include the future Statewide Transportation Operations Center in Olympia at WSDOT headquarters, WSDOT maintenance offices, Washington State Patrol, Washington State Ferries, other state and provincial DOTs, and the Camp Murray State Emergency Operations Center.

Other stakeholders include those with whom interagency data sharing is taking place at a regional or local (versus statewide) level. Other stakeholders are local city and county TMCs, local transit agencies, and regional emergency management agencies. Section 5 of this report, Operational Concept, discusses the relationships between the WSDOT TMCs and the other stakeholders.

5. OPERATIONAL CONCEPT

This operational concept is intended to present current and future relationships among Washington transportation and safety agencies, in order to maximize efficient operations for all agencies and to provide the best service to the public. The operational concept defines the relationships among organizations that are required for the deployment and operation of a program area such as congestion or incident management. The operational concept is one of the Federally required pieces of an ITS Architecture.

The operational concept for the Washington Statewide ITS Architecture has been developed with the WSDOT regional TMCs as the primary focus for transportation management. From meetings with stakeholders, it has been determined that WSDOT operations generally fall within nine ITS program areas:

1. **Congestion Management**: Monitoring, response, and management of traffic congestion.
2. **Traveler Information**: Provision of up-to-date, location-specific traveler information.
3. **Incident Management**: Detection, response, management and information dissemination concerning roadway incidents.
4. **Security Management**: A new emphasis area for WSDOT, security management involves exploring security uses for existing monitoring devices and agency partnerships.
5. **Safety Management**: Roadside safety devices intended to warn motorists of hazardous conditions, also tunnel monitoring devices, vehicle Mayday calls to emergency workers, and coordination with public and private driver assistance teams.
6. **Maintenance and Construction Management**: Collection and dissemination of roadway weather conditions information to support maintenance decisions, as well as management of construction relating to highway work zones.
7. **Transit Management**: WSDOT's role in transit management includes working with local agencies to implement Transit Signal Priority, sharing traffic information with transit agencies, and ownership and operation of the Washington State Ferries.
8. **Freight Mobility**: WSDOT's role in the Commercial Vehicle Information Systems and Networks (CVISN) program, as well as WSDOT's part in moving freight efficiently and safely across Washington and international borders.
9. **Data Management**: WSDOT's transportation programs and projects generate tremendous amounts of data; the manipulation and storage of which must be managed.

Relationships between agencies embody two main components 1) the agency-to-agency relationship defines what roles and responsibilities each agency has and 2) the kinds of information exchanges that occur between each agency. Table 1 provides a definition and example for each of the various types of relationships that may occur between WSDOT and partnering agencies as part of an operational concept. The table lists the relationships from lowest to highest level of interaction. The types of relationships begin at no interaction and move through consultation and cooperation, where joint efforts are undertaken but electronic information is not exchanged. Information and control sharing describes increasing levels of electronic information exchange and device control. The remaining relationship covers single-agency operation of field devices.

Table 1: Agency-to-Agency Relationships

Relationship	*Definition*	*"From / To" Example*
Independent	Parties operate independently with no interaction	No interaction.
Consultation	One party confers with another party, in accordance with an established process, about an anticipated action and then keeps that party informed about the actions taken. No electronic sharing of information.	FROM agency provides information on activities to interested TO agencies.
Cooperation	The parties involved in carrying out the planning, project development and operations processes work together to achieve common goals or objectives. No electronic sharing of information.	Both agencies cooperate in the development and execution of common plans, projects, and operational procedures.
Information Sharing	The electronic exchange of data and device status information between parties, for the purposes of coordinated operations, planning, and analysis.	FROM agency will provide status, data, and/or video information from the FROM agency's field devices (e.g., detectors) to the TO agency.
Control Sharing	The ability, through operational agreements, to allow for one party to control another party's field devices to properly respond to incident, event, weather, or traffic conditions	FROM agency is allowed by the TO agency to control the TO agency's field devices (e.g., DMS, select signal timing patterns) for specified defined occurrences
Operations	Agency operates and manages field equipment or units.	FROM agency will operate its own field devices.

Along with these relationship types are associated information types that are typical for agency-agency exchange. Five primary types of information exchanges may be identified. Table 2 provides definition and example for each information flow.

Table 2: Information Flow Definitions

Information Flows	*Definition*	*"From / To" Examples*
Data	The dissemination of data gathered from one party's field devices to another party. Data can include, but is not limited to, traffic, weather, parking, transit data etc.	FROM agency sends data to the TO agency's field devices
Video	The dissemination of live video and still images from one party's field camera's to another party	FROM agency sends live video and still images to the TO agency
Status	The ability for one party to monitor another parties field devices, and receive such information as current signal timing/response plan, current message sets, etc.	FROM agency sends status information on its devices to the TO agency

Information Flows	*Definition*	*"From / To" Examples*
Request	The ability for one party to solicit either data or a command change, such as DMS messaging or signal timings, from another party.	FROM agency requests information or action from the TO agency
Control	The ability for one party to control another party's field devices. Control can include but is not limited to, changing DMS messaging, changing traffic signal timings, camera control, etc.	FROM agency issues control instruction to the TO agency's field devices

The following subsections provide operational concepts for WSDOT in each of the nine program areas identified above. The operational relationships and information exchanges are presented in diagrams[13] that illustrate the focal role of the WSDOT TMCs.

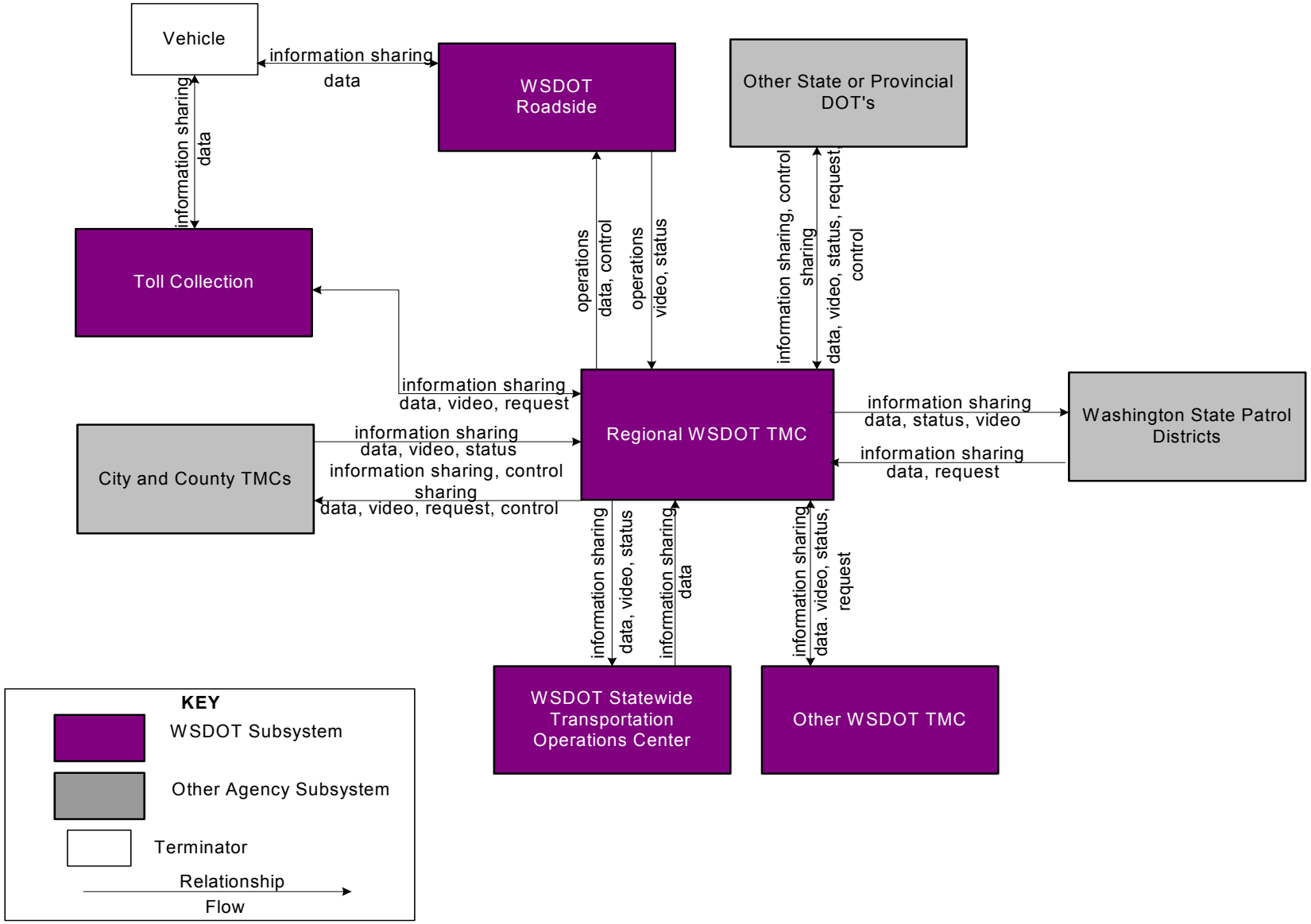
5.1 CONGESTION MANAGEMENT

WSDOT has the overall responsibility to manage congested traffic along the state's freeway system and the arterial roadway system under its jurisdiction. The Congestion Management operational concept is focused on the traffic management practices of the WSDOT TMCs in coordination with the partnering agencies to provide seamless highway system management to the traveling public. The role of the TMCs includes:

- Monitoring traffic conditions along the roadways;
- Managing traffic flow through ramp metering and traffic signals; and
- Providing and exchanging traffic condition and control information, as needed, to minimize and manage traffic congestion.

[13] Regional, City, and County TMCs and Transit Management are shown as separate entities on the operational concept diagrams, however it is recognized that the Spokane TMC is a special cooperative effort of Spokane County, City of Spokane, WSDOT, Spokane Transit Authority and the Spokane Regional Transportation Council.

Figure 4: Washington State Congestion Management Operational Concept



The table below details the typical interactions of a WSDOT TMC with other transportation management entities.

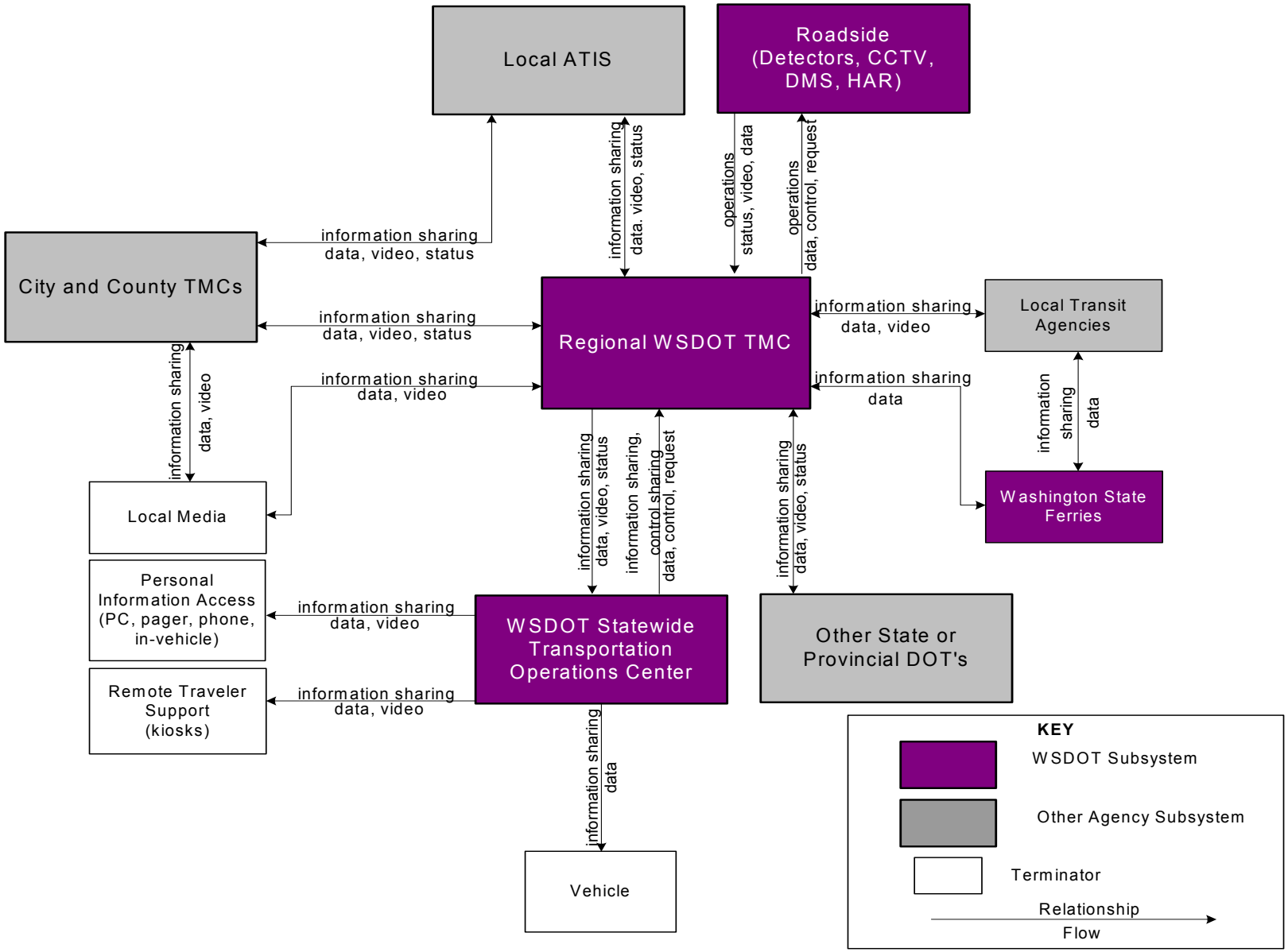
Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
City and County TMCs	Congestion, incidents, and construction on WSDOT roadways have a considerable impact on local streets as traffic backups spill over onto local arterials. Because the traveling public perceives the road network as one highway system, rather than split into local and state jurisdictions, it becomes important to maintain a seamless integration between the WSDOT TMCs and the local city/county traffic management efforts over the entire highway system. Agreements and partnerships (discussed in Section 6) may include sharing highway condition information, sharing ramp metering or traffic signal control, and sharing of CCTV camera control and image access. As the local city and county transportation management applications become more sophisticated, they become a "more equal" partner with regards to the sharing of ITS information and device control.
Other WSDOT TMC	Similar to the relationships with local city and county TMCs, neighboring WSDOT TMCs work together to coordinate traffic management activities relating to roadways that span more than one region, particularly the interstate highways and in the Puget Sound region.
Other State or Provincial DOTs	Other sources of congestion are at border crossings with Canada and Oregon. Waits at the Peace Arch border crossing on I-5 in Blaine often can surpass an hour. I-5 and I-205 are frequently congested along the border with Oregon, with commuters passing between Vancouver, Washington and Portland, Oregon. WSDOT has thus begun to work with other agencies to provide information on border crossing congestion, and partner with the Oregon DOT to develop an interstate traffic management system for the Portland-Vancouver area.
WSDOT Statewide Transportation Operations Center	WSDOT's traveler information web site is a key source of congestion information. CCTV camera images provided by the individual regions are compiled and made available statewide, and traffic flow maps provides a quick visual reference on traffic conditions. The planned Statewide Transportation Operations Center will expand the capabilities of WSDOT headquarters to improve monitoring of traffic conditions.
WSP Districts	In the Puget Sound region, WSDOT's shared control of cameras with the Washington State Patrol enables better incident verification and can aid in reduced congestion (resulting from more rapid response times) when incidents result.

Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
Toll Collection	Toll collection is included as part of congestion management in anticipation of the second Tacoma Narrows Bridge. Traffic monitoring equipment installed, as part of the toll collection infrastructure will provide WSDOT with delay information for the new bridge. The vehicle noted on the diagram above indicates electronic toll collection via a transponder located on the vehicle.
Roadside	The roadside relates to equipment installed by WSDOT along freeways and arterials under the jurisdiction of the State. This relationship in the diagram is repeated throughout the operational concept, and indicates WSDOT's operation of field devices. For Congestion Management, these devices include ramp meters, traffic signals, traffic detectors, and CCTV cameras. It is expected that in the future, "Intelligent Vehicles" will be able to communicate wirelessly with roadside devices that provide traffic conditions information. These are represented by the "Vehicle" terminator.

5.2 TRAVELER INFORMATION

The Traveler Information operational concept shown in the below diagram involves communicating with many of the same entities as Congestion Management. However, for Traveler Information, the focus is on providing information to help travelers make better decisions. This dissemination of the traveler information collected by the TMCs is one of WSDOT's key functions. WSDOT traveler information is exchanged between the regional TMCs, city and county TMCs, local Advanced Traveler Information Systems (ATIS), local transit agencies, Washington State Ferries, and neighboring transportation agencies in other states and Canada. The primary source of traveler information to the general public would be through the WSDOT traveler information web site that would be included as a function of the Statewide Transportation Operations Center.

Figure 5: Washington State Traveler Information Operational Concept

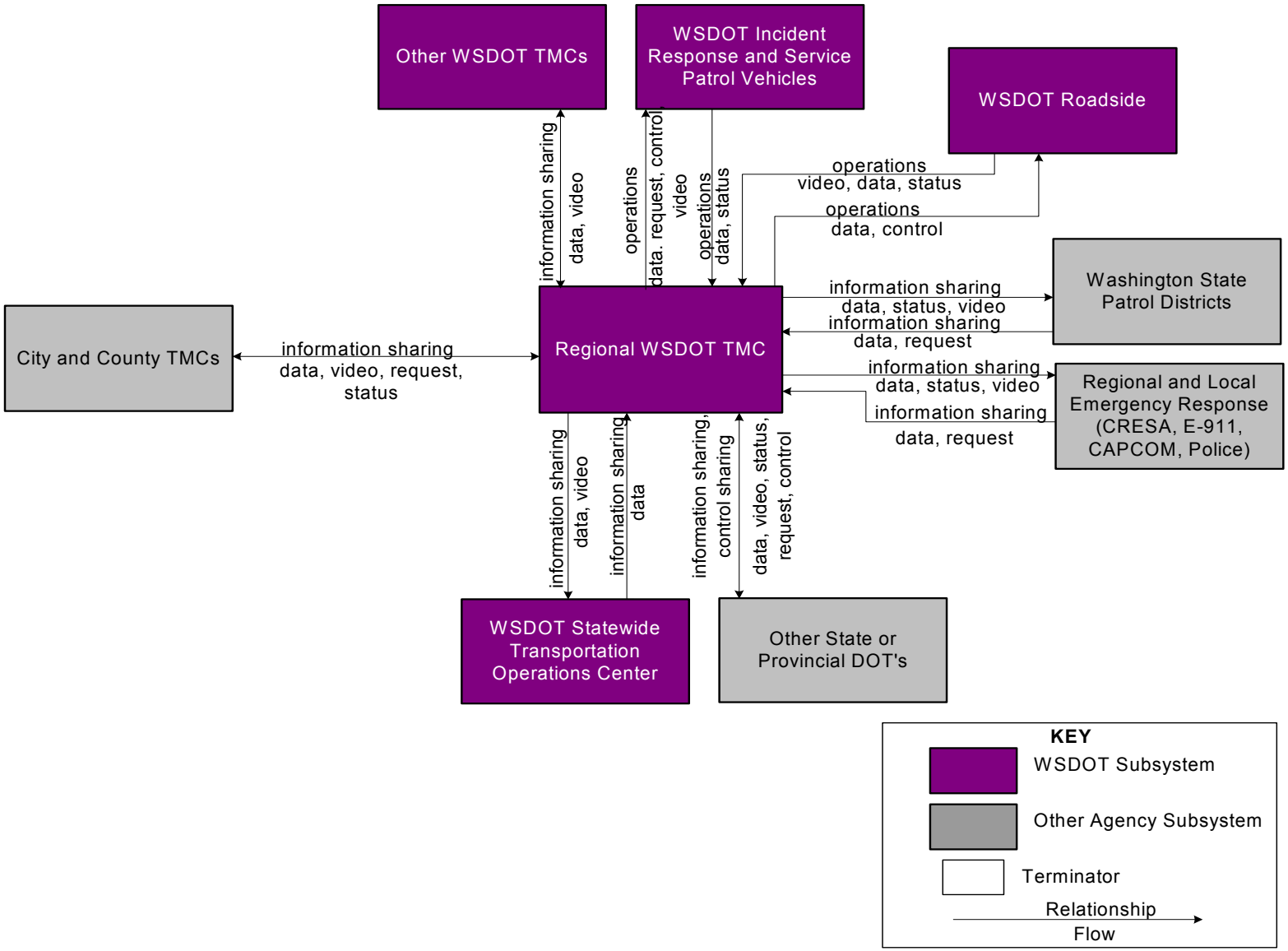


Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
City and County TMCs	Similar to their relationship for Congestion Management, the WSDOT TMCs and local City and County TMCs work together to provide more complete traveler information to citizens, including camera images and road closures.
Local ATIS	In jurisdictions where a local ATIS is operational or planned, both entities can benefit from the sharing of video, data, and device status. Information sharing between a local ATIS and TMC enables both to provide more complete information to travelers.
Other State or Provincial DOTs	As WSDOT works to provide cross-state traveler information, another crucial step is information sharing with DOTs in bordering states and British Columbia. WSDOT in Southwest Washington already works closely with the Oregon Department of Transportation to coordinate traveler information for commuters between Vancouver and Portland.
WSDOT Statewide Transportation Operations Center	The WSDOT Statewide Transportation Operations Center collects traveler information (camera images, construction information, closures, etc.) and disseminates it via the WSDOT web site, 511, kiosks, and eventually in-vehicle computers.
Local Media	A larger audience for WSDOT CCTV camera images and road closure alerts can often be reached via local television news channels. Cooperation with local media is discussed in Section 6, Agreements.
Roadside	DMS and HAR installed at the roadside have traditionally been controlled by the TMC in the region where they are located, and provide information specific only to that region. However, WSDOT's current intent is to centrally network HARs to encourage better cross-corridor communication and more up-to-date HAR messaging.
Local Transit Agencies and Washington State Ferries	These agencies exchange traffic and schedule information with the regional WSDOT TMC in order to improve routing efficiency. Local transit agencies (for example, Kitsap Transit) may exchange information with the WSF for multimodal coordination, improving service for commuters who transfer between bus and ferry.

5.3 INCIDENT MANAGEMENT

In Washington, direct access and control of the state's roadside CCTV camera network, as well as the ability to communicate directly with incident response agencies, give the TMCs an operational role in incident management that spans detection, response, and monitoring. The TMCs share incident information with each other, their counterparts at the local level, neighboring states and provinces, regional emergency response, and the Washington State Patrol. Information is also provided to the WSDOT Statewide Transportation Operations Center, for output to traveler information systems that are accessible by the public via personal devices, and monitoring of major incidents. Despite these advancements, regional and corridor incident management plans have not yet been developed. Future incident management will involve advance event planning, response planning for various potential incidents, and the development of the necessary interagency agreements that will be required.

Figure 6: Washington State Incident Management Operational Concept



Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
City and County TMCs	At the local level, the WSDOT TMCs work with city and county TMCs to better disseminate traffic information and to coordinate potential alternate route usage to minimize the impact of a freeway incident on surface street traffic.
Other WSDOT TMC	Incident information and video will be shared between regional TMCs for the purpose of alerting travelers via their roadside devices before they reach the site of the incident.
Other State or Provincial DOTs	Incident data sharing is in the works for the Southwest Region and the Oregon Department of Transportation.
WSDOT Statewide Transportation Operations Center	The ability to disseminate incident-related road closures and emergencies on a statewide basis reduces congestion by reaching travelers via kiosks and personal devices before they reach the site of the incident.
WSP Districts	A key example of efforts to coordinate incident management is the WSDOT/WSP Joint Operations Policy Statement (JOPS). JOPS has been a successful operational agreement for the two agencies. The document lays out how WSDOT and the State Patrol integrate their operations. This integration has resulted in the sharing of video between the regional TMCs and State Patrol district offices, ability for the officers to request that a particular message be placed on a roadside device, and, in the case of the South Central Region, co-locating of WSDOT and Washington State Patrol traffic management facilities. The State Patrol will soon be updating the status of the Computer Aided Dispatch system with an automatic link to WSDOT, which will also have a positive impact on incident response times.
WSDOT Incident Response and Service Patrol Vehicles	The regional TMCs have the additional responsibility of dispatching and communicating remotely with the WSDOT Incident Patrol Vehicles. The Incident Response Team staff is a specially trained group of WSDOT maintenance employees who respond to blocking incidents on freeways and highways. Their main functions are to clear roads, help drivers and restore the normal flow of traffic as safely and quickly as possible.[14] Particularly in urban areas, it is estimated that incidents cause between 50 and 60 percent of traffic delays.[15]
Regional and Local Emergency Response	Regional emergency response agencies have or will eventually have, the ability to exchange incident information with the regional TMC and request that a particular message be posted to a HAR or DMS. They may also have access to WSDOT CCTV images.
Roadside	Roadside network surveillance enables the automated detection of incidents in real-time, helping the TMCs to expedite a more timely response.

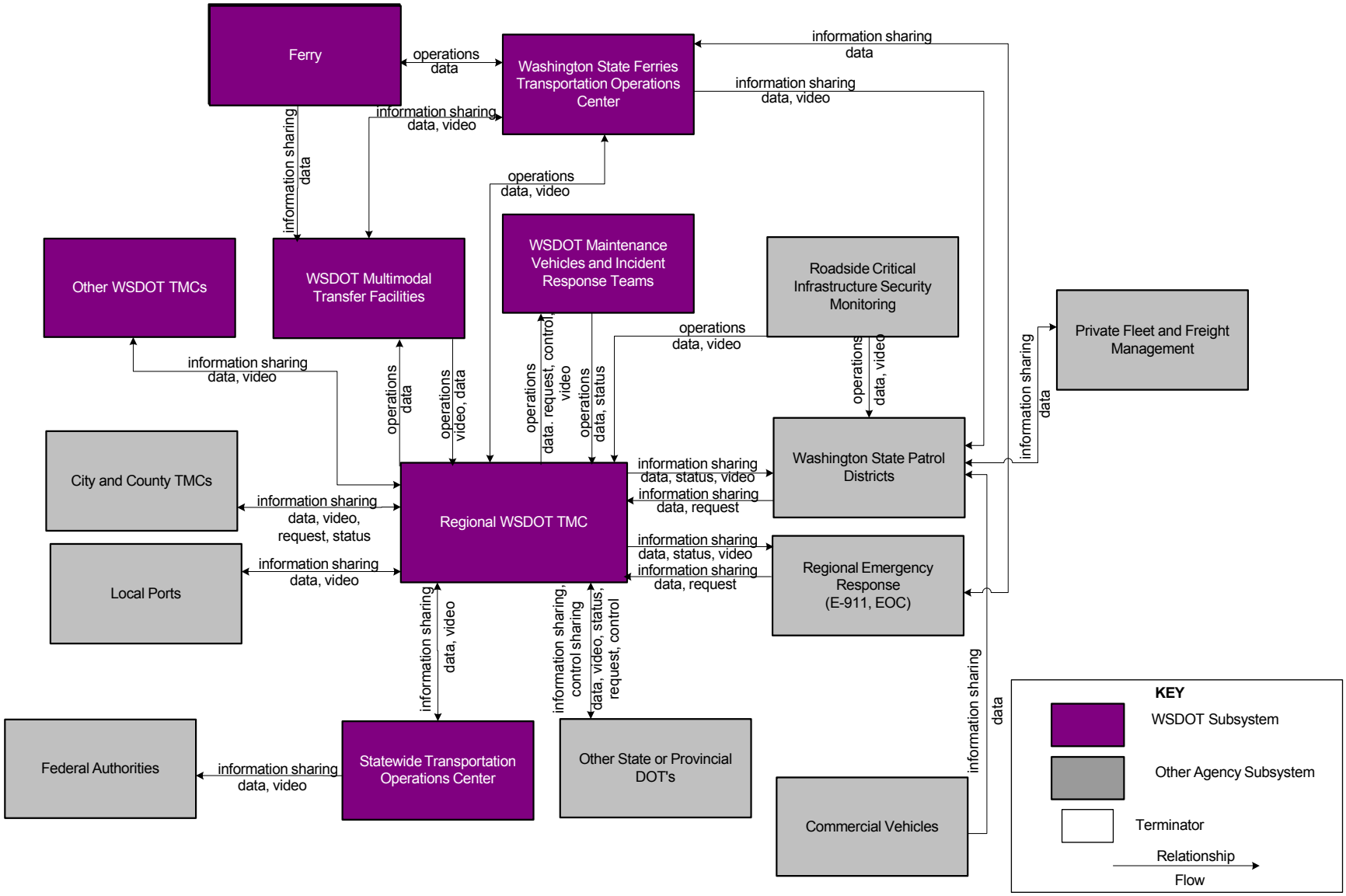
[14] Source: WSDOT press release, July 7, 2002.

[15] *Traffic Incident Management Handbook*, prepared by PB Farradyne, November 2000; page 1-3.

5.4 SECURITY MANAGEMENT

Security is a relatively new program area for WSDOT. While WSDOT has always been in the business of safety, the United States' new emphasis on the prevention of terrorist attacks has caused WSDOT to re-examine its role in maintaining a secure roadway systems infrastructure. The Security Management operational concept diagram depicts the regional TMCs at the center, exchanging information with many of the same agencies as with Incident Management. New emphasis areas include Critical Infrastructure Security Monitoring, ferry vessel security, and HAZMAT security and tracking.

Figure 7: Washington State Security Management Operational Concept



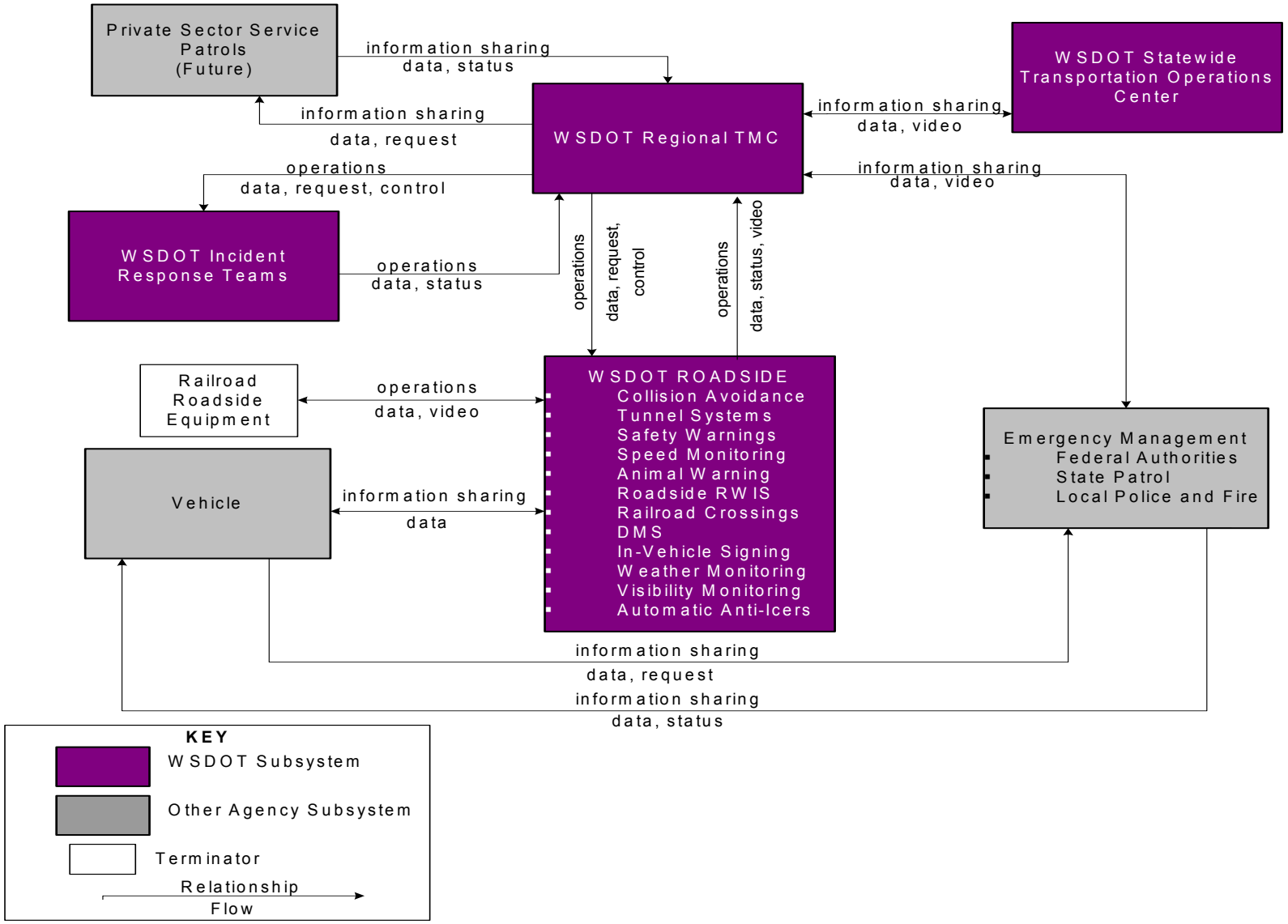
Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
Roadside Critical Infrastructure Monitoring	Roadside Critical Infrastructure Monitoring refers to the deployment and use of monitoring devices on critical roadway infrastructure such as highway bridges and tunnels. To ensure that security needs are met on Washington roadways, WSDOT and the State Patrol will operate CCTV cameras and other equipment that in many cases have or would have already been deployed for traffic monitoring purposes. This example is illustrative of WSDOT's likely overall role in security management – similar responsibilities and agency partnerships, but with a heightened awareness for suspicious behavior on or near critical infrastructure.
City and County TMCs	WSDOT TMCs work with city and county TMCs to monitor critical transportation infrastructure across a wider geographic area, and to disseminate information to travelers. The TMCs also may coordinate alternate route usage to minimize congestion resulting from incidents, and reroute traffic away from incidents.
Other WSDOT TMC	Cautions, closures, and other information and video will be shared between regional TMCs for the purpose of alerting travelers via roadside devices before they reach the site of a security-related incident.
Other State or Provincial DOTs	WSDOT will be working with other states and provinces to coordinate responses to security incidents involving vehicles at the border, i.e., road closures and information dissemination.
WSDOT Statewide Transportation Operations Center	The Washington Statewide Transportation Operations Center will interface with federal authorities to exchange security information and cooperate on response plans, in addition to serving as a central repository for incident information.
WSP Districts	WSDOT will continue to work closely with the WSP in regards to security management.
Regional Emergency Response	Regional emergency response agencies have, or will eventually have, the ability to exchange information with the regional TMC in the event of a security incident, and request that a particular message is posted to a HAR or DMS. They may also have access to WSDOT CCTV images.
WSDOT Incident Response Teams and Maintenance Vehicles	WSDOT Incident Response Teams and Maintenance vehicles are also in a unique position to provide security monitoring as part of their standard operations. These vehicles already have an operational relationship with the TMCs in that the TMC can dispatch the vehicles in response to incidents as well as share video at some time in the future.
HAZMAT Coordination	Coordination between the regional WSDOT TMCs, the Washington State Patrol, Private Fleet and Freight Management, and commercial vehicles will enable safer transport and tracking of HAZMAT materials across Washington.

Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
Federal Authorities	A link to federal security agencies enables security surveillance information can be exchanged between these agencies, regional WSDOT TMC, and the Statewide Transportation Operations Center.
WSDOT Multimodal Transfer Facilities	Multimodal transfer facilities are the park and ride lots and ferry terminals managed by WSDOT. New security measures are being undertaken at both types of facility.
Washington State Ferries Transportation Operations Center	The WSF Transportation Operations Center helps to ensure security on board ferry vessels while they are en-route by staying in constant communication with the ferries. Information is also exchanged with the ferry docks, and shared with the Northwest Region TMC.
Local Ports	Air and seaports are another partner with whom WSDOT will likely have more interaction with as a result of Security Management. In the event of a major security breach at a port, WSDOT may need to coordinate road closures or alternate routing.

5.4 SAFETY MANAGEMENT

Safety management involves optimizing conditions along roadways under WSDOT jurisdiction, in order to ensure safe transport of people and freight. In response to this ongoing need, WSDOT has deployed numerous ITS devices along the roadside. These devices monitor road conditions and alert the regional WSDOT TMCs as well as motorists to potentially perilous conditions. Other safety elements include the dispatching of WSDOT's Incident Response Teams to help keep traffic flowing in the event of both accidents and minor breakdowns. In the future, WSDOT TMCs will be able to coordinate with private sector roadside service dispatchers such as AAA. "Mayday" systems installed on private vehicles and used by motorists to request assistance also play a role in safety management.

Figure 8: Washington State Safety Management Operational Concept



Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
Roadside	The Roadside subsystem is at the center of the Safety Management operational concept diagram because most WSDOT safety monitoring and alert systems are installed at the roadside. These include: • Collision avoidance systems (future) • Tunnel monitoring systems • Wrong way and intersection safety warnings • Speed monitoring and warning signs • Wildlife detection and alerts • Roadside weather monitoring • Highway-Rail intersection safety systems • Dynamic Message Sign traffic alerts • In-vehicle signing (future) • Visibility monitoring • Automatic anti-icing systems These systems are operated by the regional WSDOT TMCs and may interface with private vehicles for electronic in-vehicle alerts.
Private Sector Service Patrols	Many new vehicles are sold with "Roadside Assistance" agreements, and many other motorists join the American Automobile Association (AAA) or other private group that offers assistance in the event of a breakdown. It is WSDOT's intent to communicate with some of these patrols in the future, in order to better coordinate incident response efforts.
WSDOT Incident Response Teams	WSDOT's Incident Response Teams improve safety by helping to rapidly clear accidents and assist motorists. They are dispatched by the regional TMCs.
Vehicle	Equipped vehicles can send Mayday alerts to emergency management agencies and can also receive advanced warning alerts and in-vehicle signing messages from roadside systems.
Railroad Roadside Equipment	Operated at the roadside, this safety equipment provides an interface to highway-rail crossings hardware
Emergency Management	Emergency Management exchanges information with the Regional TMCs and private vehicles in order to coordinate on incident response. Emergency agencies at the local, state and federal levels are included.

5.5 MAINTENANCE AND CONSTRUCTION MANAGEMENT

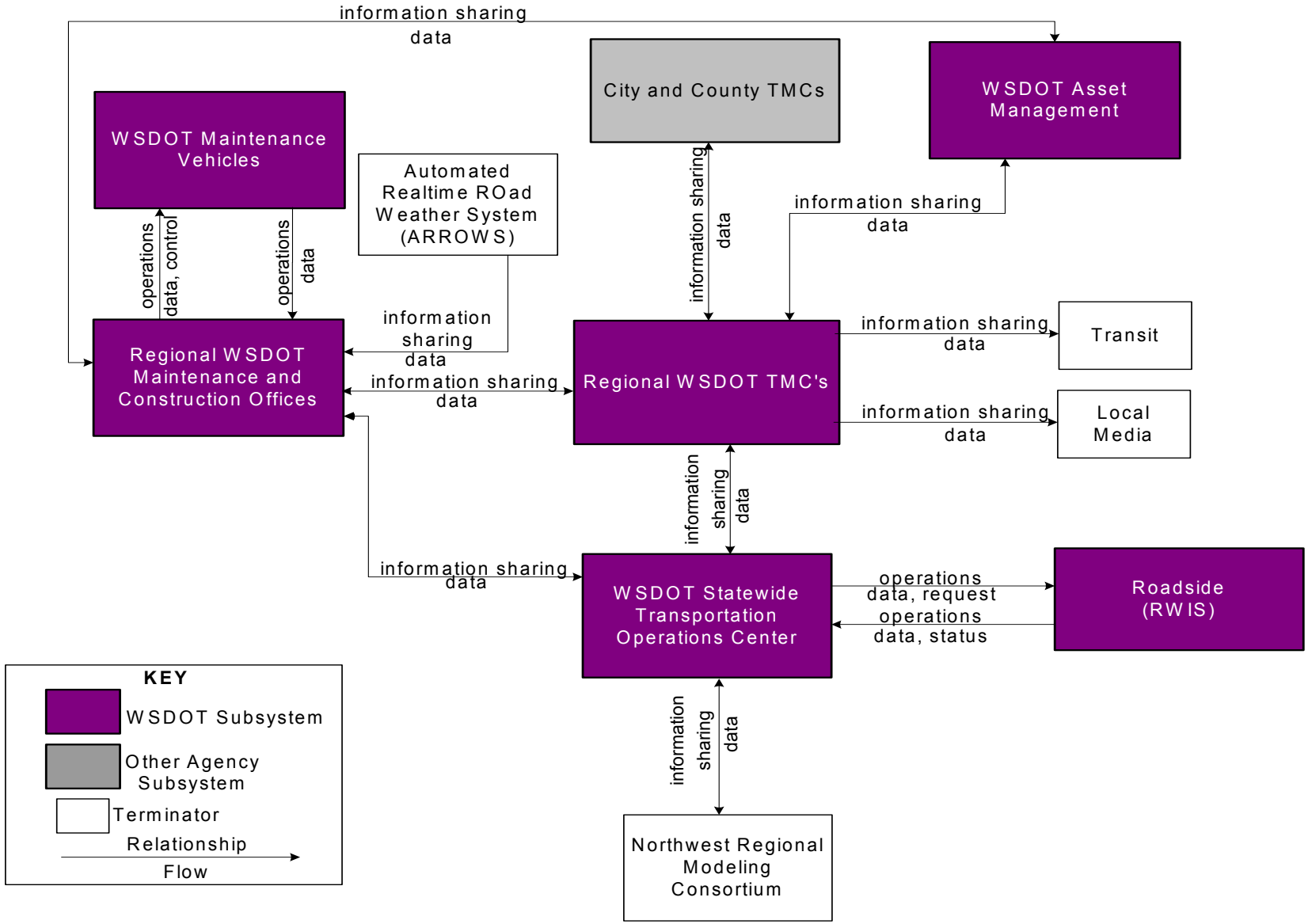
The Maintenance and Construction Management program area involves the collection of road conditions data for scheduling maintenance activities, and the dissemination of planned road construction status and weather information that is likely to result in delays or safety hazards for drivers. The inventory and tracking of WSDOT assets is also included as part of maintenance operations.

WSDOT has deployed an extensive network of Road/Weather Information System (RWIS) sensors. The data collected from these sensors is available to the public from the Traffic and Weather web site. This project collects and disseminates real-time and predictive statewide road and weather information. The program gathers data from a variety of sources and provides statewide weather and road-condition reports and forecasts[16]. Available information includes incidents, construction, mountain pass conditions, video, and audio highway advisory radio messages. WSDOT maintenance personnel may also access real-time "raw" RWIS sensor data from ScanWeb™, a proprietary program.

A decision support tool, ARROWS (Automated Real-time Road Weather System) is being developed as a weather information portal for WSDOT maintenance personnel. ARROWS compiles current and forecasted weather conditions from numerous sources to present maintenance decision-makers with present and predicted statewide weather alerts by time frame and with a measure of confidence indicated.

[16] WSDOT rWeather web site: http://www.wsdot.wa.gov/rweather/

Figure 9: Washington State Maintenance and Construction Management Operational Concept

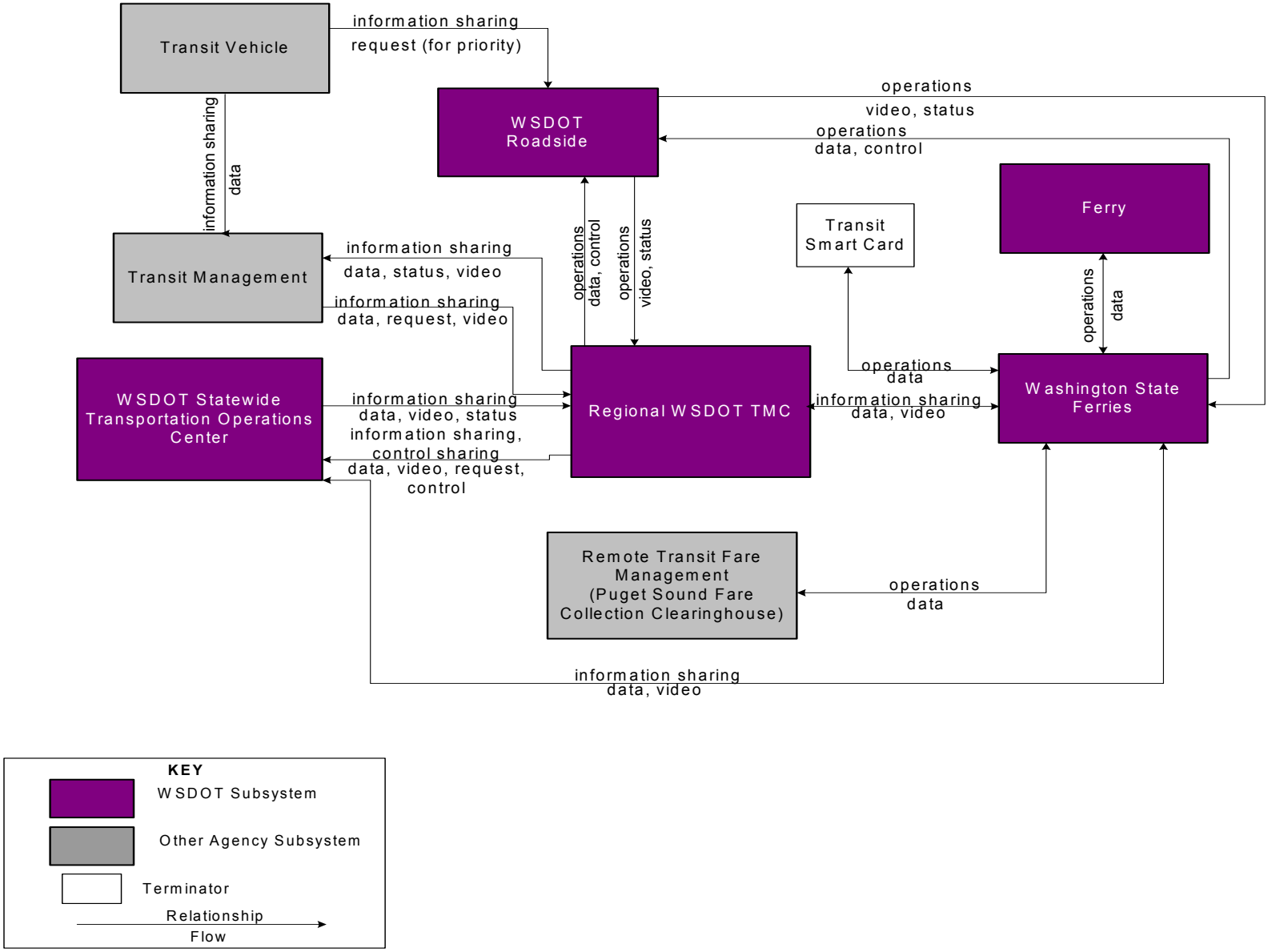


Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
Regional WSDOT Maintenance and Construction Offices	The maintenance and construction offices provide the TMCs with information on their planned activities that might affect traffic on the roadways monitored by the TMC. The TMC may then opt to post a work zone alert message on DMS and/or HAR in the area. These offices dispatch maintenance vehicles and receive road conditions information from vehicles in the field.
WSDOT Statewide Transportation Operations Center	The WSDOT Statewide Transportation Operations Center houses the hardware and software that accesses the RWIS devices in the field and also outputs the information to the Northwest Regional Modeling Consortium where it is calibrated with other local weather information to provide the data output on the Traffic and Weather site. The Statewide Transportation Operations Center also hosts the Traffic and Weather site, which is accessed by the public via kiosks and personal devices.
WSDOT Asset Management	Asset management involves decision-making support for maintenance, upgrade, and operation of physical transportation assets and requires inventorying and managing both "hard" (i.e., maintenance trucks) and "soft" (i.e., people and software) assets. For WSDOT, this information is shared between both the regional TMCs and the Maintenance and Construction offices.
Transit and Local Media	Transit agencies and local media are two groups who frequently request, or have a standing agreement to receive, weather, construction, and maintenance activity information. Media can broadcast this information to better reach the public, and transit agencies can use the information to re-route their vehicles around congested work zones or roads closed due to poor weather.
City and County TMCs	In order to facilitate better traffic management around work zones, the WSDOT TMCs exchange weather alerts and construction schedules and closures with their local counterparts.

5.5 TRANSIT MANAGEMENT

WSDOT's role in transit management includes operation of the Washington State Ferries (operations and fare management), interaction with local transit agencies for information sharing, and implementation of Transit Signal Priority (in coordination with local agencies) on roadways under WSDOT's jurisdiction. Additionally, the MyBus and BusView real-time transit location applications rely upon the WSDOT-funded ITS Backbone for transmitting bus data. The operational concept diagram also includes the future Smart Card electronic fare collection application under development in the Puget Sound region.

Figure 10: Washington State Transit Management Operational Concept



Regional WSDOT TMCs: Partnerships	
Agency	Description of Relationship
Transit Management	WSDOT's relationship with local transit management agencies involves the sharing of video images and traffic conditions, plus cooperation on Transit Signal Priority (TSP). Priority requests may be kept at the roadside and be limited to the late-running transit vehicle requesting priority directly from the signal controllers. Taken a step further, bus location information can be sent from the vehicle to a Transit Management center. If the bus is running behind, Transit Management can request priority from the TMC[17]. Automatic Vehicle Location (AVL) data is required in order for these communications to occur.
Washington State Ferries	Washington State Ferries (WSF) is the largest ferry system in the United States, serving eight counties within Washington and British Columbia, Canada. WSF currently controls ten routes and 29 vessels.[18] The ferry system is both an extension of the highway system as well as a mass transit system. WSF exchanges CCTV video from the ferry docks and other information with the TMCs. The Puget Sound region has been working to implement a regional Smart Card fare management application. A remote fare collection clearinghouse would manage fare collection for the various transit agencies, including city and inter-county bus service and the ferries. This system will require the WSF to collect information from rider Smart Cards.
WSDOT Statewide Transportation Operations Center	Ferry schedule information and ferry terminal camera images are shared with the Statewide Transportation Operations Center, where they are made available to the public via personal electronic devices.
Roadside	As discussed above, transit vehicles can request priority at signalized intersections. CCTV video of the ferry docks is also available to the TMC.

[17] In the Eastern Region, Spokane Transit is co-located at the TMC.

[18] Source: WSDOT

5.6 FREIGHT MOBILITY

"Movement of freight is the circulatory system of our economy. The Puget Sound region is a major North American gateway for trade with Pacific Rim countries, and is the major economic engine for Washington."[19]

The application of ITS technology can help to improve freight mobility through two principal methods. The first is to provide real-time traffic condition information to organizations responsible for fleet and freight management (i.e. trucking companies), commercial vehicles, and air and seaports. As illustrated in Figure 11, the dissemination of traffic condition information begins with the Regional WSDOT TMC gathering data and providing it directly to air and seaports, to en-route truckers through DMS and HAR and to the WSDOT ISP for dissemination to trucking companies.

The second method is under a US Department of Transportation, Federal Motor Carrier Safety Administration (FMCSA) program called CVISN (Commercial Vehicle Information Systems and Networks). "CVISN refers to the collection of information systems and communications networks that support commercial vehicle operations (CVO). These include information systems owned and operated by governments, motor carriers, and other stakeholders. FMCSA's CVISN program is not trying to create a new information system, but rather to create a way for existing and newly designed systems to exchange information through the use of standards and available communications infrastructure. The CVISN program provides a framework or "architecture" that will enable government agencies, the motor carrier industry, and other parties engaged in CVO safety assurance and regulation to exchange information and conduct business transactions electronically. The goal of the CVISN program is to improve the safety and efficiency of commercial vehicle operations".[20]

The development of CVISN in Washington is a cooperative effort among the following organizations[21], as shown in Figure 11:

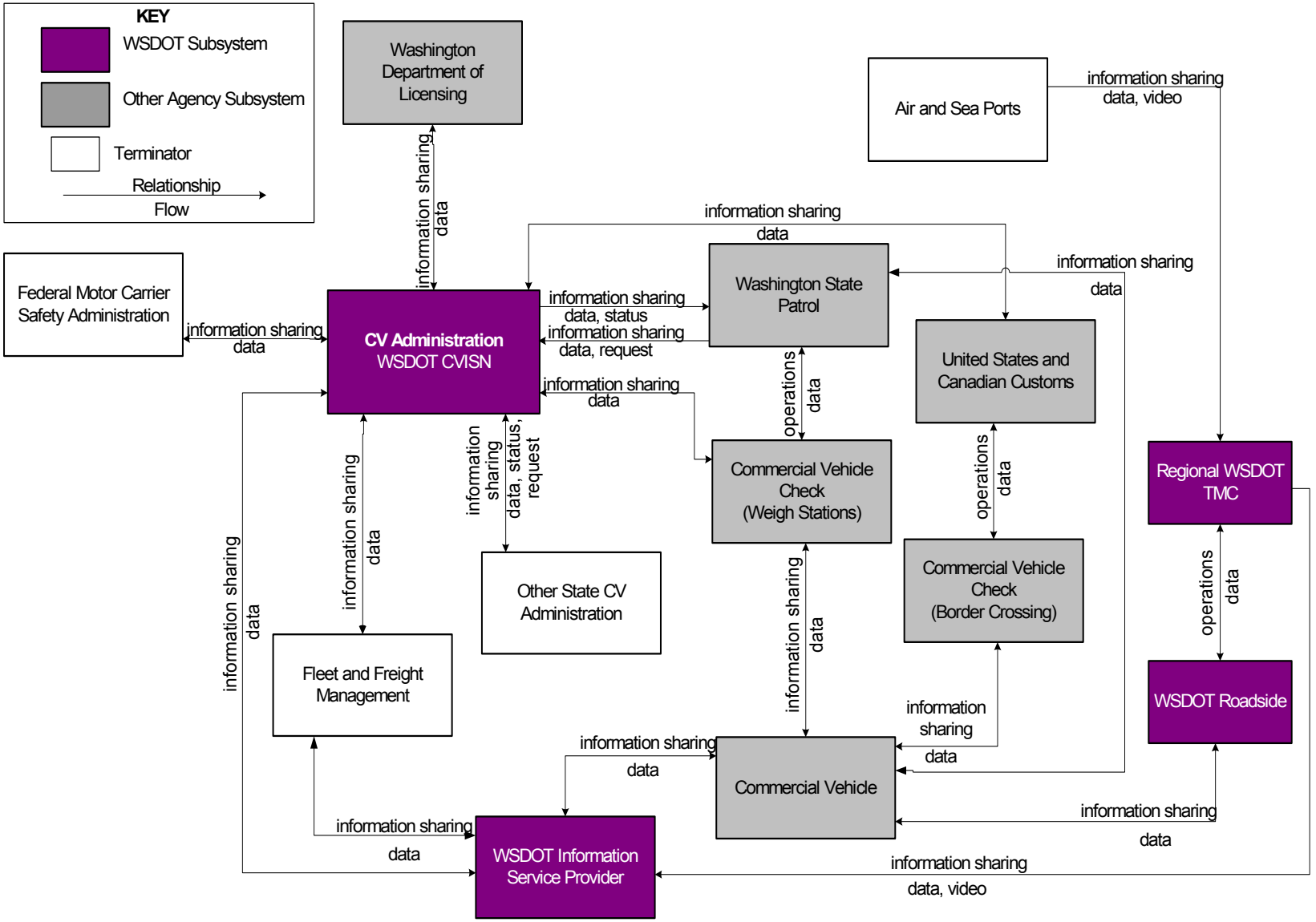
- Washington State Patrol
- Washington State Department of Licensing
- Washington State Department of Transportation
- Federal Motor Carrier Safety Administration

WSDOT is implementing CVISN to enhance safety for drivers and trucks and to improve the operating efficiencies for both government agencies and motor carriers. One aspect of the project allows trucks with proper credentials and the correct weight to by-pass weigh stations. AVI transponders are used to identify trucks and provide a key to a roadside database to check credentials, while Weigh-In-Motion (WIM) sensors measure the weight of the truck. The operational concept diagram below illustrates WSDOT's interactions with other agencies with regards to commercial vehicle operations and information sharing. The latest information on CVISN can be found at the WSDOT CVISN web site: http://cvisn.wsdot.wa.gov

[19] Puget Sound Regional Council
[20] Kim E. Richeson, Introductory Guide to CVISN (POR-99-7186) Preliminary Version P.2, February 2000
[21] WSDOT CVISN web site: http://cvisn.wsdot.wa.gov/

The approach taken by CVISN for electronic transfer of data has been expanded in Washington to allow for the sharing of information at international border crossings with British Columbia.

Figure 11: Washington State Freight Mobility Operational Concept



5.7 DATA MANAGEMENT

The Data Management Operational Concept covers the collection, short-term storage, and eventual archival of WSDOT transportation data. WSDOT's data range from the real-time data used to power the traveler information web site, to yearlong accumulations of traffic count data that will eventually be archived. Future data could include an accurate inventory of existing communications infrastructure and other system and operational performance data. The collection of diverse types of data will require coordination with existing and future management procedures and policies.

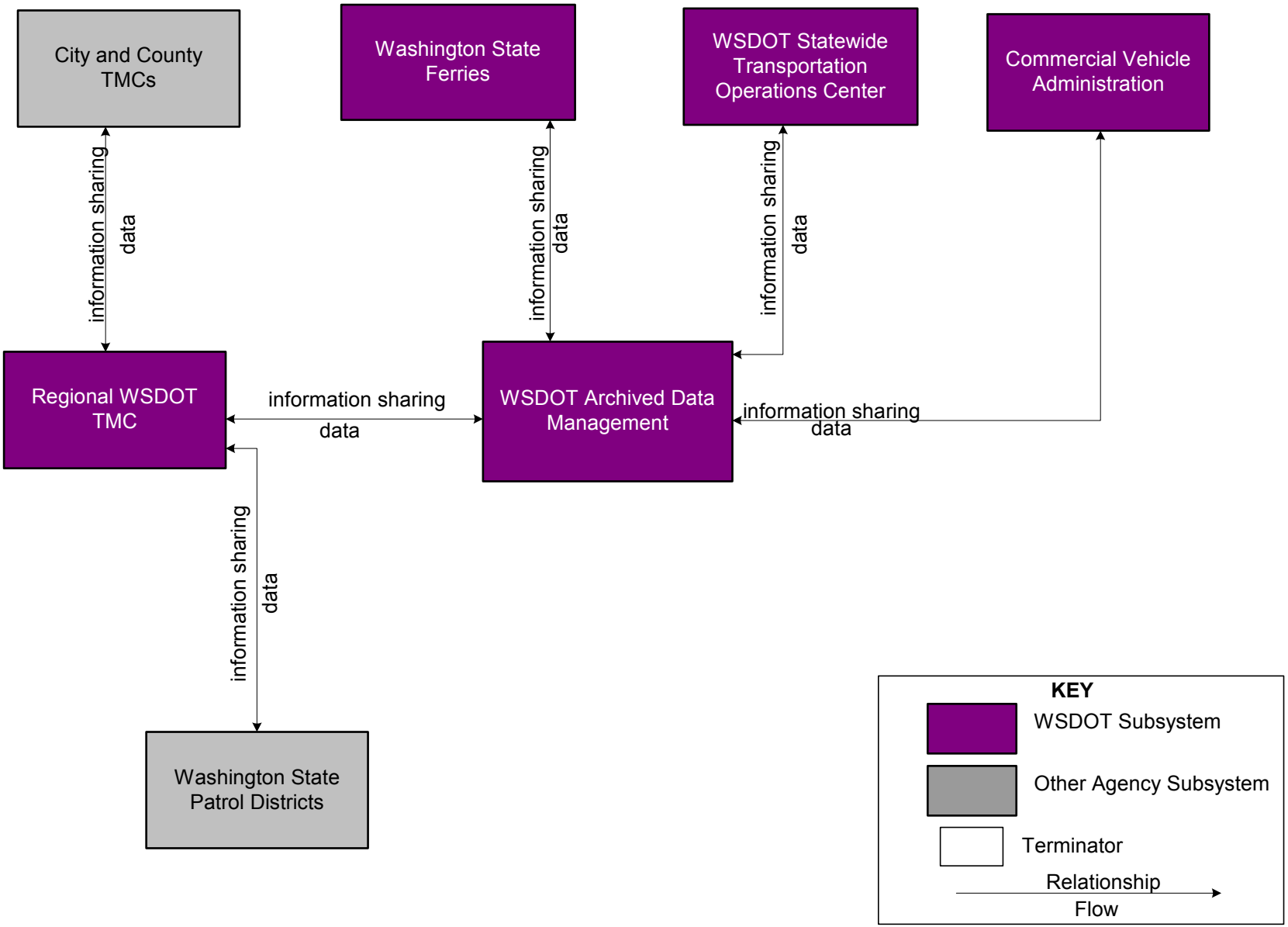
The National ITS Architecture describes the Archived Data Management subsystem as follows: "The Archived Data Management Subsystem collects, archives, manages, and distributes data generated from ITS sources for use in transportation administration, policy evaluation, safety, planning, performance monitoring, program assessment, operations, and research applications." Data management actions include formatting, attribute tagging, and other "meta" (data that describes data) information that can be used to generate reports and other "information products".

The Archived Data Management subsystem can be implemented by a solo agency or region, or it may be operated as a data repository that collects and "warehouses" data from multiple agencies and sources for further analysis.

The WSDOT Archived Data Management subsystem will receive input from the following sources:

- Washington State Ferries
- WSDOT Statewide Transportation Operations Center
- Commercial Vehicle Administration
- Regional WSDOT TMCs

Figure 12: Washington State Data Management



5.8 MARKET PACKAGE SELECTION

In the National ITS Architecture, market packages depict the data flows between different entities providing the "service" granted by the deployment of the market package. For example, the incident management system market package requires that traffic management and emergency management centers exchange information. This implies that an operational concept and an institutional relationship must be established between the two organizations that are cooperating. The operational concept presented in the previous subsections provides a vision for integrated transportation and safety management in Washington and the subsystems and information flows required as part of the vision. Within each program area, specific services such as network surveillance, weather information processing and distribution, regional traffic control, etc., are implicit. Market packages from the National Architecture map up with these services. The selection of market packages for each operational concept program area is given in Table 3.

Definitions of each market package included in this statewide ITS Architecture are given in Appendix B.

The next section of this document covers the topic of interagency agreements for data sharing, device control sharing, and other relationships presented as desirable in the operational concept. and that are necessary in order to bring the operational concept into fruition.

Table 3: Washington State Market Packages by ITS Emphasis Area

Market Packages		Congestion Management	Traveler Info	Incident Mgmt.	Security Mgmt.	Safety Mgmt	Data Mgmt.	Maintenance and Construction	Transit Mgmt.	Freight Mobility
AD2	ITS Data Warehouse						x			
AD3	ITS Virtual Data Warehouse						x			
APTS1	Transit Vehicle Tracking								x	
APTS2	Transit Fixed Route Operations								x	
APTS4	Transit Passenger and Fare Management								x	
APTS5	Transit Security				x				x	
APTS6	Transit Maintenance								x	
APTS7	Multi-modal Coordination	x							x	
APTS8	Transit Traveler Information								x	
ATIS1	Broadcast Traveler Information		x							
ATIS2	Interactive Traveler Information		x							
ATIS6	Integrated Transportation Management/Route Guidance								x	
ATIS9	In Vehicle Signing		x			x				
AVSS04	Lateral Safety Warning					x				
AVSS05	Intersection Safety Warning					x				
ATMS01	Network Surveillance	x			x					
ATMS02	Probe Surveillance	x								
ATMS03	Surface Street Control	x								
ATMS04	Freeway Control	x								
ATMS05	HOV Lane Management	x								
ATMS06	Traffic Information Dissemination		x							
ATMS07	Regional Traffic Control	x								
ATMS08	Incident Management System			x						
ATMS09	Traffic Forecast and Demand Management	x								
ATMS10	Electronic Toll Collection	x								
ATMS13	Standard Railroad Grade Crossing					x				
ATMS14	Advanced Railroad Grade Crossing					x				
ATMS16	Parking Facility Management		x							
ATMS17	Regional Parking Management									
ATMS18	Reversible Lane Management	x				x				
ATMS19	Speed Monitoring	x		x		x		x		
ATMS20	Drawbridge Management	x								
CVO02	Freight Administration									x
CVO03	Electronic Clearance									x
CVO04	CV Administrative Processes									x
CVO05	International Border Electronic Clearance									x
CVO06	Weigh-In-Motion									x
CVO07	Roadside CVO Safety									x
EM1	Emergency Response			x	x					
EM2	Emergency Routing			x						
EM3	Mayday Support					x				
EM4	Roadway Service Patrols			x	x	x				
MC01	Maintenance and Construction Vehicle Tracking							x		
MC02	Maintenance and Construction Vehicle Maintenance							x		
MC03	Road Weather Data Collection							x		
MC04	Weather Information Processing and Distribution					x		x		
MC05	Roadway Automated Treatment					x		x		
MC06	Winter Maintenance							x		
MC07	Roadway Maintenance and Construction							x		
MC08	Work Zone Management							x		
MC09	Work Zone Safety Monitoring							x		
MC10	Maintenance and Construction Activity Coordination							x		

6. AGREEMENTS BETWEEN ORGANIZATIONS

The operational concept presented in the previous section gave an overall vision for WSDOT's cooperative interactions with other transportation and safety agencies across the state. Fully implemented, the operational concept envisions a fully integrated, seamless roadway network. With its focus on inter-jurisdictional coordination, the operational concept points directly to the types of agreements that may potentially be required between individual organizations. Informal or formal agreements are needed in order to define the roles and responsibilities for each of the interactions discussed in Section 5. This section of the report discusses existing, planned and potential agreements that are part of WSDOT's interagency program development; as well as provides a checklist of items for consideration in developing an agreement.

6.1 EXISTING, PLANNED AND POTENTIAL AGREEMENTS

The following are some projects and program areas that have, or are likely to in the future, require the establishment of formal agreements to define the roles and responsibilities of each party:

- **Regional Traffic Control**: Already in place between some local cities, counties, and WSDOT, the complete statewide implementation of this market package would result in the joint sharing and potential control of traffic signals, detectors, cameras, ramp meters, and dynamic message signs. Agreements that detail the limits of authority, operational discretion, and liability will be required before "joint control" would be implemented. A critical technical agreement required for interoperability will be the identification of the preferred center-to-center NTCIP standard to enable this market package.
- **Coordination with the Washington State Patrol**: The WSDOT/WSP Joint Operations Policy Statement (JOPS) has been developed to formalize the close working relationship between WSDOT and the State Patrol.
- **Maintenance and Construction Coordination**: Information on planned construction events is already available from the WSDOT web site; however, benefits could be seen from increased coordination with local jurisdictions to improve traffic flow on arterials around construction zones.
- **Incident Management**: Agreements between transportation and emergency management organizations will need to be developed if a formal interagency incident management system is deployed statewide.
- **Security Management**: It is likely that some new agreements will be required in order to improve communications between agencies involved in new security monitoring measures, including WSDOT, Federal authorities, and local ports.
- **Freight Mobility:** Freight mobility requires new and expanded coordination with Federal authorities, ports, and Canadian customs.

- **511 Three-Digit Traveler Information Telephone Number**: The Federal Communications Commission (FCC) has designated 511 as the new telephone number for traveler information across the country. This number is designed to be the single telephone number for obtaining traveler information for all modes. Washington State jurisdictions have begun a cooperative process to transition the multiple transportation information numbers in the region to this one number. An initial rollout has enabled 511 to be activated and available to customers of Cingular Wireless. Access via other cellular networks is pending.
- **Data Archival Management:** Moving toward an automated system of archiving data at the regional TMC level will require the development of agreements on the format, access and use of the information. Archival at the statewide level requires a means of transmitting the data from the regions to WSDOT headquarters. Not all of the local regions currently have this capability.
- **Communications**: There are multiple examples and opportunities for the sharing of communications infrastructure throughout the state. The upcoming statewide communications plan and subsequent agreements that define responsibilities could result in the communications network required to link the various ITS applications together.

In Washington, there is a long history of formal and informal inter-agency agreements. The majority of formal agreements involve the transfer of funds from one organization to another, and have generally involved transportation construction projects. However, there are still a wide number of existing agreements that address operations and maintenance, which can serve as models.

6.2 ELEMENTS OF AN AGREEMENT

Agreements are established to clearly define responsibilities among the involved parties. The level of formality generally increases as risks escalate and when financial transactions take place. Formality will also increase when the performance or lack of performance on the part of one organization impacts the operations of another. For example, if an agency maintains and operates the traffic signals of another agency, failure to restore a failed traffic signal in a timely fashion could have a significant impact. As different systems are linked together, they will depend upon each other. The clear definition of responsibilities for all parties will help ensure smooth operations.

The following is an annotated checklist of elements to consider in the development of an agreement for ITS operations and maintenance. Not all elements are relevant to exchange of information. The level of specificity will depend on the nature of the information link. This list is provides as a starting point for considering interagency cooperative agreements for device control sharing, information sharing or transfer of device ownership.

- Operational Concept (A layman's introduction to the nature and purpose of the agreement.)
- Duties of Responsible Organizations (A summary of duties and responsibilities.)
- Data Sharing (Aspects of sharing data to be considered.)
  - Provision of Data
  - Data Rights
  - Data Reuse

  - Data Identification
  - Data Availability
  - Data Accuracy

- Control Sharing (Aspects of sharing control to be considered with rights and priorities being clearly understood.)
  - Provision of Control
  - Control Rights
  - Control Restrictions
  - Control Priority
  - Control Availability
- Connections (Defines how the connection is made.)
  - Provision of Equipment
  - Physical Access Point
  - Demarcation Point
  - Security
  - Configuration Management
  - Standards and Protocols
- System Documentation
- Operations
  - Contacts
  - Hours of Operations
  - Responsibilities
- Maintenance
  - Contacts
  - Hours of Operations
  - Responsibilities
  - Response Time
- Liability
  - Indemnity
  - Damage to Equipment
  - Liability
- Ownership
  - Equipment
  - Software
  - Intellectual Property
- Coordination
  - Notification
  - Periodic Reporting
  - Pre-Change Coordination Meeting

- Dispute Resolution
- Termination of Agreement
- Compensation

System functional requirements, interface requirements and information exchanges for statewide ITS deployments, as given in the National ITS Architecture, are covered in the following section.

7. SYSTEM FUNCTIONAL REQUIREMENTS, INTERFACE REQUIREMENTS AND INFORMATION EXCHANGES

In Section 5, market packages were selected for each ITS program area (congestion management, traveler information, incident management, safety management, security management, maintenance and construction management, data management, transit management, and freight mobility). The Washington Statewide ITS Architecture uses these selections, combined with the market package diagrams contrived by the National Architecture, to compose customized, program-specific physical architecture diagrams that depict the National Architecture elements critical to a WSDOT-focused ITS program. Market package diagrams illustrate the system functional requirements, interface requirements, and information exchanges that occur between subsystems. They include subsystems, equipment packages, and architecture flows for each ITS deployment area.

The physical architecture flow diagrams developed for the statewide ITS Architecture depict all subsystem relationships that are considered possible or desirable based on stakeholder feedback, and includes existing, planned, and potential operations. The architecture flow diagrams summarize the flow of information between each of the entities interfacing directly with WSDOT[22], as well as the interface requirements for each of these entities. The diagrams also identify each of the equipment packages that will be required to meet the system functional requirements for Washington. These equipment packages are, again, based upon the market packages. The equipment packages are shown as boxes inside the major subsystems. Architecture flow diagrams for all of the ITS program areas are found in Appendix C. The following paragraphs describe the physical architecture flow diagrams that were developed:

- **Congestion Management**: Congestion Management requires the regional WSDOT TMC to monitor traffic conditions for backups and to control devices used in alleviating traffic delays. The WSDOT TMC is constantly exchanging information with devices deployed at the roadway such as ramp meters, signals, and CCTV cameras. Traffic signals are timed and coordinated with those controlled by other regional jurisdictions from city and county TMCs. Multi-modal crossings (i.e., drawbridges) may be monitored. Traffic control information (i.e., signal timing plans) and traffic images are shared with other transportation agencies at the city, county, state and international level. Traffic conditions information is shared directly with the Washington State Patrol and also output to the WSDOT Statewide Transportation Operations Center subsystem.

  Tolls will be collected electronically from vehicles crossing the second Tacoma Narrows Bridge. The toll collection subsystem provides the capability for vehicle operators to pay tolls without stopping their vehicles,[23] helping to improve traffic flow over the bridge. The regional WSDOT TMC provides operational support to the toll administration with traffic conditions information and images.

[22] Regional, City, and County TMCs and Transit Management are shown as separate entities on the physical architecture diagrams, however it is recognized that the Spokane TMC is a special cooperative effort of Spokane County, City of Spokane, WSDOT, Spokane Transit Authority and the Spokane Regional Transportation Council.

[23] National ITS Architecture Version 4.0

- **Traveler Information**: For their role in disseminating traveler information, the TMCs provide road conditions information and traffic images to the local media, local ATIS, and other local agency TMCs. The WSDOT TMCs also control WSDOT's network of dynamic message signs and highway advisory radio transmitters. Traveler information, including road closures and traffic images, is provided to the WSDOT Statewide Transportation Operations Center subsystem and output to Personal Information Access and Remote Traveler Support subsystems. These subsystems enable travelers to access information from personal computers, cell phones, and rest area kiosks. In the future, roadside devices that can communicate with in-vehicle systems will be deployed. These systems enable in-vehicle reception of traffic alerts beyond the existing highway advisory radio messages.
- **Incident Management**: Regional WSDOT TMC roadway monitoring enables incident detection and response. The Washington State Patrol and WSDOT work closely together to respond to incidents and exchange road conditions data. Via several regional TMCs, WSP officers have direct access to cameras and other equipment. In response to an incident, traffic information can also be shared with other WSDOT, state, provincial, city or county TMCs, as well as regional emergency response agencies, enabling the deployment of a regional incident response plan as needed.

  The Emergency Vehicle subsystem includes WSDOT's incident response and service patrol vehicles and, in regard to their role in monitoring for and responding to incidents, maintenance vehicles. Emergency vehicle signal preemption is also part of this program area.

  Incident information is reported to the Statewide Transportation Operations Center subsystem for dissemination to the public.
- **Security Management**: To ensure the security of roadway infrastructure such as bridges and highway tunnels, the regional WSDOT TMC will use existing network monitoring devices. WSDOT's incident response and maintenance vehicles also have a role in detecting potential security breaches. The WSDOT TMCs coordinate with the State Patrol, Incident Response Teams, local emergency response, other local, state and international TMCs, and the WSDOT maintenance offices to route traffic and disseminate information in the event of a security incident. Security information is provided to the State Transportation Operations Center subsystem where it may be shared with Federal authorities and disseminated to the public if appropriate. Transit vessel and park and ride lot security is also included.
- **Safety Management**: WSDOT has implemented many roadside safety devices, which are controlled by the regional TMCs. These include advanced rail crossing safety systems, reversible lane safety systems, automated anti-icing systems, wildlife detection, and speed monitoring. As more automotive manufacturers develop personal vehicles with collision warning systems and in-vehicle signing, WSDOT will implement the corresponding roadside devices. Weather information dissemination is also part of safety management and involves alerting travelers and maintenance crews to poor weather conditions. Incident Response and Service Patrol vehicles are dispatched by the WSDOT regional TMCs to help clear accidents and stalled vehicles. "Mayday" calls for assistance are handled by the State Patrol.

- **Maintenance and Construction Management**: The Maintenance and Construction Management program area covers operation of WSDOT's regional maintenance offices. Equipment packages were selected to indicate all aspects of the departments' various maintenance and work zone management duties, encompassing vehicle maintenance, winter roadway maintenance, safety, environmental monitoring, and work zone incident management. Equipment packages for the maintenance vehicle subsystem include vehicle tracking (GPS-based), monitoring and diagnostics, environmental monitoring, and work zone, safety, and maintenance support. The Statewide Transportation Operations Center subsystem exchanges weather information with other weather modeling and forecast systems to provide better weather information to maintenance personnel. Weather information and planned construction information is disseminated to local media and traffic and transit management agencies. The regional WSDOT TMCs share traffic conditions information with the maintenance offices and can also request that maintenance personnel be dispatched in response to an incident.

- **Transit Management**: WSDOT's role in transit management is primarily operation and management of the Washington State Ferries, including scheduling, routing, security monitoring, maintenance, and fare management. Transit information and images showing backups at the ferry terminals are provided to the WSDOT Statewide Transportation Operations Center subsystem for dissemination to the public.

  The Puget Sound region is planning the implementation of a Smart Card for multimodal transit fare payment, enabling one means of payment for multiple transit providers. Transactions will be tracked and managed via a Puget Sound Regional Fare Clearinghouse.

  Local transit agencies interact with WSDOT to implement and control Transit Signal Priority. In this case, the transit vehicle subsystem represents both ferry vessels (operated by WSDOT) and transit buses operated by local transit agencies. Local transit buses are included in the diagram for Transit Signal Priority deployments on roadways within WSDOT's jurisdiction.

- **Freight Mobility**: The Freight Mobility physical architecture flow diagram details the architecture flows and equipment packages that support the operational concept discussed in Section 5. The physical architecture supports both the electronic exchange of information for domestic and border commercial vehicle regulatory compliance. The domestic program fall under CVISN and is illustrated by the subsystem to subsystem links between WSDOT CVISN (as a Commercial Vehicle Administration subsystem), Washington State Patrol, Washington State Department of Licensing, Federal Motor Carrier Safety Administration, Other State CV Administration, Fleet and Freight Administration (i.e. trucking companies), commercial vehicle check subsystem (i.e. weigh stations), and commercial vehicles. The international border portion is represented by flows among Customs, WSDOT CVISN, border crossings, and commercial vehicles. Information on roadway conditions to assist commercial vehicles in selecting efficient routes is support by information flows among regional WSDOT TMCs, WSDOT roadside, WSDOT ISP, and Fleet and Freight Administration

- **Data Management**: The regional WSDOT TMC collects large amounts of traffic data, which is stored at the WSDOT TMC as well as shared with WSDOT's archived data repository. Three market packages are represented in part by this subsystem: Virtual Data Warehouse, Data Warehouse and the smaller Data Mart. WSDOT's state-level data warehouse is already in existence, and refers to the statewide collection of traffic data. Not all local regions have a data mart in place but these may be developed in the future as more advanced traffic management systems are deployed.

8. ITS STANDARDS

ITS standards are paving the way for interoperability and interchangeability of ITS equipment. An ITS architecture must include discussion of the standards that are relevant to the region of study. US DOT maintains an up-to-date summary on the status of ITS standards (http://www.its-standards.net/). This online summary document provides an explanation of key standards and provides additional contact information to obtain more details. Because ITS standards are under active development, information is being updated regularly at the US DOT website and should be consulted for the latest information. Key standards that will support systems interoperability in Washington are discussed below. A compilation of National ITS Standards for Washington, mapped to the appropriate market packages, can be found in Appendix D.

8.1 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:

- **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. This standard will be critical for linking to local TMCs.
- **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.
- **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 EMC**: Standards describing the form and content of the incident management messages sets for emergency management systems (EMS) to traffic management systems (TMS) and from emergency management systems to the emergency telephone system (ETS) or (E911).
- **Standard for Data Dictionaries for Intelligent Transportation Systems**: A set of meta entities and meta attributes for ITS data dictionaries, as well as associated conventions and 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, video camera control traffic, parking management and weather forecasting, as well as data elements related to detectors, actuated signal controllers, vehicle probes, and dynamic message signs.
- **Standard for Traffic Incident Management Message Sets for Use by EMCs**: Enables consistent standardized communications among Incident Management Centers, Fleet and Freight Management Centers, Information Service Providers, Emergency Management Centers, Planning Subsystems, Traffic Management Centers and Transit Management Centers.

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.

8.2 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 is between two transportation management centers (or systems) that is called center-to-center (C2C). The second type is the link from a transportation management system or center to a field device like a traffic signal or dynamic message sign. The second type is call center-to-field (C2F). Additional information on NTCIP standards is found at the following website – http://www.ntcip.org/index.html.

NTCIP provides two alternative protocol choices for center-to-center communications. One is Data Exchange Between Systems (DATEX) and the other is based on the widely used Internet standard Common Object Request Broker Architecture (CORBA). These two different protocols were found necessary to meet the variety of requirements for inter-system data exchanges. A third choice is emerging based upon Extensible Markup Language (XML) protocol. It is feasible to use all three protocols in the same network, with some centers acting as a bridge, or translator, between them. Each C2C connection will likely have different functional and policy related requirements which will determine what type(s) of protocols are necessary. Factors that influence the C2C protocol choices include:

- Characteristics of systems to be linked
- Functions to be supported
- System life cycle considerations
- System performance
- Communications infrastructure and demand

Other issues that WSDOT must address when developing C2C communications links include levels of security/access, location identification conventions, exchange and sharing of data for information and/or control purposes, and when sharing control--device use conflict resolution. These issues should all be resolved through operational agreements between participating agencies. Additional dialogue among the transportation management center operators and managers will be required before a choice is made. This selection of a common C2C standard will be critical to the establishing communication links among regional WSDOT TMCs and local TMCs.

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.[24] Key C2F standards that should be adopted and used by regional jurisdictions are shown in Table 4 below.

Table 4: NTCIP Center-to-Field Standards

NTCIP STANDARD	NAME	DESCRIPTION
NTCIP 1202	Object Definitions for Actuated Traffic Signal Controller Units	Specifications for objects that are specific to actuated signal controllers and definitions of standardized object groups that can be used for conformance statements.
NTCIP 1203	Object Definitions for Dynamic Message Signs	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 System	Definitions of objects that are specific to environmental sensor stations (ESS) and object groups, which can be used for conformance statements.
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 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.

[24] 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

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	This standard will define the objects necessary to manage a field master.

8.3 TRANSIT COMMUNICATIONS INTERFACE PROTOCOL

Transit Communications Interface Protocol (TCIP) is a suite of data interface standards for the transit industry (http://www.tcip.org/). This suite of standards includes the wide range of transit ITS applications. A summary of the TCIP standards is found in the Table 5. This effort began after the three regional standards discussed below were already adopted.

Table 5: TCIP Standards

TCIP STANDARD	NAME	DESCRIPTION
1400	Framework Document	Defines how the various TCIP standards work together
1401	Common Public Transportation (CPT) Business Area Standard	Defines those data elements and data frames that are generic to multiple TCIP Business areas
1402	Incident Management (IM) Business Area Standard	Defines the data elements and messages used for exchanging information on incident management operations
1403	Passenger Information (PI) Business Area Standard	Defines the data elements and messages used for passenger information data exchange
1404	Scheduling/Run cutting (SCH) Business Area Standard	Defines the data elements and messages used for exchanging information about transit schedules and run cutting information
1405	Spatial Representation (SP) Business Area Standard	Defines the data elements and messages used for exchange of location and spatial concepts

TCIP STANDARD	NAME	DESCRIPTION
1406	Onboard (OB) Business Area Standard	Defines the data elements and messages used for exchanging information about devices and operations aboard the transit vehicle
1407	Control Center (CC) Business Area Standard	Defines the data elements and messages used for exchanges between control centers
1408	Fare Collection (FC) Business Area Standard	Defines the data elements and messages used for exchanging information about fare collection operations

In the Puget Sound region, three regional standards for transit ITS applications have already been accepted by the regional transportation agencies for implementation. These standards should influence future decisions by the Washington State Ferry. They include:

- **Electronic Fare Collection**: The transit agencies in the Puget Sound region are participating in the selection and deployment of a common electronic fare collection system using a common fare card. The use of this common fare medium and related business rules will enable interoperability for transit electronic fare collection within the region.
- **Transit Traveler Information**: The Puget Sound Regional Automated Trip Planning (RATP) project is the beginning of a regional transit information system and provides a common format for the exchange of information.
- **Transit Signal Priority**: A common set of equipment for both roadside and bus TSP equipment has been selected for King and Snohomish Counties. However, another approach has been selected for Pierce and Kitsap Counties. The TSP approach selected by Pierce and Kitsap Counties is also being used throughout the remainder of the state.

Both the regional fare coordination project and the RATP will provide common regional standards for the exchange of fare and traveler information in the region for the middle term. TCIP standards should be considered in the future when these two applications are updated. When other transit ITS applications are considered for implementation, the emerging TCIP standards should be considered to ensure interoperability among the regional transit agencies.

8.4 PUGET SOUND ITS BACKBONE

The Puget Sound Regional Integration Strategy calls for the use of the ITS Backbone as a means to speed the sharing of real-time transportation information among jurisdictions in the Puget Sound region. The Backbone is based upon a solid foundation of information technology and research at the University of Washington. It depends upon a set of paradigms and protocols called Self-Describing Data (SDD). Information on the backbone, and the software required to implement SDD can be obtained free from the following website - http://www.its.washington.edu/bbone/.

9. SEQUENCE OF PROJECTS REQUIRED FOR IMPLEMENTATION

WSDOT has identified several statewide projects and programs that are high priority for deployment. These projects all play a key role in the integration of WSDOT's statewide operations and partnerships with other agencies. At the same time, there are institutional issues that must be addressed in order to implement the priority projects and the operational concept.

9.1 WSDOT PRIORITIES FOR FUTURE ITS DEPLOYMENTS

The following are WSDOT's near-term priorities for new ITS deployments that will affect the entire state:

- **Computer Aided Dispatch Interface**: The Washington State Patrol will be implementing a new Computer Aided Dispatch (CAD) system. The ability to interface with this system will enable better coordination of incident response between the State Patrol and the regional TMCs.
- **Statewide Integration of HAR**: This project proposes using a network server system to update HAR messages, enabling improved timeliness of HAR messages and maximized availability of travel choices and emergency information to the public.
- **Statewide Wireless Upgrade**: WSDOT's 800 MHz wireless radio network is experiencing considerable interference. WSDOT is considering either upgrading the 800 MHz system by boosting its signals or migrating to 700 MHz, or upgrading the microwave backbone network that is owned by Washington State Patrol and used by WSDOT.
- **Development of WSDOT Communications Infrastructure**: After the termination of the "Light Lanes" project that would have built a statewide fiber optics network, WSDOT has been left without a comprehensive communications infrastructure. The Statewide Communications Plan, currently under development, is a first step in identifying needs and options for getting back on track with communications deployment.
- **Border Crossing Enhancements**: WSDOT is working with Customs in the United States and Canada to deploy ITS at the border crossings, helping to expedite the crossing of commercial vehicles. These include eSeals[25], transponders on trucks that can contain electronic information about its cargo and inspection status, and upgraded software for Customs agents.
- **Security Assessment Of Critical Infrastructure**: A first step in implementing the Security Management operational concept will be assessing bridges and tunnels to determine security flaws and issues that may be addressed by ITS or other means.
- **Statewide Transportation Operations Center**: The purpose of a statewide transportation operations center will be to integrate and monitor statewide sources for traffic, travel and weather information, as well as to develop new applications for raw transportation data that are not currently used for operations or public information.

[25] eSeals are electronic locking devices that can be installed on cargo containers. eSeals can be tracked electronically to ensure that cargo is not tampered with.

9.2 WSDOT INSTITUTIONAL ISSUES

- **Incident Management Planning**: Currently, no advance planning for incidents is in place in Washington. Incident management planning would bring together WSDOT, local jurisdictions, and law enforcement to work out specific response plans, including traffic management, for incidents such as major accidents, natural disasters, or domestic security breaches.
- **Coordinate With Local ATIS**: WSDOT is working to determine their level of involvement with local ATIS. WSDOT may become the operator of several ATIS. This involvement will broaden the reach of both WSDOT and the local jurisdiction's traveler information.
- **Coordinate The Delivery Of Arterial Traveler Information**: Coordination of arterial traveler information is needed to enable drivers on WSDOT freeways and visitors to WSDOT web sites to be alerted to closures and congestion on arterials.
- **Interface To Local Traffic Management Centers**: As they grow, more and more Washington cities and counties are coming online with their own traffic management centers. These jurisdictions are collecting traffic and traveler information that can benefit WSDOT's operations, and vice versa. In the early planning stages, WSDOT and local jurisdictions need to work together to ensure that compatible traffic management systems are procured and to work out information sharing and device control agreements. While many local TMCs stay in regular contact with their WSDOT regional TMC, a necessary effort is to expand electronic communication between agencies for greater integration.
- **WSDOT's Role In Security**: As discussed in the Security Management operational concept, a key issues facing WSDOT is its role in maintaining secure bridges, ferries, and other transportation infrastructure.

APPENDIX A

WSDOT Organizational Chart

Washington State Department of Transportation

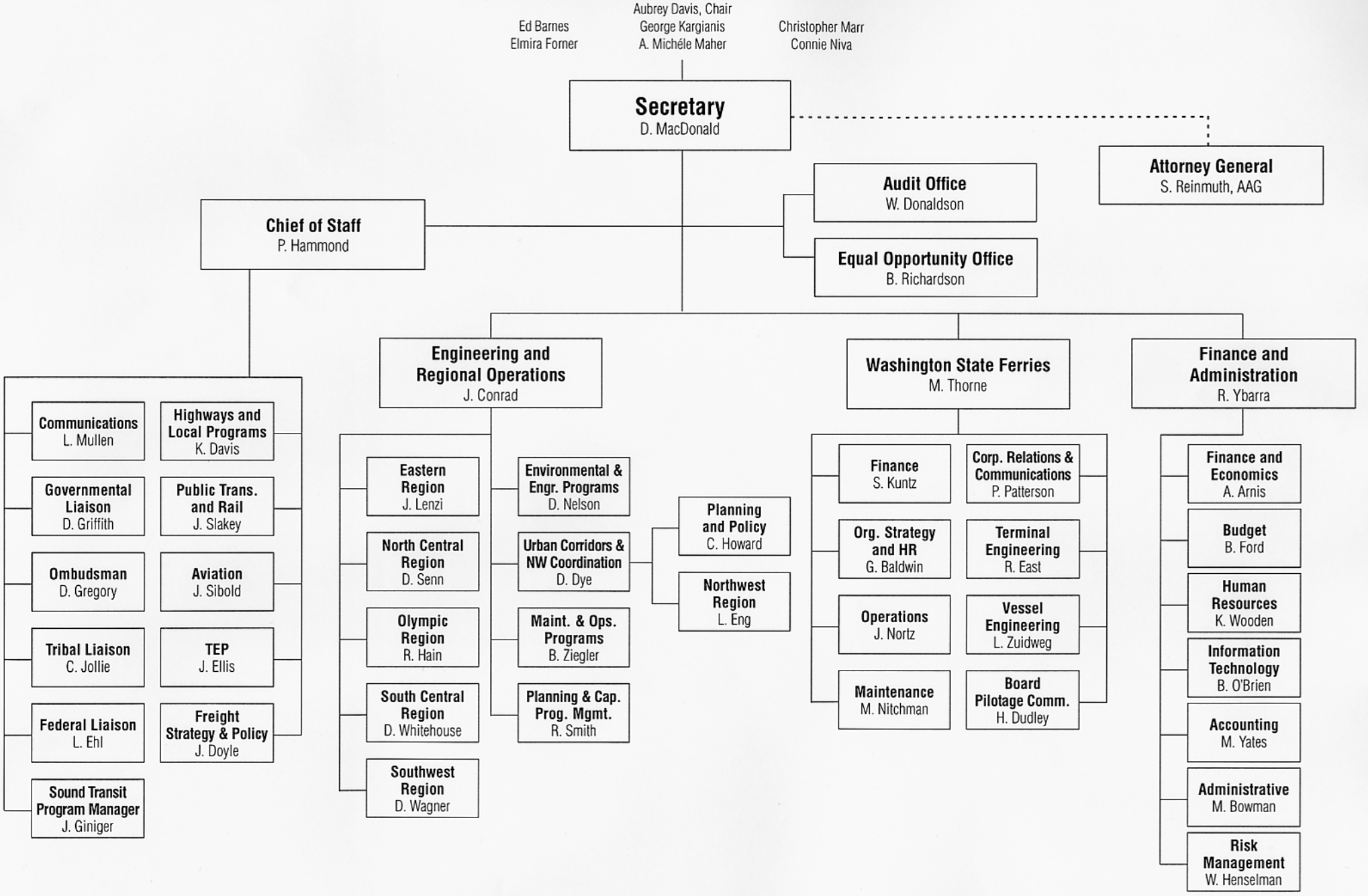
Citizens of Washington State

Governor Gary Locke

Washington State Transportation Commission

Aubrey Davis, Chair
Ed Barnes
George Kargianis
Christopher Marr
Elmira Forner
A. Michéle Maher
Connie Niva

Douglas B. MacDonald _____ Date _____



APPENDIX B

Market Package Definitions

NATIONAL ITS ARCHITECTURE MARKET PACKAGE DEFINITIONS FOR WASHINGTON [1]

ITS Data Mart: This market package provides a focused archive that houses data collected and owned by a single agency, district, private sector provider, research institution, or other organization. This focused archive typically includes data covering a single transportation mode and one jurisdiction that is collected from an operational data store and archived for future use. It provides the basic data quality, data privacy, and meta data management common to all ITS archives and provides general query and report access to archive data users.

ITS Data Warehouse: This market package includes all the data collection and management capabilities provided by the ITS Data Mart, and adds the functionality and interface definitions that allow collection of data from multiple agencies and data sources spanning across modal and jurisdictional boundaries. It performs the additional transformations and provides the additional meta data management features that are necessary so that all this data can be managed in a single repository with consistent formats. The potential for large volumes of varied data suggests additional on-line analysis and data mining features that are also included in this market package in addition to the basic query and reporting user access features offered by the ITS Data Mart.

Transit Vehicle Tracking: This market package provides for an Automated Vehicle Location System to track the transit vehicle's real time schedule adherence and updates the transit system's schedule in real-time. Vehicle position may be determined either by the vehicle (e.g., through GPS) and relayed to the infrastructure or may be determined directly by the communications infrastructure. A two-way wireless communication link with the Transit Management Subsystem is used for relaying vehicle position and control measures. Fixed route transit systems may also employ beacons along the route to enable position determination and facilitate communications with each vehicle at fixed intervals. The Transit Management Subsystem processes this information, updates the transit schedule and makes real-time schedule information available to the Information Service Provider Subsystem via a wireline link.

Transit Fixed-Route Operations: This market package performs automatic driver assignment and monitoring, as well as vehicle routing and scheduling for fixed-route services. This service uses the existing AVL database as a source for current schedule performance data, and is implemented through data processing and information display at the transit management subsystem. This data is exchanged using the existing wireline link to the information service provider where it is integrated with that from other transportation modes (e.g., rail, ferry, air) to provide the public with integrated and personalized dynamic schedules.

Transit Passenger and Fare Management: This market package allows for the management of passenger loading and fare payments on-board vehicles using electronic means. The payment instrument may be either a stored value or credit card. This package is implemented with sensors mounted on the vehicle to permit the driver and central operations to determine vehicle loads, and readers located either in the infrastructure or on-board the transit vehicle to allow fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Subsystem using existing wireless infrastructure.

[1] These Market Package definitions are given for all of the Market Packages developed for Version 4.0 of the National ITS Architecture. Further information, including definitions of subsystems and equipment packages are available at http://www.odetics.com/itsarch

Transit Security: This market package provides for the physical security of transit passengers. An on-board security system is deployed to perform surveillance and warn of potentially hazardous situations. Public areas (e.g., stops, park and ride lots, stations) are also monitored. Information is communicated to the Transit Management Subsystem using the existing or emerging wireless (vehicle to center) or wireline (area to center) infrastructure. Security related information is also transmitted to the Emergency Management Subsystem when an emergency is identified that requires an external response. Incident information is communicated to the Information Service Provider.

Transit Maintenance: This market package supports automatic maintenance scheduling and monitoring. On-board condition sensors monitor critical system status and transmit critical status information to the Transit Management Subsystem. Hardware and software in the Transit Management Subsystem processes this data and schedules maintenance activities.

Multi-Modal Coordination: This market package establishes two way communications between multiple transit and traffic agencies to improve service coordination. Intermodal coordination between transit agencies can increase traveler convenience at transfer points and also improve operating efficiency. Coordination between traffic and transit management is intended to improve on-time performance of the transit system to the extent that this can be accommodated without degrading overall performance of the traffic network. More limited local coordination between the transit vehicle and the individual intersection for signal priority is also supported by this package.

Transit Traveler Information: This market package provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop annunciation, imminent arrival signs, and real-time transit schedule displays that are of general interest to transit users. Systems that provide custom transit trip itineraries and other tailored transit information services are also represented by this market package.

Broadcast Traveler Information: This market package provides the user with a basic set of ATIS services; its objective is early acceptance. It involves the collection of traffic conditions, advisories, general public transportation, toll and parking information, incident information, air quality and weather information, and the near real time dissemination of this information over a wide area through existing infrastructures and low cost user equipment (e.g., FM subcarrier, cellular data broadcast). Different from the market package ATMS6--Traffic Information Dissemination--which provides the more basic HAR and DMS information capabilities, ATIS1 provides the more sophisticated digital broadcast service. Successful deployment of this market package relies on availability of real-time traveler information from roadway instrumentation, probe vehicles or other sources.

Interactive Traveler Information: This market package provides tailored information in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported. The traveler can obtain current information regarding traffic conditions, transit services, ride share/ride match, parking management, and pricing information. A range of two-way wide-area wireless and wireline communications systems may be used to support the required digital communications between traveler and the information service provider. A variety of interactive devices may be used by the traveler to access information prior to a trip or en-route to include phone, kiosk, Personal Digital Assistant, personal computer, and a variety of in-vehicle devices. Successful deployment of this market

package relies on availability of real-time transportation data from roadway instrumentation, probe vehicles or other means.

Integrated Transportation Management and Route Guidance: This market package provides advanced route planning and guidance which is responsive to current conditions, and supports collection of near-real time information on intended routes for a proportion of the vehicles in the network. This comprehensive road network probe information can be used by the Traffic Management Subsystem to optimize the traffic control strategy based on anticipated vehicle routes. The Traffic Management Subsystem would utilize the individual and ISP route planning information to optimize signal timing while at the same time providing updated signal timing information to allow optimized route plans. The use of predictive link times for this market package are possible through utilizing the market package ATMS9--Traffic forecast and Demand Management--at the traffic management center.

In-Vehicle Signing: This market package supports distribution of traffic and travel advisory information to drivers through in-vehicle devices. It includes short range communications between roadside equipment and the vehicle and wireline connections to the Traffic Management Subsystem for coordination and control. This market package also informs the driver of both highway-highway and highway-rail intersection status.

Lateral Safety Warning: This market package allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.

Intersection Safety Warning: This market package will determine the probability of a collision in an equipped intersection (either highway-highway or highway-rail) and provide timely warnings to drivers in response to hazardous conditions. Monitors in the roadway infrastructure assess vehicle locations and speeds near an intersection. Using this information, a warning is determined and communicated to the approaching vehicle using a short range communications system. Information can be provided to the driver through the market package ATIS9--In-Vehicle Signing.

Network Surveillance: This market package includes traffic detectors, other surveillance equipment, the supporting field equipment, and wireline communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal control system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this market package enables traffic managers to monitor traffic and road conditions, identify and verify incidents, detect faults in indicator operations, and collect census data for traffic strategy development and long range planning. The collected data can also be analyzed and made available to users and the Information Service Provider Subsystem.

Probe Surveillance: This market package provides an alternative approach for surveillance of the roadway network. Two general implementation paths are supported by this market package: 1) wide-area wireless communications between the vehicle and Information Service Provider is used to communicate current vehicle location and status, and 2) dedicated short range communications between the vehicle and roadside is used to provide equivalent information back to the Traffic Management Subsystem. The first approach leverages wide area communications equipment that may already be in

the vehicle to support personal safety and advanced traveler information services. The second approach utilizes vehicle equipment that supports toll collection, in-vehicle signing, and other short range communications applications identified within the architecture. The market package enables traffic managers to monitor road conditions, identify incidents, analyze and reduce the collected data, and make it available to users and private information providers. It requires one of the communications options identified above, roadside beacons and wireline communications for the short range communications option, data reduction software, and utilizes wireline links between the Traffic Management Subsystem and Information Service Provider Subsystem to share the collected information. Both "Opt out" and "Opt in" strategies are available to ensure the user has the ability to turn off the probe functions to ensure individual privacy. Due to the large volume of data collected by probes, data reduction techniques are required in this market package which include the ability to identify and filter out-of-bounds or extreme data reports.

Surface Street Control: This market package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this market package ranging from static pre-timed control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. Additionally, general advisory and traffic control information can be provided to the driver while en-route. This market package is generally an intra-jurisdictional package that does not rely on real-time communications between separate control systems to achieve area-wide traffic signal coordination. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would be represented by this package. This market package is consistent with typical urban traffic signal control systems.

Freeway Control: This market package provides the communications and roadside equipment to support ramp control, lane controls, and interchange control for freeways. Coordination and integration of ramp meters are included as part of this market package. This package is consistent with typical urban traffic freeway control systems. This package incorporates the instrumentation included in the Network Surveillance Market Package to support freeway monitoring and adaptive strategies as an option.

This market package also includes the capability to utilize surveillance information for detection of incidents. Typically, the processing would be performed at a traffic management center; however, developments might allow for point detection with roadway equipment. For example, a CCTV might include the capability to detect an incident based upon image changes. Additionally, this market package allows general advisory and traffic control information to be provided to the driver while en-route.

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

Traffic Information Dissemination: This market package allows traffic information to be disseminated to drivers and vehicles using roadway equipment such as dynamic message signs or highway advisory radio. This package provides a tool that can be used to notify drivers of incidents; careful placement of the roadway equipment provides the information at points in the network where the drivers have

recourse and can tailor their routes to account for the new information. This package also covers the equipment and interfaces that provide traffic information from a traffic management center to the media (for instance via a direct tie-in between a traffic management center and radio or television station computer systems), transit management center, emergency management center, and information service provider.

Regional Traffic Control: This market package advances the Surface Street Control and Freeway Control Market Packages by adding the communications links and integrated control strategies that enable integrated Interjurisdictional traffic control. This market package provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This package relies principally on roadside instrumentation supported by the Surface Street Control and Freeway Control Market Packages and adds hardware, software, and wireline communications capabilities to implement traffic management strategies which are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of control between traffic management centers.

Incident Management System: This market package manages both predicted and unexpected incidents so that the impact to the transportation network and traveler safety is minimized. Requisite incident detection capabilities are included in the freeway control market package and through the regional coordination with other traffic management and emergency management centers, weather service entities, and event promoters supported by this market package. Information from these diverse sources are collected and correlated by this market package to detect and verify incidents and implement an appropriate response. This market package provides Traffic Management Subsystem equipment that supports traffic operations personnel in developing an appropriate response in coordination with emergency management and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications and presentation of information to affected travelers using the Traffic Information Dissemination market package. The same equipment assists the operator by monitoring incident status as the response unfolds. The coordination with emergency management might be through a CAD system or through other communication with emergency field personnel. The coordination can also extend to tow trucks and other field service personnel.

Traffic Forecast and Demand Management: This market package includes advanced algorithms, processing, and mass storage capabilities that support historical evaluation, real-time assessment, and forecast of the roadway network performance. This includes the prediction of travel demand patterns to support better link travel time forecasts. The source data would come from the Traffic Management Subsystem itself as well as other traffic management centers and forecasted traffic loads derived from route plans supplied by the Information Service Provider Subsystem. This market package provides data that supports the implementation of TDM programs, and policies managing both traffic and the environment. The package collects information on vehicle pollution levels, parking availability, usage levels, and vehicle occupancy to support these functions. Demand management requests can also be made to Toll Administration, Transit Management, and Parking Management Subsystems.

Electronic Toll Collection: This market package provides toll operators with the ability to collect tolls electronically and detect and process violations. The fees that are collected may be adjusted to implement demand management strategies. Dedicated short range communication between the roadway

equipment and the vehicle is required as well as wireline interfaces between the toll collection equipment and transportation authorities and the financial infrastructure that supports fee collection. Vehicle tags of toll violators are read and electronically posted to vehicle owners. Standards, inter-agency coordination, and financial clearinghouse capabilities enable regional, and ultimately national interoperability for these services. The toll tags and roadside readers that these systems utilize can also be used to collect road use statistics for highway authorities. This data can be collected as a natural by-product of the toll collection process or collected by separate readers that are dedicated to probe data collection.

Standard Railroad Grade Crossing: This market package manages highway traffic at highway-rail intersections (HRIs) where operational requirements do not dictate more advanced features (e.g., where rail operational speeds are less than 80 miles per hour). Both passive (e.g., the crossbuck sign) and active warning systems (e.g., flashing lights and gates) are supported. (Note that passive systems exercise only the single interface between the roadway subsystem and the driver in the architecture definition.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification by interfaced wayside equipment of an approaching train. 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 to both highway and railroad officials through wayside interfaces and interfaces to the traffic management subsystem.

Advanced Railroad Grade Crossing: This market package manages highway traffic at highway-rail intersections (HRIs) where operational requirements demand advanced features (e.g., where rail operational speeds are greater than 80 miles per hour). This market package includes all capabilities from the Standard Railroad Grade Crossing Market Package and augments these with additional safety features to mitigate the risks associated with higher rail speeds. The active warning systems supported by this market package include positive barrier systems that preclude entrance into the intersection when the barriers are activated. Like the Standard Package, the HRI equipment is activated on notification by wayside interface equipment which detects, or communicates with the approaching train. In this market package, the wayside equipment provides additional information about the arriving train so that the train's direction of travel, estimated time of arrival, and estimated duration of closure may be derived. This enhanced information may be conveyed to the driver prior to, or in context with, warning system activation. This market package also includes additional detection capabilities that enable it to detect an entrapped or otherwise immobilized vehicle within the HRI and provide an immediate notification to highway and railroad officials.

Parking Facility Management: This market package provides enhanced monitoring and management of parking facilities. The included equipment assists in the management of parking operations, coordinates with transportation authorities, and supports electronic collection of parking fees. This is performed by sensing and collecting current parking facilities status, sharing the data with information service providers and traffic operations, and automatic fee collection using short-range communications with the same in-vehicle equipment utilized for electronic toll collection.

Reversible Lane Management: This market package provides for the management of reversible lane facilities. In addition to standard surveillance capabilities, this market package includes sensory

functions that detect wrong-way vehicles and other special surveillance capabilities that mitigate safety hazards associated with reversible lanes. The package includes the field equipment, physical lane access controls, and associated control electronics that manage and control these special lanes. This market package also includes the equipment used to electronically reconfigure intersections and manage right-of-way to address dynamic demand changes and special events.

Speed Monitoring: This market package monitors the speeds of vehicles traveling through a roadway system. If the speed is determine to be excessive, 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. This service can also support notifications to an enforcement agency to enforce the speed limit on a roadway system.

Drawbridge Management: This market package supports systems that manage drawbridges at rivers and canals and other multimodal crossings. (other than railroad grade crossings which are specifically covered by other market packages). The equipment managed by this market package includes control devices (e.g., gates, warning lights, dynamic message signs) at the draw bridge as well as the information systems that keep travelers appraised of current and forecasted draw bridge status.

Freight Administration: This market package tracks cargo and the cargo condition. This information is communicated with the Fleet and Freight Management Subsystem via the existing wireless infrastructure. Interconnections are provided to intermodal shippers and intermodal freight depots for tracking the cargo from source to destination.

Electronic Clearance: This market package provides for automated clearance at roadside check facilities. The roadside check facility communicates with the Commercial Vehicle Administration subsystem over wireline to retrieve infrastructure snapshots of critical carrier, vehicle, and driver data to be used to sort passing vehicles. This package allows a good driver/vehicle/carrier to pass roadside facilities at highway speeds using transponders and dedicated short range communications to the roadside. The roadside check facility may be equipped with AVI, weighing sensors, transponder read/write devices, computer workstation processing hardware, software, and databases.

CV Administrative Processes: This market package provides for electronic application, processing, fee collection, issuance, and distribution of CVO credential and tax filing. Through this process, carriers, drivers, and vehicles may be enrolled in the electronic clearance program provided by a separate market package which allows commercial vehicles to be screened at mainline speeds at commercial vehicle check points. Through this enrollment process, current profile databases are maintained in the Commercial Vehicle Administration Subsystem and snapshots of this database are made available to the commercial vehicle check facilities at the roadside to support the electronic clearance process.

International Border Electronic Clearance: This market package provides for automated clearance specific to international border crossings. This package augments the electronic clearance package by allowing interface with customs related functions and permitting NAFTA required entry and exit from the US to Canada and Mexico.

Weigh-In-Motion: This market package provides for high speed weigh-in-motion with or without AVI attachment. Primarily this market package provides the roadside with additional equipment, either fixed

or removable. If the equipment is fixed, then it is thought to be an addition to the electronic clearance and would work in conjunction with the AVI and AVC equipment in place.

Roadside CVO Safety: This market package provides for automated roadside safety monitoring and reporting. It automates commercial vehicle safety inspections at the Commercial Vehicle Check roadside element. The capabilities for performing the safety inspection are shared between this market package and the On-Board CVO Safety Market Package which enables a variety of implementation options. The basic option, directly supported by this market package, facilitates safety inspection of vehicles that have been pulled in, perhaps as a result of the automated screening process provided by the Electronic Clearance Market Package. In this scenario, only basic identification data and status information is read from the electronic tag on the commercial vehicle. The identification data from the tag enables access to additional safety data maintained in the infrastructure which is used to support the safety inspection, and may also inform the pull-in decision if system timing requirements can be met. More advanced implementations, supported by the On-Board CVO Safety market package, utilize additional vehicle safety monitoring and reporting capabilities in the commercial vehicle to augment the roadside safety check.

HAZMAT Management: This market package integrates incident management capabilities with commercial vehicle tracking to assure effective treatment of HAZMAT material and incidents. HAZMAT tracking is performed by the Fleet and Freight Management Subsystem. The Emergency Management subsystem is notified by the Commercial Vehicle if an incident occurs and coordinates the response. The response is tailored based on information that is provided as part of the original incident notification or derived from supplemental information provided by the Fleet and Freight Management Subsystem. The latter information can be provided prior to the beginning of the trip or gathered following the incident depending on the selected policy and implementation.

Emergency Response: This market package provides the computer-aided dispatch systems, emergency vehicle equipment, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Subsystems supports emergency notification and coordinated response between agencies. Existing wide area wireless communications would be utilized between the Emergency Management Subsystem and an Emergency Vehicle to enable an incident command system to be established and supported at the emergency location. The Emergency Management Subsystem would include hardware and software for tracking the emergency vehicles. Public safety, traffic management, and many other allied agencies may each participate in the coordinated response managed by this package.

Emergency Routing: This market package supports dynamic routing of emergency vehicles and coordination with the Traffic Management Subsystem for special priority on the selected route(s). The Information Service Provider Subsystem supports routing for the emergency fleet based on real-time traffic conditions and the emergency routes assigned to other responding vehicles. In this market package, the Information Service Provider Subsystem would typically be integrated with the Emergency Management Subsystem in a public safety communications center. The Emergency Vehicle would also optionally be equipped with dedicated short-range communications for local signal preemption.

Mayday Support: This package allows the user (driver or non-driver) to initiate a request for emergency assistance and enables the Emergency Management Subsystem to locate the user and

determine the appropriate response. The Emergency Management Subsystem may be operated by the public sector or by a private sector provider. The request from the traveler needing assistance may be manually initiated or automated and linked to vehicle sensors. The data is sent to the Emergency Management subsystem using wide area wireless communications with voice as an option. Providing user location implies either a location technology within the user device or location determination within the communications infrastructure.

Roadway Service Patrols: This market package supports roadway service patrol vehicles that monitor roads that typically have incidents, offering rapid response to minor incidents (flat tire, accidents, out of gas) to minimize disruption to the traffic stream. If problems are detected, the roadway service patrol vehicles will provide assistance to the motorist (e.g., push a vehicle to the shoulder or median).

Maintenance and Construction Vehicle Tracking: This market package will track the location of maintenance and construction vehicles and other equipment to ascertain the progress of their activities. These activities can include ensuring the correct roads are being plowed and work activity is being performed at the correct locations.

Maintenance and Construction Vehicle Maintenance: This market package performs vehicle maintenance scheduling and manages both routine and corrective maintenance activities on vehicles and other maintenance and construction equipment. It includes on-board sensors capable of automatically performing diagnostics for maintenance and construction vehicles, and the systems that collect this diagnostic information and use it to schedule and manage vehicle maintenance.

Road Weather Data Collection: This market 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, sensing of the roadway environment can also occur from sensor systems located on Maintenance and Construction Vehicles. The collected environmental data is used by the Weather Information Processing and Distribution Market Package to process the information and make decisions on operations.

Weather Information Processing and Distribution: This market package processes and distributes the environmental information collected from the Road Weather Data Collection market package. This market package uses the environmental data to detect environmental hazards such as icy road conditions, high winds, dense fog, etc. so system operators and decision support systems can make decision on corrective actions to take. The continuing updates of road condition information and current temperatures can be used by system operators to more effectively deploy road maintenance resources, issue general traveler advisories, issue location specific warnings to drivers using the Traffic Information Dissemination market package, and aid operators in scheduling work activity.

Winter Maintenance: This market package supports winter road maintenance including snowplow operations, roadway treatments (e.g., salt spraying and other anti-icing material applications), and other snow and ice control activities. This package monitors environmental conditions and weather forecasts and uses the information to schedule winter maintenance activities, determine the appropriate snow and ice control response, and track and manage response operations.

Roadway Maintenance and Construction: This market package supports numerous services for scheduled and unscheduled maintenance and construction on a roadway system or right-of-way. Maintenance services would include landscape maintenance, hazard removal (roadway debris, dead animals), routine maintenance activities (roadway cleaning, grass cutting), and repair and maintenance of both ITS and non-ITS equipment on the roadway (e.g., signs, traffic controllers, traffic detectors, dynamic message signs, traffic signals, CCTV, etc.). Environmental conditions information is also received from various weather sources to aid in scheduling maintenance and construction activities.

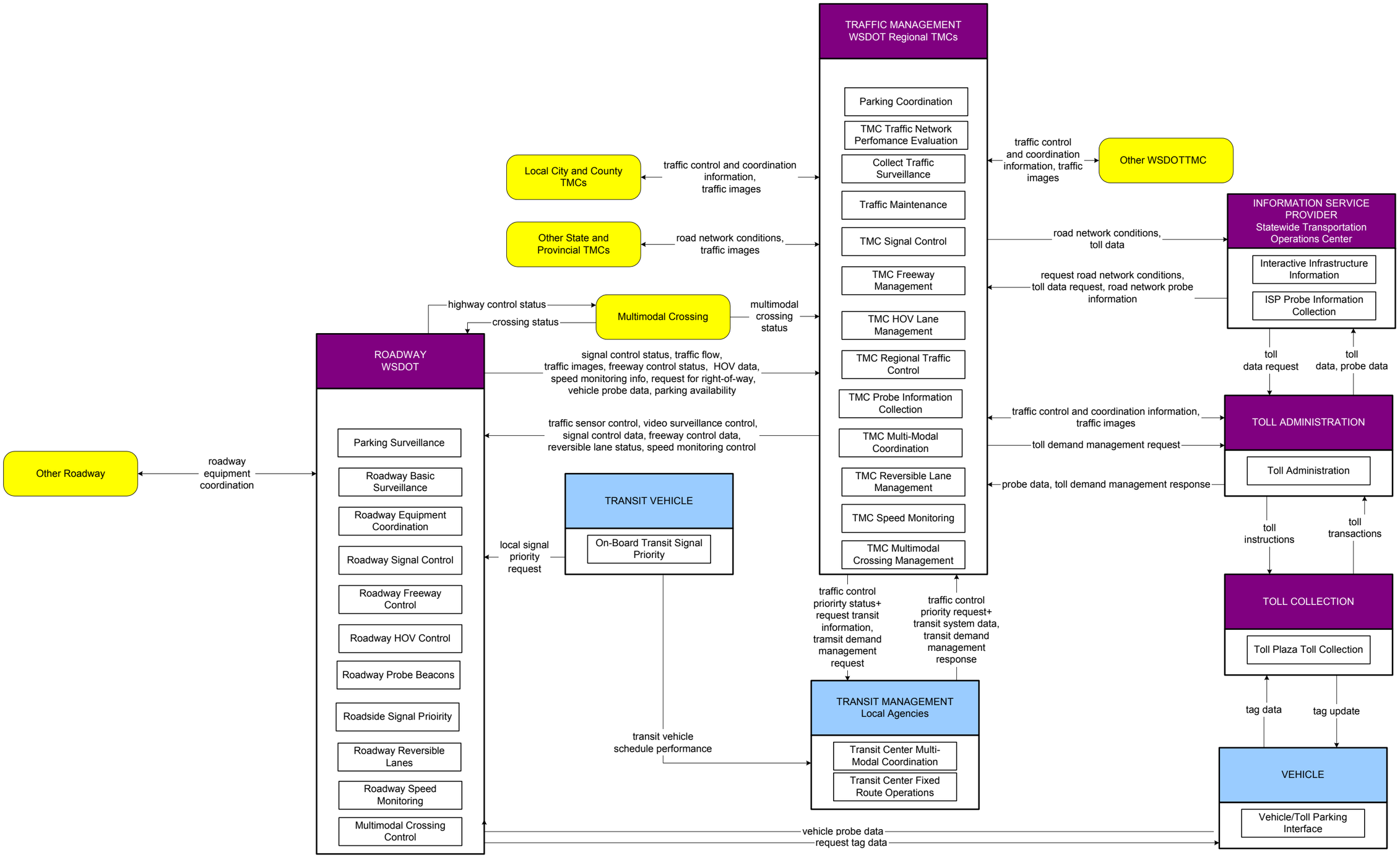
Work Zone Management: This market package directs activity in work zones, controlling traffic through portable dynamic message signs (DMS) and informing other groups of activity (e.g., ISP, TM, other maintenance and construction centers) for better coordination management. Work zone speeds and delays are provided to the motorist prior to the work zones.

Work Zone Safety Monitoring: This market package includes systems that improve work crew safety and reduce collisions between the motoring public and maintenance and construction vehicles. This market package detects vehicle intrusions in work zones and warns crew workers and drivers of imminent encroachment or other potential safety hazards. Crew movements are also monitored so that the crew can be warned of movement beyond the designated safe zone. The market package supports both stationary and mobile work zones.

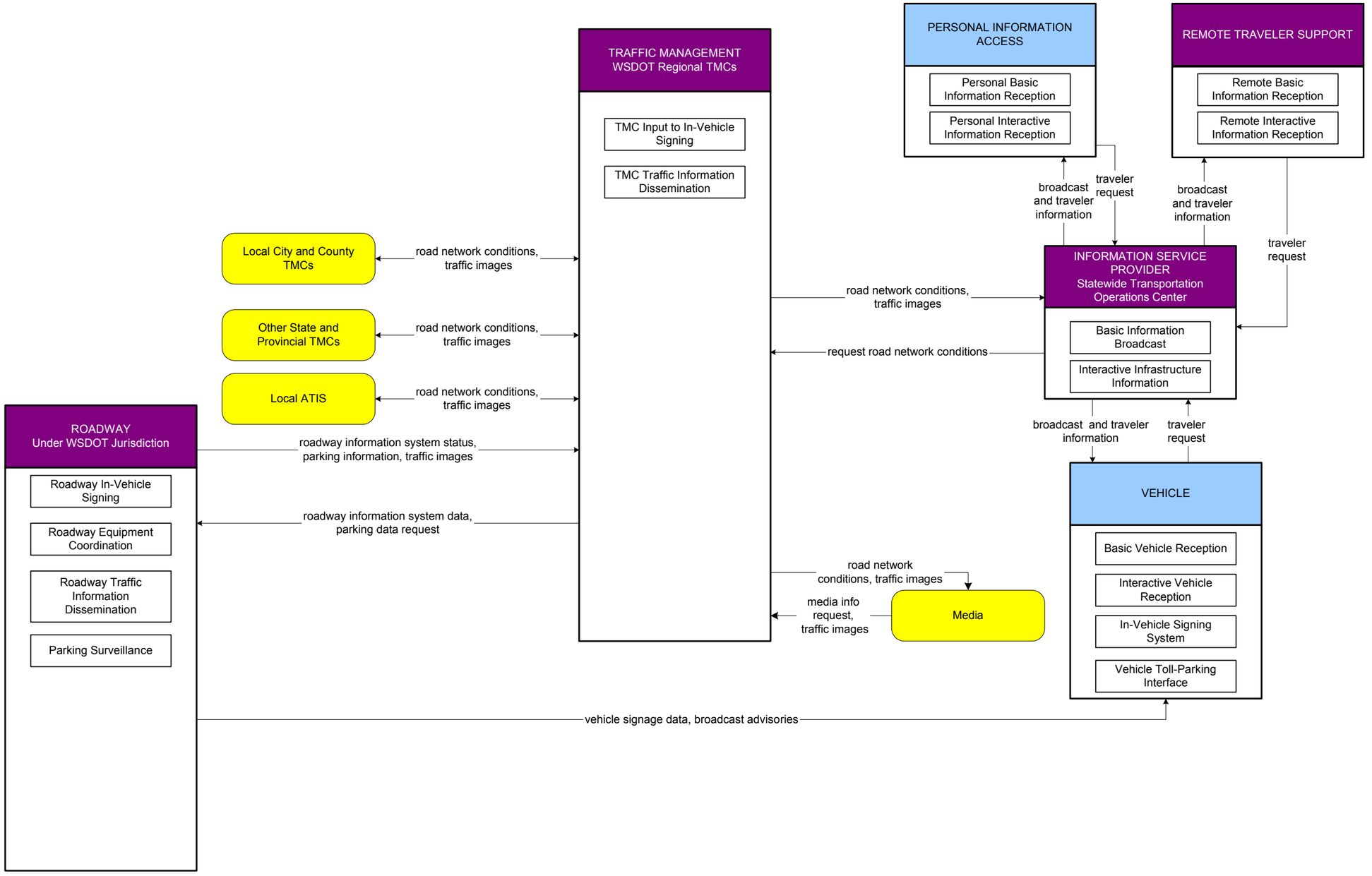
Maintenance and Construction Activity Coordination: This market package supports the dissemination of maintenance and construction activity to centers, which can utilize it as part of their operations, or to Information Service Providers who can provide the information to travelers.

APPENDIX C

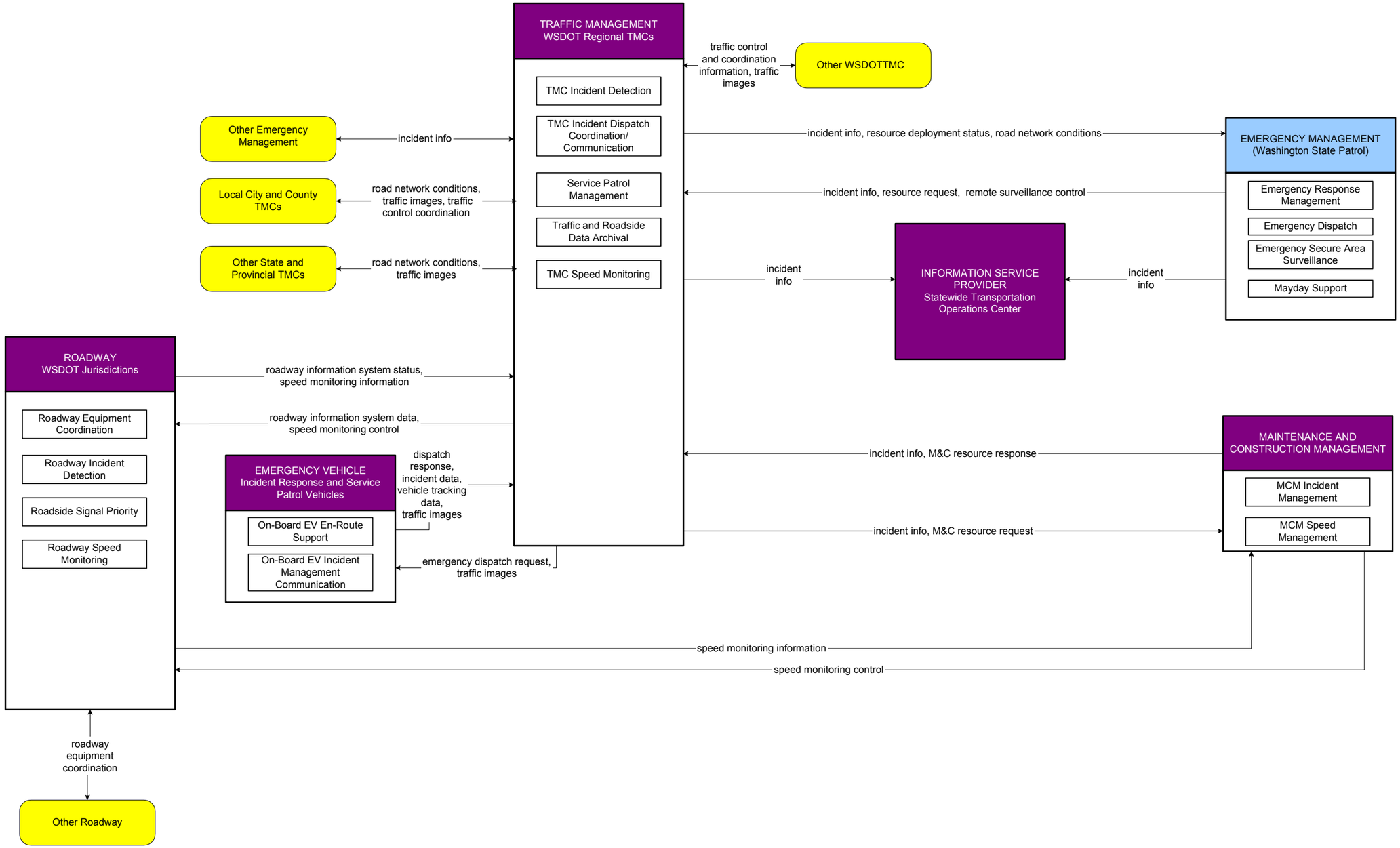
Physical Architecture Flow Diagrams



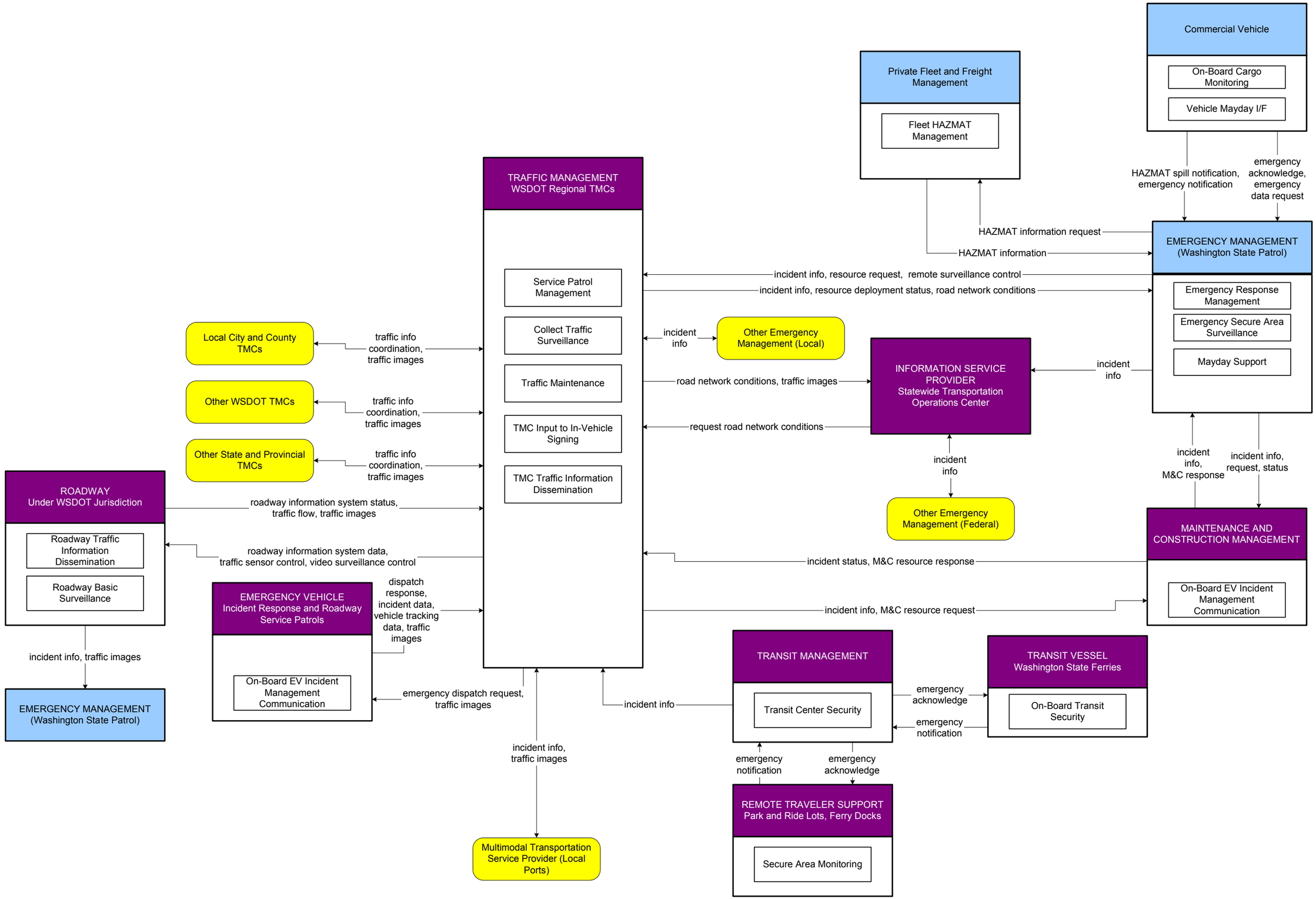
WSDOT Congestion Management Physical Architecture



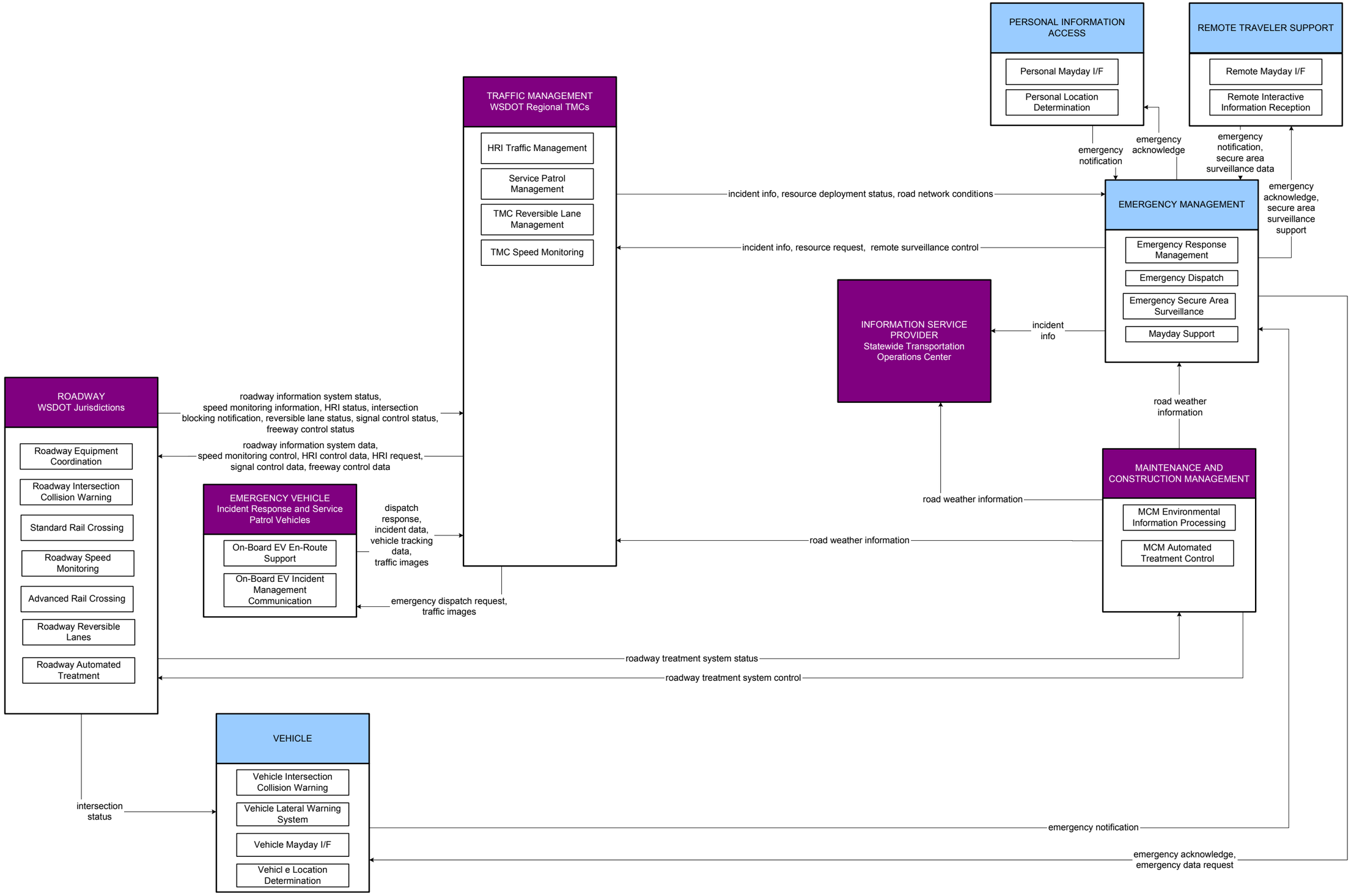
WSDOT Traveler Information Physical Architecture



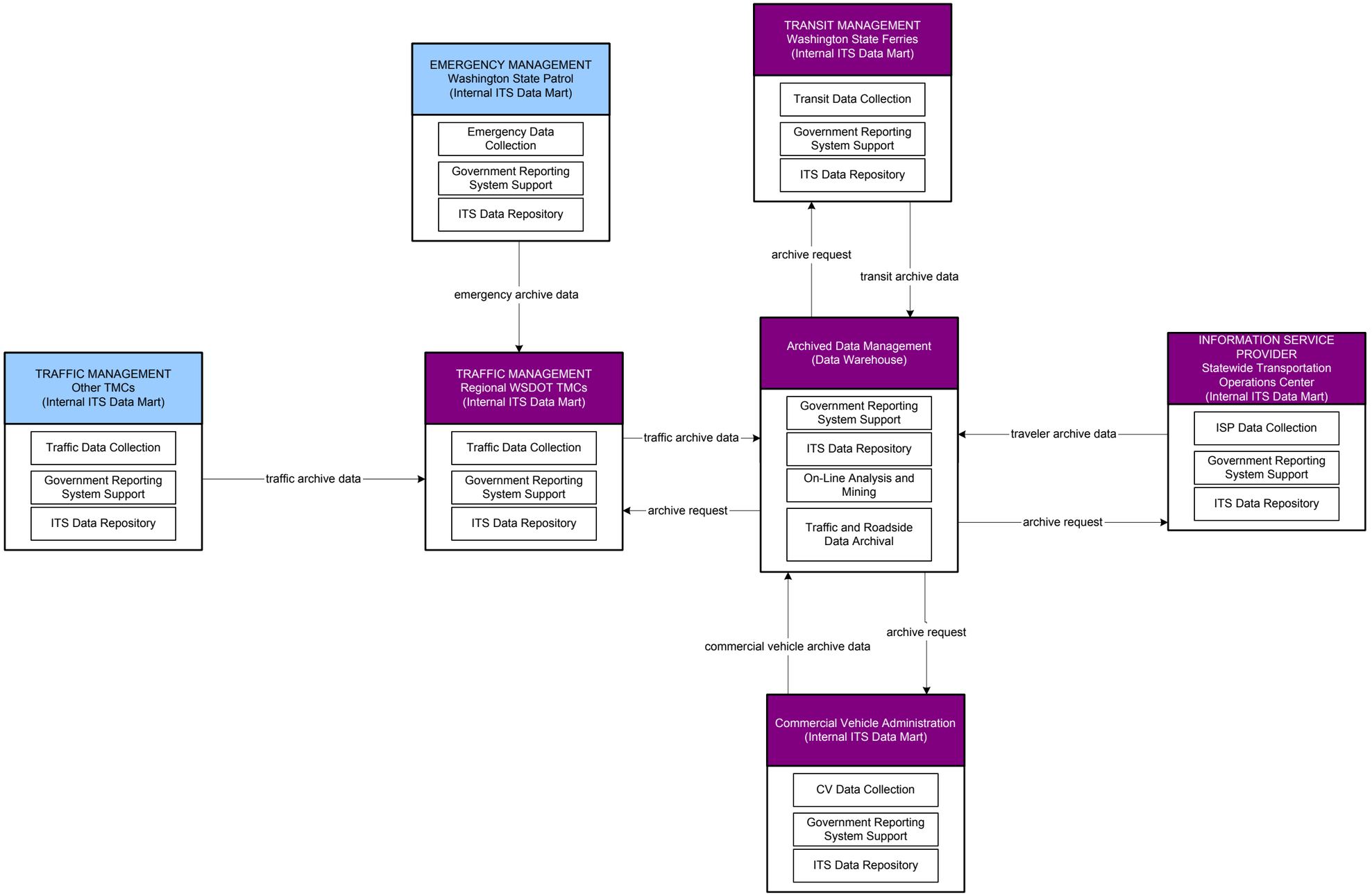
WSDOT Incident Management Physical Architecture



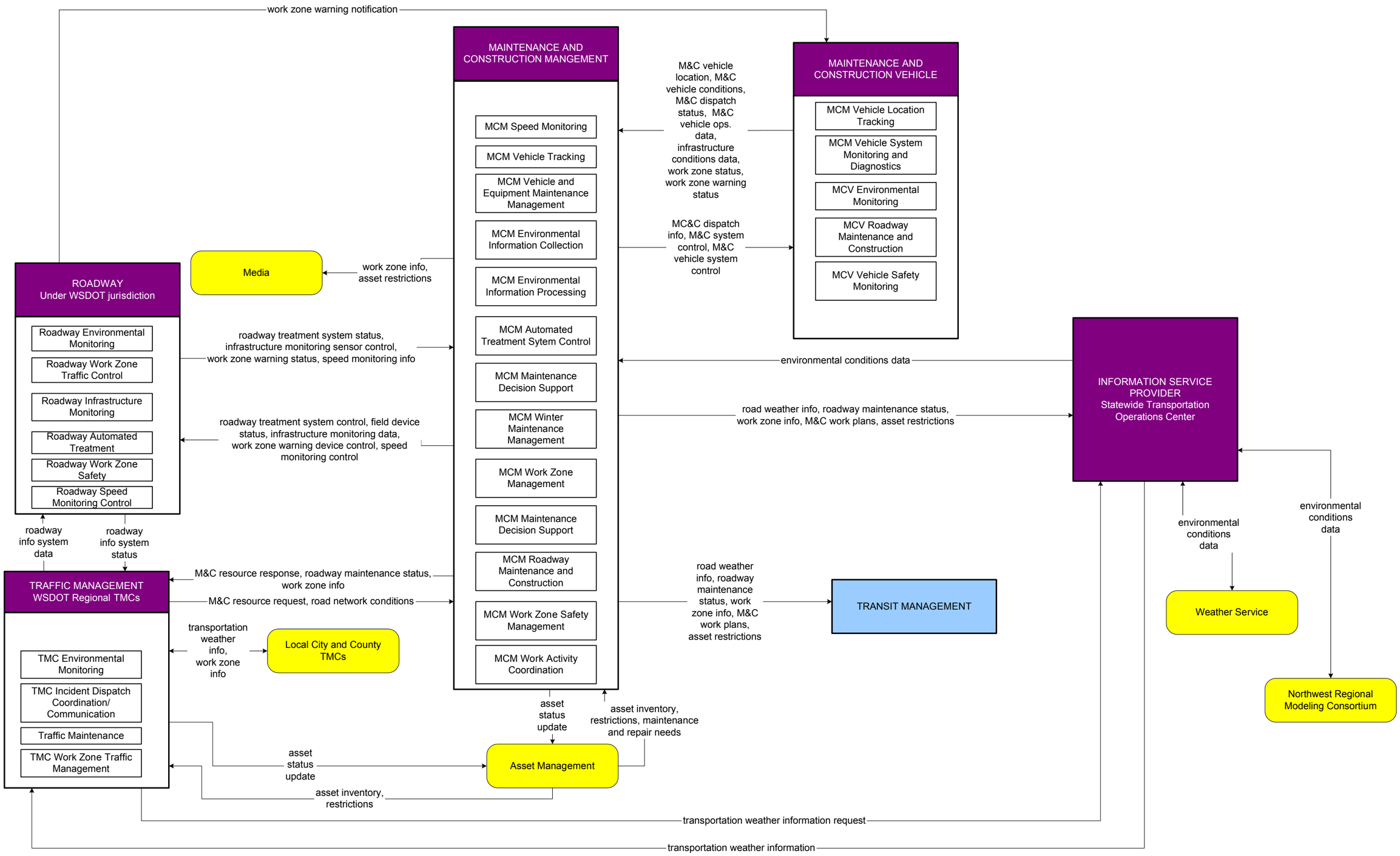
WSDOT Security Management Physical Architecture



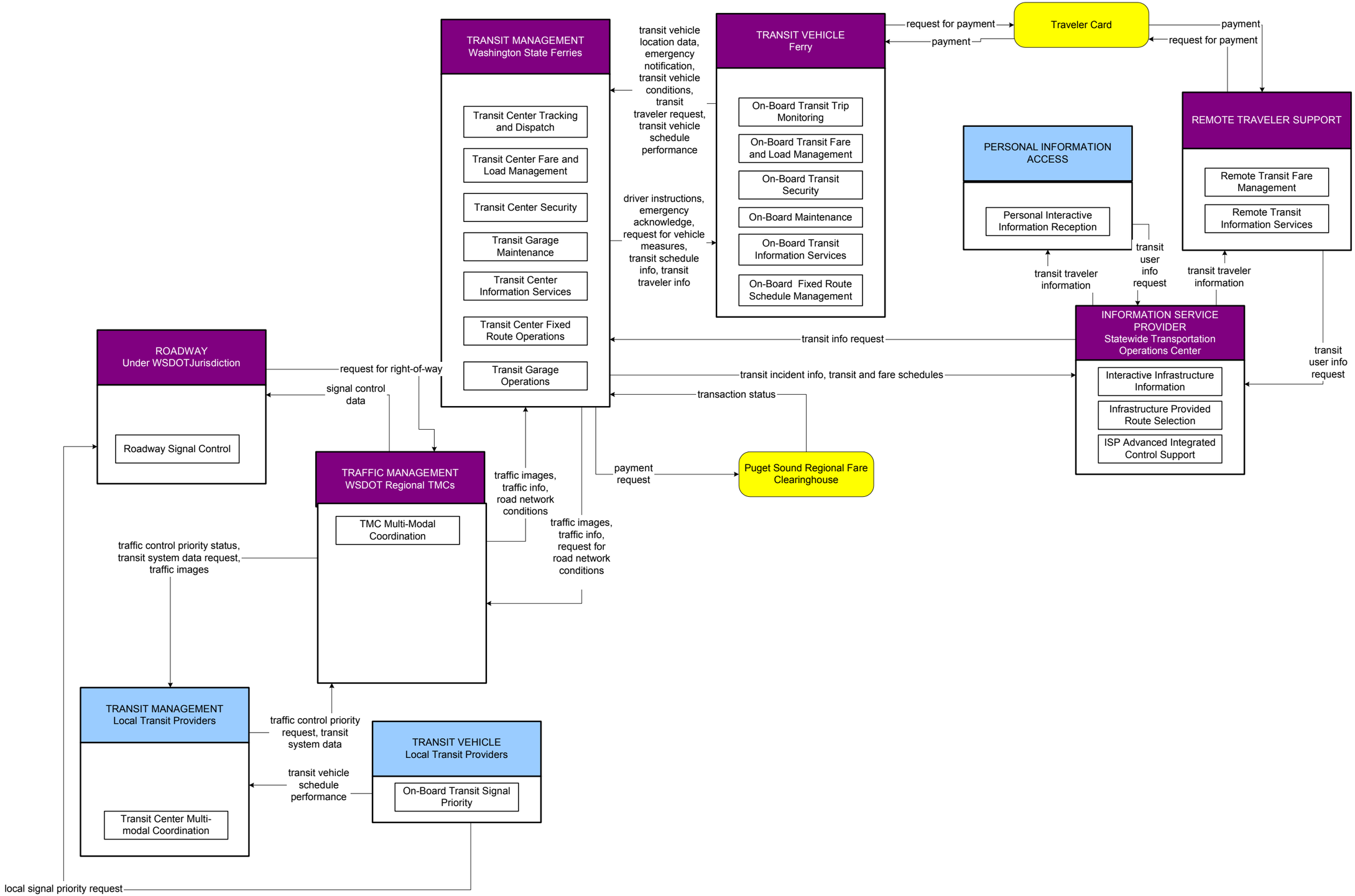
WSDOT Safety Management Physical Architecture



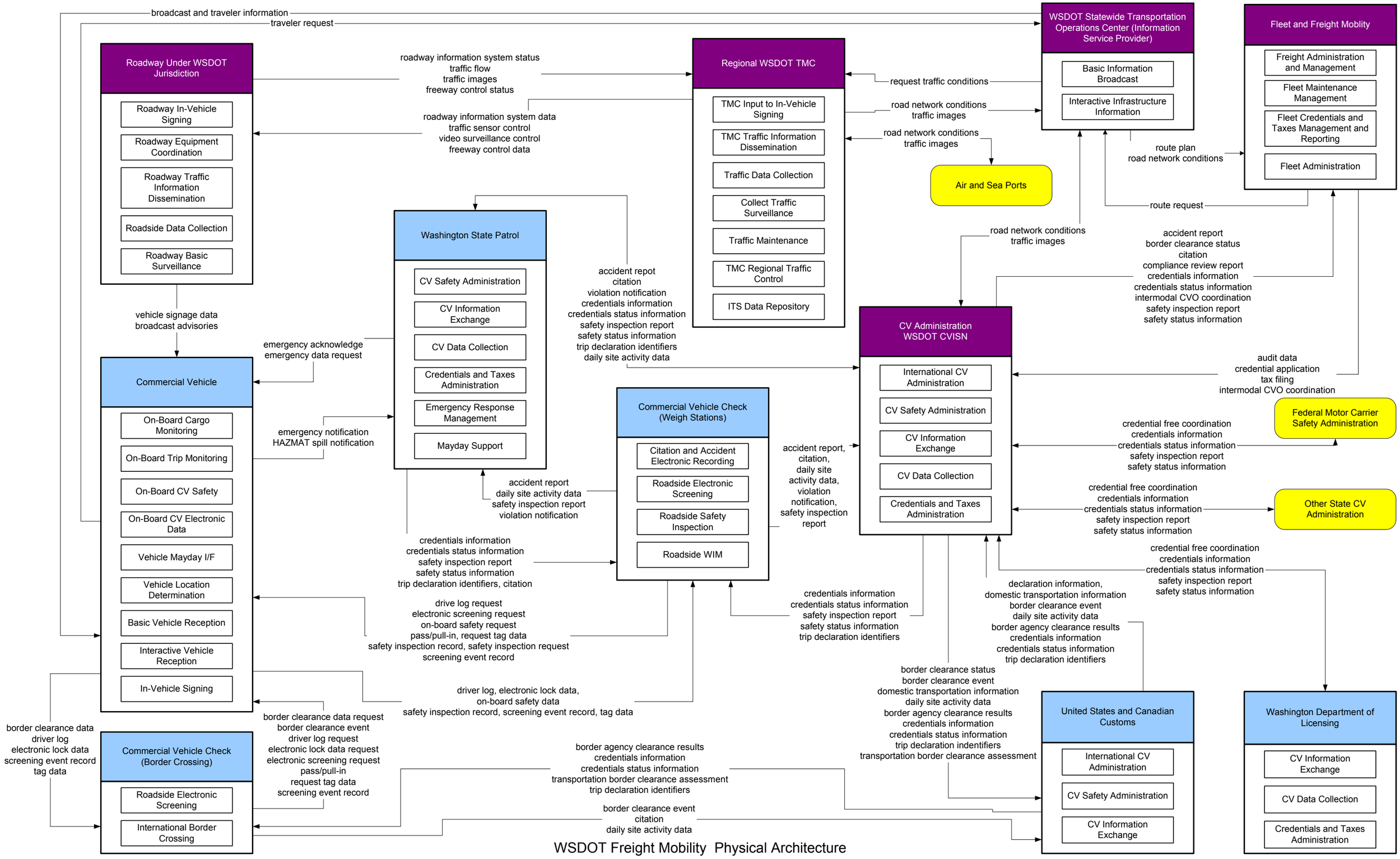
WSDOT Data Management Physical Architecture



WSDOT Maintenance and Construction Management Physical Architecture



WSDOT Transit Management Physical Architecture



WSDOT Freight Mobility Physical Architecture

APPENDIX D

ITS Standards Relevant to WSDOT Deployments

WSDOT Applicable Standards by Market Package

Standard	Advanced Railroad Grade Crossing	Broadcast Traveler Information	CV Administrative Processes	Drawbridge Management	Electronic Clearance	Electronic Toll Collection	Emergency Response	Emergency Routing	Freeway Control	Freight Administration	HAZMAT Management	HOV Lane Management	In Vehicle Signing	Incident Management System	Integrated Transportation Management/Route Guidance	Interactive Traveler Information	International Border Electronic Clearance	ITS Data Warehouse	ITS Virtual Data Warehouse	Maintenance and Construction Activity Coordination	Maintenance and Construction Vehicle Maintenance	Maintenance and Construction Vehicle Tracking	Mayday Support	Multi-modal Coordination	Network Surveillance	Regional Traffic Control	Reversible Lane Management	Road Weather Data Collection	Roadside CVO Safety	Roadway Automated Treatment	Roadway Maintenance and Construction	Roadway Service Patrols	Speed Monitoring	Standard Railroad Grade Crossing	Surface Street Control	Traffic Forecast and Demand Management	Traffic Information Dissemination	Transit Fixed-Route Operations	Transit Maintenance	Transit Passenger and Fare Management	Transit Security	Transit Traveler Information	Transit Vehicle Tracking	Weather Information Processing and Distribution	Weigh-In-Motion	Winter Maintenance	Work Zone Management	Work Zone Safety Monitoring
A Conceptual ITS Architecture: An ATIS Perspective		x				x								x	x	x									x															x	x	x					
Adaptive Cruise Control: Operating Characteristics and User Interface		x				x							x		x	x							x												x											
ADMS Data Dictionary Specifications																		x	x																													
ATC Cabinet	x								x					x											x		x							x	x												
Commercial Vehicle Credentials			x		x						x						x											x																				
Commercial Vehicle Safety and Credentials Information Exchange			x		x									x			x											x																				
Commercial Vehicle Safety Reports					x												x											x																				
Data Dictionary for Advanced Traveler Information System (ATIS)		x		x										x		x									x											x						x	x				
Data Radio Channel (DARC) System		x																																														
Interface		x				x							x		x	x							x																									
Information Report		x														x																																
ISP-Vehicle Location Referencing Message Profiles		x													x	x																															
ISP-Vehicle Location Referencing Standard		x													x	x																															
ITS Data Bus Conformance Test Procedure																							x																								
ITS Data Bus Data Security Services Recommended Practice																							x																								
ITS Data Bus Gateway Recommended Practice																							x																								
ITS Data Bus Protocol - Application Layer Recommended Practice																							x																								
ITS Data Bus Protocol - Link Layer Recommended Practice																							x																								
ITS Data Bus Protocol - Physical Layer Recommended Practice																							x																								
ITS Data Bus Protocol - Thin Transport Layer Recommended Practice																							x																								
ITS In-Vehicle Message Priority		x				x							x		x	x							x																								
Mayday Industry Survey Information Report							x	x															x																								
(Def. & Meas.)		x				x							x		x	x							x																								
Message Set for Advanced Traveler Information System (ATIS)		x		x										x		x									x											x						x	x				
Message Set for External TMC Communication (MS/ETMCC)		x	x	x		x	x	x	x		x	x		x	x	x		x	x					x	x	x				x					x	x	x	x			x	x			x	
Message Sets for DSRC ETTM & CVO					x	x											x											x																	x			
Standards		x		x										x		x									x												x						x	x				
Architecture (CORBA)				x	x																				x																	x	x	x				
NTCIP - Application Profile for File Transfer Protocol (FTP)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	x		x	x	x
Framework	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x			x	x	x	x	x	x		x	x	x	x				x	x
NTCIP - Application Profile for Trivial File Transfer Protocol	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x			x	x	x	x	x	x		x	x	x	x				x	
Architecture	x	x	x			x	x	x	x		x	x		x	x	x		x	x	x				x	x	x		x			x			x	x	x	x	x			x	x	x	x	x		x	x	
NTCIP - Applications Profile for Data Exchange ASN.x (DATEX)	x	x	x	x		x	x	x	x		x	x		x	x	x		x	x	x				x	x	x		x			x			x	x	x	x	x			x	x	x	x	x		x	x	
NTCIP - Base Standard: Octet Encoding Rules (OER)		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	
NTCIP - Class A and Class C Communications Profiles	x							x	x			x	x	x				x							x	x	x	x								x	x	x										
NTCIP - Class B Profile	x			x				x	x			x	x	x				x							x	x	x	x	x		x			x		x	x	x									x	x
NTCIP - CORBA Near Real Time Data Service		x		x	x		x	x						x		x		x		x						x	x		x		x		x				x				x	x	x	x		x	x	

WSDOT Applicable Standards by Market Package

Standard	Advanced Railroad Grade Crossing	Broadcast Traveler Information	CV Administrative Processes	Drawbridge Management	Electronic Clearance	Electronic Toll Collection	Emergency Response	Emergency Routing	Freeway Control	Freight Administration	HAZMAT Management	HOV Lane Management	In Vehicle Signing	Incident Management System	Integrated Transportation Management/Route Guidance	Interactive Traveler Information	International Border Electronic Clearance	ITS Data Warehouse	ITS Virtual Data Warehouse	Maintenance and Construction Activity Coordination	Maintenance and Construction Vehicle Maintenance	Maintenance and Construction Vehicle Tracking	Mayday Support	Multi-modal Coordination	Network Surveillance	Regional Traffic Control	Reversible Lane Management	Road Weather Data Collection	Roadside CVO Safety	Roadway Automated Treatment	Roadway Maintenance and Construction	Roadway Service Patrols	Speed Monitoring	Standard Railroad Grade Crossing	Surface Street Control	Traffic Forecast and Demand Management	Traffic Information Dissemination	Transit Fixed-Route Operations	Transit Maintenance	Transit Passenger and Fare Management	Transit Security	Transit Traveler Information	Transit Vehicle Tracking	Weather Information Processing and Distribution	Weigh-In-Motion	Winter Maintenance	Work Zone Management	Work Zone Safety Monitoring
NTCIP - CORBA Naming Convention		x		x	x		x	x						x						x					x			x			x					x					x	x			
NTCIP - CORBA Security Service		x		x	x		x	x						x		x		x		x					x			x			x	x				x					x	x			
NTCIP - Data Collection & Monitoring Devices									x			x		x				x							x	x	x								x	x										
NTCIP - Data Dictionary for Closed Circuit Television (CCTV)									x				x	x											x		x								x						x						x	
NTCIP - Global Object Definitions	x			x		x	x		x														x	x		x	x	x				x	x	x			x							x	
NTCIP - Information Profile for CORBA		x		x	x		x	x						x		x		x		x					x			x		x	x				x					x	x				x	
NTCIP - Information Profile for DATEX		x		x	x		x	x						x		x		x		x					x			x		x	x				x					x	x				x	
NTCIP - Internet (TCP/IP and UDP/IP) Transport Profile	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x
NTCIP - Message Set for Weather Reports		x		x			x	x								x									x					x						x										x	
NTCIP - Object Definitions for Actuated Traffic Signal Controller Units								x	x															x	x	x	x							x												x	
NTCIP - Object Definitions for Dynamic Message Signs																																																x	
Roadside Weather Information System		x							x							x		x							x										x												
NTCIP - Object Definitions for Video Switches									x					x											x										x											x	
NTCIP - Objects for Signal Control Priority								x																x		x									x												
NTCIP - Objects for Signal Systems Master								x																x		x									x												
Profile								x	x																	x		x		x			x											x			x	x
NTCIP - Profiles - Framework and Classification of Profiles	x					x			x			x		x											x	x	x						x	x	x	x										
NTCIP - Ramp Meter Controller Objects									x			x													x	x	x							x												
NTCIP - Simple Transportation Management Framework (STMF)	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x	x	x	x	x	x	x	x			x	x	x	x	x	x		x	x	x	x			x	x
NTCIP - Simple Transportation Management Protocol								x	x					x										x	x	x		x		x			x		x										x	x
NTCIP - Subnet Profile for Ethernet		x					x	x	x					x				x		x				x	x	x		x		x	x	x	x		x						x	x	x	x		x	x
NTCIP - Subnet Profile for Point-to-Point Protocol using RS 232								x	x					x										x	x	x		x					x		x											x	x
NTCIP - Subnet Profile for PMPP Over FSK modems								x	x					x				x						x	x	x		x		x			x		x											x	x
NTCIP - Transportation System Sensor Objects									x			x		x				x							x	x	x						x		x	x										
NTCIP - Transportation Transport Profile								x	x					x				x						x	x	x				x			x		x										x	x
On-Board Land Vehicle Mayday Reporting Interface											x												x																	x							
Security/Privacy of Vehicle/RS Communications including Smart Card Communications						x		x																x																							
Specification for Dedicated Short Range Communication (DSRC) Data Link Layer: Medium Access and Logical Link Control						x																																									
Restricted Media		x													x																																	
for use by EMCs		x					x	x			x			x	x	x		x	x					x		x					x	x	x	x		x	x	x			x					
Standard for Emergency Management Data Dictionary							x							x																	x	x														
(TMDD)	x	x	x			x	x	x	x		x	x	x	x	x	x		x	x					x	x	x	x	x			x			x	x	x	x	x			x	x			x	
Standard for Hazardous Material IMMS for use by EMCs							x							x																																
Standard for Message Sets for Vehicle/Roadside Communications					x	x							x				x																													x	

WSDOT Applicable Standards by Market Package

Standard	Advanced Railroad Grade Crossing	Broadcast Traveler Information	CV Administrative Processes	Drawbridge Management	Electronic Clearance	Electronic Toll Collection	Emergency Response	Emergency Routing	Freeway Control	Freight Administration	HAZMAT Management	HOV Lane Management	In Vehicle Signing	Incident Management System	Integrated Transportation Management/Route Guidance	Interactive Traveler Information	International Border Electronic Clearance	ITS Data Warehouse	ITS Virtual Data Warehouse	Maintenance and Construction Activity Coordination	Maintenance and Construction Vehicle Maintenance	Maintenance and Construction Vehicle Tracking	Mayday Support	Multi-modal Coordination	Network Surveillance	Regional Traffic Control	Reversible Lane Management	Road Weather Data Collection	Roadside CVO Safety	Roadway Automated Treatment	Roadway Maintenance and Construction	Roadway Service Patrols	Speed Monitoring	Standard Railroad Grade Crossing	Surface Street Control	Traffic Forecast and Demand Management	Traffic Information Dissemination	Transit Fixed-Route Operations	Transit Maintenance	Transit Passenger and Fare Management	Transit Security	Transit Traveler Information	Transit Vehicle Tracking	Weather Information Processing and Distribution	Weigh-In-Motion	Winter Maintenance	Work Zone Management	Work Zone Safety Monitoring
While Driving		x				x							x		x	x							x																									
Standard for Navigation and Route Guidance Man-Machine Interface															x																																	
Transactions		x				x							x			x							x																									
Standard for Public Safety IMMS for use by EMCs							x							x																																	
EMCs							x							x																		x	x													x		
Standard Railroad Grade Crossing																																		x													
Standard Specification for 5.9 GHz Physical Layer						x		x																x				x																			x
Standard Specification for 5.9 GHz Data Link Layer						x		x																x				x						x													x
Standard Specification for DSRC - Data Link Layer						x		x					x																																		
Standard Specification for DSRC - Physical Layer 902-928 MHz					x	x		x					x				x												x																	x		
Subcarrier Traffic Information Channel (STIC) System		x																																													
TCIP - Common Public Transportation (CPT) Business Area Standard																								x																	x	x	x	x	x	x				
TCIP - Control Center (CC) Business Area Standard			x			x									x		x							x														x		x	x	x		x				
TCIP - Fare Collection (FC) Business Area Standard			x			x									x		x																									x						
TCIP - Framework Document																								x																	x	x	x	x	x	x				
TCIP - Incident Management (IM) Business Area Standard		x					x			x				x	x								x																				x					
TCIP - Onboard (OB) Business Area Standard																								x																	x	x	x			x				
TCIP - Passenger Information (PI) Business Area Standard		x													x																									x		x		x	x				
TCIP - Scheduling/Runcutting (SCH) Business Area Standard		x													x																									x					x	x			
TCIP - Spatial Representation (SP) Business Area Standard																								x																	x	x	x	x	x	x				
TCIP - Traffic Management (TM) Business Area Standard																								x																	x	x								