Whatcom Regional ITS Architecture

Intelligent Transportation Systems Planning in Whatcom County

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as part of the Way to Go, Whatcom: 2045 Regional/Metropolitan Transportation Plan

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1. Introduction

The 2022 Whatcom Regional Intelligent Transportation Systems (ITS) Architecture is a plan that describes existing and planned transportation technology systems and how they interact with one another. The architecture identifies:

- What ITS systems are currently deployed in Whatcom County
- What ITS systems are planned for the region
- How these systems might work together to share data for the broader benefit of regional stakeholders
- How these systems relate to the **Way to Go, Whatcom** regional transportation plan's goals and objectives.

The Whatcom Council of Governments (WCOG), the Metropolitan Planning Organization (MPO) for Bellingham and the Regional Transportation Planning Organization (RTPO) for Whatcom County, maintains this architecture.

ITS is defined as the application of advanced sensor, computer, electronics, and communications technologies and management strategies – in an integrated manner – to improve the safety and efficiency of the surface transportation system.

Why Whatcom needs an ITS Architecture

There are several reasons why it is important to periodically update and maintain a regional ITS architecture. The plan:

- Is legally required for the region to qualify for certain federal funding opportunities
- Identifies opportunities for data sharing between agencies for the maximum benefit of public investments
- Documents best practices and lessons learned in the deployment of systems

Prior versions

The first Whatcom Regional ITS Architecture was developed in 2004 by IBI Group as a response to the January 8, 2001, U.S. Federal Highway Administration (FHWA) Rule and Federal Transit Administration (FTA) Policy requiring regions with existing ITS applications to have a Regional ITS Architecture completed.

An updated version of the architecture was developed at by WCOG in 2011 to update the previous document. In 2013 a spreadsheet version of the architecture was developed in conjunction with the 2012 Whatcom Transportation Plan with the goal of better incorporating broader goals and objectives of the regional planning process into the document. This was updated in 2018.

The 2022 Whatcom Regional ITS Architecture has been developed in conjunction with the regional

transportation plan that is updated every five years. WCOG will continue to tie both plans together to give the architecture a broader context that remains current with transportation goals and priorities.

Structure

Components of an ITS architecture are determined by Title 23 (Highways), Chapter I, Subchapter K, Part 940 of the United States Code of Federal Regulations (CFR), which describes "Intelligent Transportation System Architecture and Standards." The purpose of the regulation or policy was to provide "policies and procedures for implementing section 5206(e) of the Transportation Equity Act for the 21st Century (TEA-21), Public Law 105-178, 112 Stat. 457, pertaining to conformance with the National Intelligent Transportation Systems Architecture and Standards."

Components of a regional ITS architecture include:

- Architecture scope
- List of stakeholders
- Connection of architecture to regional planning goals, objectives, and strategies
- Inventory of ITS elements
- Regional ITS services
- User needs
- Operation concept (Stakeholders' roles and responsibilities)
- System functions and requirements
- System interfaces supporting the services
- Communications and device standards
- Interagency agreements to support ITS services and projects
- Sequence of regional ITS projects

Regional ITS architectures reference a national document called the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT). This architecture provides a common basis for describing and mapping a myriad of ITS systems that relate to regional transportation initiatives. ARC-IT can be viewed online at: https://www.arc-it.net/

Developing a regionally appropriate architecture

Since the original concept of an ITS architecture was first developed in 2005 there have been numerous changes, not only to the technology involved, the field of ITS, and how systems are categorized, but also how the architecture fits within a region.

Although a region is required to have an ITS architecture, updated guidance notes that "While the regulation establishes a requirement, the 'need' for a regional ITS architecture is based more on its utility in ITS project planning and implementation."[1]

Guidance also states that "the goal is to develop an architecture that can actually be used by the region to

[1] *Regional ITS Architecture Guide*, November 2020: https://www.arc-it.net/documents/raguide/raguide.pdf

guide ITS implementation."[2]

Although many stakeholders benefit from ITS systems deployed in the region, there are only four agencies that specifically install, operate, and maintain ITS technology in Whatcom County. This limited number of stakeholders reduces the need for a complex architecture to map out future projects.

In addition, while some ITS architectures may be used for project development, in this region the architecture serves more use as a transportation planning tool. With that in mind, the key benefit of this document is to link services to regional planning objectives.

After an evaluation of the Regional Architecture Development for Intelligent Transportation (RAD-IT) tool, and after discussion with regional stakeholders, it was determined that most of the outputs from that database would not be used in this region. What would benefit, however, is an approach strategizing how ITS investments relate to regional planning goals, where investments may want to focus on in the future, and how certain projects may benefit multiple agency objectives through collaboration.

2. Architecture scope

Geographic scope

This architecture covers ITS deployments in Whatcom County and the jurisdictions within. This includes the incorporated cities, unincorporated county area, state highways, and the U.S. – Canada land ports-of-entry.

Timeframe

Because this architecture is being developed in conjunction with the Way to Go, Whatcom 2045 long-range transportation plan, the timeframe for services included is twenty-three years. This architecture will be updated every five years.

What is included in the architecture

WCOG includes an ITS system in the architecture if that system **automatically shares data** with one or more devices or databases. If there is no automated transmission of data, it is not included here. For example, if a traffic light dynamically transmits data to a traffic management center, it will be included. However, if no data are collected, or data are only accessible by downloading directly from the device in the field, then it is not included at this time.

3. Stakeholders

Stakeholders are agencies that operate ITS systems within Whatcom County. These include:

B.C. Ministry of Transportation and Infrastructure (BCMOTI)	Canadian provincial agency responsible for managing and maintaining province-owned

[2] Ibid.

	transportation infrastructure
Canada Border Services Agency (CBSA)	Canadian federal agency responsible for the safety and management of Canadian ports-of-entry
City of Bellingham	Municipality in Whatcom County, WA
City of Bellingham Office of Emergency Management	Department of emergency services for the City of Bellingham, WA
City of Blaine	Municipality in Whatcom County, WA
City of Everson	Municipality in Whatcom County, WA
City of Ferndale	Municipality in Whatcom County, WA
City of Lynden	Municipality in Whatcom County, WA
City of Nooksack	Municipality in Whatcom County, WA
City of Sumas	Municipality in Whatcom County, WA
Lummi Nation	Native American tribe of the Coast Salish in Whatcom County, WA
Lummi Transit	Transportation provider for Lummi Nation
Skagit Transit	Skagit County's regional transportation authority
U.S. Customs & Border Protection (CBP)	Agency under the U.S. Department of Homeland Security responsible for land and air ports-of-entry
WA State Department of Transportation (WSDOT)	State transportation agency responsible for managing, operating, and maintaining state-owned transportation infrastructure
WA State Emergency Management Division	State emergency division that assists regional emergency operations as needed
WA State Highway Patrol (WSP)	State highway transportation public safety agency that also administers commercial vehicle registration, licensing, and enforcement
Whatcom Council of Governments	Metropolitan Planning Organization (MPO) and Regional Transportation Planning Organization (RTPO) for Whatcom County, WA

Whatcom County	County government agency in Whatcom County, WA
Whatcom County Sheriff's Office Division of Emergency Management	This division is responsible for providing emergency management services for all of unincorporated Whatcom County and for the cities of Lynden, Ferndale, Blaine, Sumas, Everson, Nooksack and the Port of Bellingham
Whatcom Transportation Authority (WTA)	Whatcom County's regional transportation authority
Whatcom Unified Emergency Operations Center	Center coordinating efforts between Bellingham and Whatcom County's divisions of emergency management

It's important to note that some of the municipalities and agencies listed above may not have direct control over ITS equipment they benefit from, but they are listed here as a recipient of data coming from those systems.

ITS Stakeholder Group

WCOG met with a subset of ITS stakeholders to complete a more in-depth review of ITS systems in operation and what plans are in place for future investment. These agencies include:

- City of Bellingham
- WA State Department of Transportation
- Whatcom County
- Whatcom Transportation Authority

4. Incorporating regional planning goals

Architecture and long-range planning

Guidance notes that a regional ITS architecture supports the long-range planning process of a region in the following ways:

- The services described in the regional ITS architecture can be related to the operational objectives or operational strategies that can be used to improve the transportation system to meet the

region's vision and goals.

- The definition of an integrated transportation system described by the regional ITS architecture can support the operations and management element of the transportation plan.
- The process of developing and maintaining a regional ITS architecture can help to enhance the linkage between operations and planning through closer involvement of a wider array of stakeholders from both areas of transportation.[3]

Coordination with *Way to go, Whatcom*

The *Way to Go, Whatcom – 2045 Regional/Metropolitan Transportation Plan* for the Whatcom Region is part of the WCOG's ongoing regional strategy to advance transportation goals through programs, projects, collaborative efforts, and public engagement. The plan is a snapshot of the region's goals (outcomes expected from transportation investments), the regional transportation system as it exists and functions today and forecasted transportation demand that the region will experience over the next 22 years.

Seven regional transportation goals are described in the plan and take precedence in prioritizing project funding requests and developing performance measures and targets.

1. **Safety:** The safety of all users of the region's transportation system – pedestrians, bicyclists, automobile drivers and passengers, and truckers – must be maximized to the greatest degree practicable in the establishment of regional transportation policies and investment decisions.

2. **Provide all types of transportation (multimodal):** To serve the growing number of trips and goods movement effectively and efficiently, our transportation network must provide and promote attractive and well-connected options for all types of trip-making: walking, rolling, biking, cars, buses, trucks, etc. Operating a multi-modal transportation system means that we are striving to serve *trips* (people, goods, and services) as well as managing road capacity for *vehicles*.

3. Climate (greenhouse gas reduction) & environmental quality: Reducing greenhouse gas (GHG) emissions and more broadly advancing environmental mitigation and restoration (e.g., energy conservation, habitat preservation, and air and water quality) are outcomes of paramount importance in the region.

4. Maintain existing infrastructure in good, operating condition (preservation): This goal indicates the Whatcom region's intent to ensure that existing transportation systems are kept in a state of good repair before pursuing system expansions. This goal includes the principle of sustainability – choosing investments in facilities and programs that our region has the ability and willingness to pay for, operate, and maintain into the future.

5. System Efficiency & Reliability (Mobility): High quality travel and goods movement as indicated by various measures such as travel time, travel-time predictability, reliability, and comfort. The goal of mobility and our region's strategies to optimize it pertain to all types (modes) of transportation. Mobility depends on adequate transportation system capacity. To track progress on this goal (and other goals), WCOG emphasizes planning for the whole system's operational capacity for serving forecast increases in *trips* rather than a narrower focus on our roads' capacity for *vehicles*.

6. Access, Equity, & Economic Opportunity: The region's transportation system should work for all people; should acknowledge and reduce barriers related to age (seniors and youth), income, and physical

[3] Ibid.

ability; and should connect people to resources and opportunities critical to economic success (especially education and employment).

7. **Freight and Economic Vitality:** In addition to providing for the movement of people, our regional transportation system must provide for effective and efficient movement of goods and services and do so in a way that is consistent with our other goals listed above. A transportation network that enables transactions and the associated movement of products and services is essential to economic vitality.

Objectives and strategies related to ITS

Because *Way to Go, Whatcom* is a regional long-range transportation plan, it references the comprehensive plans of Whatcom County's jurisdictions. It is at the jurisdictional level that specific strategies are identified that relate to the application of ITS solutions.

5. Inventory

ITS systems in Whatcom County that currently exist and are functioning are summarized in this section. The "physical architecture" described here is broken out by what kind of system is being defined – whether it is equipment in the field, a centralized location managing equipment, a software component that compiles and shares data, or an end user in a vehicle or using a personal device.

Centers

Traffic and transit management centers are locations where data are collected, analyzed, and either acted upon, stored, or shared with another system or device. The following centers have data feeds and manage transportation systems that impact travelers in Whatcom County:

Border Inspection Administration

U.S. Customs and Border Protection (CBP) has a centralized management system that oversees processing of people and cargo entering the United States.

City of Bellingham Traffic Management Center (TMC)

The City of Bellingham Public Works department has a TMC that oversees city traffic signals and lighting. It also shares information with WSDOT's TMC. Whatcom Transportation Authority (WTA), which has cameras aboard their buses, have camera feeds that share with the TMC as well.

The TMC oversees the following elements:

- Traffic signals in the City of Bellingham
- Traffic signals for surrounding jurisdictions including Ferndale, Lynden, and unincorporated Whatcom County
- WSDOT signals at intersections with state routes
- Parking management software and equipment

WA State Department Traffic Management Center (WSDOT TMC)

WSDOT has six TMCs across the state, with the Shoreline TMC overseeing traffic operations for Whatcom County and the border. The center monitors traffic conditions in real-time, manages ITS deployed ITS systems across its road networks, coordinates activities of their incident response teams and WA State Patrol, and collects and shares transportation data for distribution to partner agencies and the public.

The TMC oversees the following elements within Whatcom's ITS Architecture:

- I-5 road monitoring
- SR 539 (Guide Meridian) road monitoring
- SR 543 (Pacific Highway) road monitoring
- SR 542 (Mt. Baker Highway) road monitoring
- SR 546 (Badger Road) road monitoring
- SR 9 road monitoring
- Northbound border information system

Whatcom Transportation Authority Transit Management

WTA has several ITS services in operation across its fleet and at stations. Their technology department manages and maintains these systems. These include:

- Transit data warehouse
- Performance monitoring
- Fixed and dynamic route operations
- Automatic vehicle location
- Electronic fare collection
- Transit security systems
- Fleet management
- Travel demand response
- Passenger counting
- Traveler information
- Multimodal coordination

Whatcom Unified Emergency Operations Center

Whatcom County Sheriff's Division of Emergency Management and the City of Bellingham's Office of Emergency Management coordinate efforts in regional emergencies through a shared facility that has staff from both agencies. This department manages numerous emergency and safety-related functions, including:

- Emergency call-taking and dispatch
- Emergency response

- Emergency vehicle preemption
- Transportation Infrastructure Protection
- Wide-area alert system
- Early warning system
- Incident management center

Field devices

This category of "physical architecture" includes equipment or systems deployed on location.

Border inspection systems

Through the U.S. Customs and Border Protection (CBP) information system shares booth status data with BCMOTI's southbound traveler information system and the Cascade Gateway Border Data Warehouse. This system includes:

- portal radiation monitors (vehicle counts)
- vehicle primary client equipment (data entry at booths)

Electric charging station equipment

The City of Bellingham will be installing a system that collects data for the city's charging stations throughout Bellingham.

WTA will also be installing charging equipment in the future for their electric buses.

ITS roadway equipment

ITS roadway equipment refers to any type of hardware physically installed at locations that provide real-time data to a traffic management center or support system. These include:

- Traffic signals
- Loop detectors in the road
- Lighting systems
- Weather data collection systems
- Vehicle preemption systems

Parking area equipment

The City of Bellingham works with payment applications that allow individuals to pay for city parking on their phones.

Security monitoring equipment

WTA and WSDOT use cameras to provide real-time information about the safety and security of locations and roadways throughout Whatcom County. These feeds are provided to TMCs as needed.

The Whatcom Unified Emergency Operations Center has systems in place at sensitive infrastructure to provide alerts in case of damage.

Weather detection equipment

Both WSDOT and Whatcom County have in-road weather detection devices to alert agencies of dangerous driving conditions that may require the closure of a roadway.

Variable message signs

WSDOT uses variable message signs (VMS) on major routes to display important travel information. In Whatcom County, these signs typically display border wait times, and any emergency updates.

Vehicles

Transit vehicles

WTA fixed route and paratransit vehicles include the following components:

- Wi-fi access
- Security cameras
- Emergency silent alarm
- Passenger counting systems
- Payment collection systems
- GPS location

Emergency vehicles

Emergency vehicles in Whatcom County are monitored by the Whatcom Unified Emergency Operations Center. Within the vehicles sensors can detect:

- GPS location
- Vehicle status
- Communication

Support

This category of "physical architecture" includes predominantly software solutions – archived data systems, data distribution systems, communication systems, and other elements needed to connect field equipment with TMCs, vehicles, and end users.

Cascade Gateway Border Data Warehouse (BDW)

WCOG manages the BDW, which collects data from the northbound and southbound border traveler information systems and archives it in a system available online and directly through API links with partner agencies.

Transit Performance Measurement

WTA maintains a data archive of transit data to help measure performance and evaluate changes in operations, technology, and service.

Wide-Area Information Disseminator System

The Whatcom Unified Emergency Operations Center manages both an early detection system and wide-area alert system for quickly sharing safety information through a broad range of messaging options.

Other ITS Communications Equipment

This element includes the software and communications components needed to run the other systems.

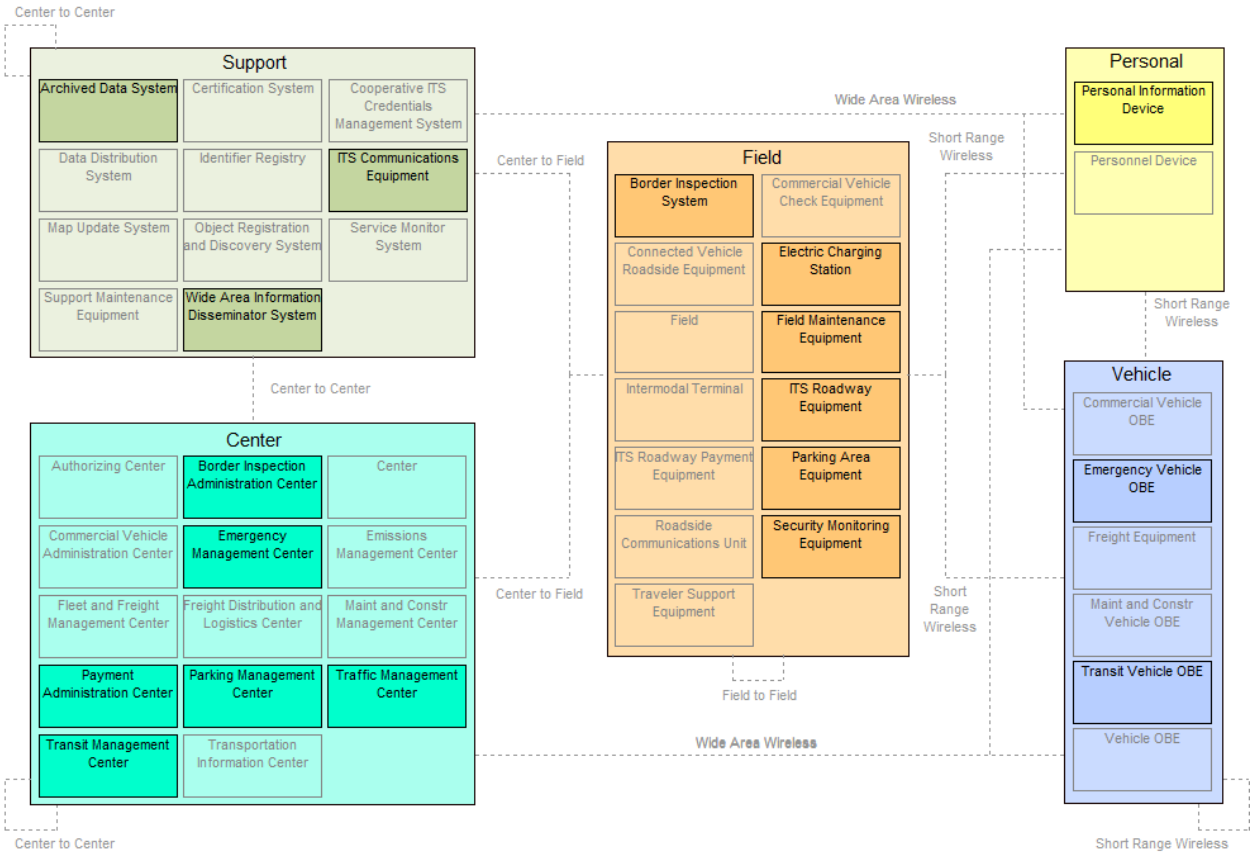
Personal

This category of the physical architecture includes any information exchanged with individual travelers, either through personal devices such as smart phones, connected vehicle systems, area alert systems, or between employers and personnel.

WTA Traveler Information

WTA provides an app that allows individuals to receive updates and alerts regarding their routes.

Figure 1: Regional inventory of physical architecture systems



Inventory of elements

The following table breaks out all elements included in this architecture along with the related stakeholders.

Element Name	Element Description	Status	Stakeholder
BCMOTI Traffic Management Center (BCMOTI)	BCMOTI's central Traffic Management Center.	Existing	BC Ministry of Transportation and Infrastructure (BCMOTI)
Bellingham Traffic Management Center (TMC)	Bellingham's Traffic Management Center operates most of ITS services in Whatcom County, and coordinates with WSDOT and other agencies.	Existing	City of Bellingham
Bellingham Traffic Signals	Traffic signal controls in the City of Bellingham, managed by City of Bellingham TMC.	Existing	City of Bellingham
Cascade Gateway Border Data Warehouse	Data archive of border volumes and delays from the northbound and southbound border traveler information systems.	Existing	Whatcom Council of Governments (WCOG)
CBP Border Inspection System	Provides booth-status data to the border data warehouse and southbound advanced traveler information system.	Existing	U.S. Customs and Border Protection (USCBP)

Element Name	Element Description	Status	Stakeholder
Early Warning System	The tsunami warning system is managed by the Whatcom County Sheriff's Office Division of Emergency Management. They can also send EAS and WEA alerts to television and radio stations and to cell phones. They use AlertSense.	Existing	Whatcom County Sheriffs Office Division of Emergency Management
Electric Charging Stations Management	The City of Bellingham intends to work with a vendor to install nearly 100 electric charging stations across the city in addition to the ones already in place. This network will be managed though the city.	Planned	City of Bellingham
Emergency Dispatch	the WUEOC coordinates emergency dispatching and vehicle tracking at its shared facility.	Existing	Whatcom Unified Emergency Operations Center
Emergency Mobile Communications	The Whatcom County Sheriff's Office Division of Emergency Management manages all law enforcement radio systems in the County and works hand in hand with the City of Bellingham radio shop to manage the City of Bellingham's radio infrastructure. This includes a mobile communications van that can be dispatched to emergency scenes to support tactical dispatching and on-scene interagency communications.	Existing	Whatcom Unified Emergency Operations Center
Emergency Vehicle Preemption	The City of Bellingham's traffic signals offer signal preemption for emergency vehicles.	Existing	City of Bellingham
Ferndale Traffic Signals	Traffic signal controls in the City of Ferndale managed by City of Bellingham TMC.	Existing	City of Bellingham, City of Ferndale
I-5 Monitoring System	ITS monitoring of I-5 for better management and safety.	Existing	WA State Department of Transportation (WSDOT)
Incident Management Center	The Sherrif's Office Division of Emergency Operations and the City of Bellingham Department of Emergency Management both coordinate emergency incident responses through a software, a shared physical office, and an incident in-field vehicle.	Existing	Whatcom Unified Emergency Operations Center
Lynden Traffic Signals	Traffic signal controls in the City of Lynden, managed by City of Bellingham TMC.	Existing	City of Bellingham, City of Lynden
Northbound Border Traveler Information System	Advanced Traveler Information System (ATIS) consisting of loop detectors, variable message signs, 511 and web applications to distribute border wait time information.	Existing	WA State Department of Transportation (WSDOT)
Parking Electronic Payment	The City of Bellingham works with Pay by Phone currently and will also work with the vendor Park Mobile in the near future. Both services allow drivers to pay for parking via smart phone apps.	Existing	City of Bellingham
Parking Space Management System	The City of Bellingham is contracting with a vendor to manage parking spaces in the city. The system will eventually allow users to identify where available parking stalls are located.	Planned	City of Bellingham

Element Name	Element Description	Status	Stakeholder
Smart Park and Ride	WTA would like to better utilize its park and ride facilities and this resource could assist in the future.	Planned	Whatcom Transportation Authority (WTA)
Southbound Border Traveler Information System	Advanced Traveler Information System (ATIS) consisting of loop detectors, variable message signs, 511 and web applications to distribute border wait time information.	Existing	BC Ministry of Transportation and Infrastructure (BCMOTI)
Transportation Infrastructure Protection	The WUEOC has sensors and cameras on sensitive infrastructure to detect emergencies.	Existing	Whatcom Unified Emergency Operations Center
WA State Route 539 Monitoring System	ITS monitoring of WA State Route 539 (Guide Meridian) for better management and safety.	Existing	WA State Department of Transportation (WSDOT)
WA State Route 542 Monitoring System	ITS monitoring of WA State Route 542 (Mt. Baker Highway) for better management and safety.	Existing	
WA State Route 543 Monitoring System	ITS monitoring of WA State Route 543 (Pacific Highway) for better management and safety.	Existing	WA State Department of Transportation (WSDOT)
WA State Route 9 Monitoring System	ITS monitoring of WA State Route 9 for better management and safety.	Existing	
Whatcom County Traffic Signals	Traffic signal controls in the unincorporated areas of Whatcom County, managed by the City of Bellingham TMC	Existing	Whatcom County , City of Bellingham,
Weather Data Collection	Whatcom County has installed infrastructure censors monitoring certain routes to determine if they need to be closed during weather events.	Existing	Whatcom County
Wide-Area Alert System	The AHAB (All Hazard Alert Broadcast) outdoor siren systems are in coastal areas. The system is managed from the WUEOC. They also utilize AlertSense.	Existing	Whatcom Unified Emergency Operations Center
WTA Automatic Vehicle Location	Vehicle tracking for both paratransit and fixed route now in place.	Existing	Whatcom Transportation Authority (WTA)
WTA Demand Response	This demand response system is for the paratransit fleet only.	Existing	Whatcom Transportation Authority (WTA)
WTA Intermittent Bus Lanes	WTA has an increase of bus rapid transit routes included in its strategic plan, and one component of this may be the use of intermittent bus lanes.	Planned	Whatcom Transportation Authority (WTA)
WTA Transit Electronic Fare Collection Management	Management of transit pass system and collection of electronic fares for WTA passengers.	Existing	Whatcom Transportation Authority (WTA)
WTA Transit Fleet Management	WTA will be installing technology to track the status of its fleet vehicles remotely and in real-time, as part of its overall computer-aided dispatch system.	Planned	Whatcom Transportation Authority (WTA)
WTA Transit Management	WTA systems not separated out including passenger counting, operations management, and fleet management.	Existing	Whatcom Transportation Authority (WTA)
WTA Transit Security	WTA has monitoring abilities at all their transit centers. Images can be shared with the City of Bellingham. It also has cameras in transit vehicles.	Existing	Whatcom Transportation Authority (WTA)
WTA Transit Signal Priority	WTA has a transit signal prioritization system built on the City of Bellingham traffic management system.	Existing	Whatcom Transportation Authority (WTA)

6. Regional services

Categories of ITS systems, solutions, and/or equipment deployment are called service packages. ARC-IT has identified twelve major categories of ITS service packages:

1. Commercial vehicle operations
2. Data management
3. Maintenance and construction
4. Parking management
5. Public safety
6. Public transportation
7. Support
8. Sustainable travel
9. Traffic management
10. Traveler information
11. Vehicle safety
12. Weather

The following services were identified by Whatcom ITS stakeholders. Descriptions for each service that come directly from ARC-IT are italicized. A brief statement of how the system is/will be deployed regionally is also included.

Commercial vehicle operations

Commercial vehicle operations services address the management of the efficiency, safety, and operations of commercial vehicle fleets and the movement of freight. It includes activities that expedite the authorization process of freight to move across jurisdictional boundaries, activities that expedite transfers of freight, and the exchange of information regarding the motor carrier, the vehicle, the driver, and the cargo.

CVO20: International Border Registration (Existing)

Stakeholders: CBP, CBSA

This service package covers registration of importers, carriers, conveyance, and drivers for expedited clearance at the border. It represents enrollment in programs such as FAST, NEXUS, Customs Self-Assessment, C-TPAT, PIP, ACI, and ACE.

CBP and CBSA operate expedited border processing programs at the five land border ports-of-entry between Whatcom County, WA and the Lower Mainland of British Columbia. If all components of a cross-border movement (carrier, cargo, and driver) are C-TPAT enrolled, that vehicle has access to a specialized lane to bypass border crossing queues. In addition, cargo that is filed electronically through the CBP ACE program may cross within 30 minutes of completion. This service represents the registration of carriers, cargo, and drivers into these expedited programs.

CVO21: International Border Electronic Clearance (Existing)

Stakeholders: CBP, CBSA

This service package provides for automated clearance at international border crossings. It augments the Electronic Clearance service package by allowing interface with border administration and border inspection related functions. This service package processes the entry documentation for vehicle, cargo, and driver, checks compliance with import/export and immigration regulations, handles duty fee processing, and reports the results of the crossing event to manage release of commercial vehicle, cargo, and driver across an international border. It interfaces with administrative systems used by customs and border protection, immigration, carriers, and service providers (e.g., brokers) and inspection systems at international border crossings to generate, process, and store entry documentation.

This relates to the same system listed above but represents the data centers and field equipment needed to complete the clearance.

CVO22: International Border Coordination (Existing)

Stakeholders: CBP, CBSA

This service package covers coordination and sharing of information between agencies to support expedited clearance, customs pre-processing, and border crossing inspections.

CBP and CBSA share data with other federal safety agencies. That partnership is covered in this service package.

Data management

This area addresses the management of data that can be used by some or all transportation agencies and other organizations to support transportation planning, performance monitoring, safety analysis, and research. Data are collected from detectors and sensors, connected vehicles, and operational data feeds from centers.

DM01: ITS Data Warehouse (Existing)

Stakeholders: WCOG, WTA

This service package provides access to transportation data to support transportation planning, condition and performance monitoring, safety analysis, and research. Configurations range from focused repositories that house data collected and owned by a single agency, district, private sector provider, or research institution to broad repositories that contain multimodal, multidimensional data from varied data sources covering a broader region. Both central repositories and physical distributed ITS data repositories are supported. Requests for data that are satisfied by access to a single repository in the ITS Data Warehouse service package may be parsed by the local repository and dynamically translated to requests to other repositories that relay the data necessary to satisfy the request. The repositories could include a data registry capability that allows registration of data identifiers or data definitions for interoperable use throughout a region.

WCOG maintains the Cascade Gateway Border Data Warehouse, an archived database collecting information from the northbound and southbound border traveler systems, in addition to the CBP booth status feed. Data are available to the public via the website, pushed out by email notification, and may be

used for other applications via API.

WTA manages a data warehouse for their transit management system.

DM02: Performance Monitoring (Existing)

Stakeholders: WTA

The Performance Monitoring service package uses information collected from detectors and sensors, connected vehicles, and operational data feeds from centers to support performance monitoring and other uses of historical data including transportation planning, condition monitoring, safety analyses, and research. The information may be probe data information obtained from vehicles in the network to determine network performance measures such as speed and travel times, or it may be information collected from the vehicles and processed by the infrastructure, e.g. environmental data and infrastructure conditions monitoring data. Additional data are collected including accident data, road condition data, road closures and other operational decisions to provide context for measured transportation performance and additional safety and mobility-related measures. More complex performance measures may be derived from the collected data.

WTA monitors real-time performance of their transit system and vehicles using information from their computer-aided dispatching (CAD) system.

Parking management

This area addresses the management of parking operations including both space management and the electronic payment for parking. This area supports communication and coordination between equipped parking facilities and regional coordination between parking facilities and traffic and transit management systems. It includes monitoring and managing parking spaces and in lots, garages, and other parking areas and facilities as well as loading/unloading zones.

PM01: Parking Space Management (Planned)

Stakeholders: City of Bellingham

This service package monitors and manages parking spaces in lots, garages, and other parking areas and facilities. It assists in the management of parking operations by monitoring parking lot ingress and egress, parking space occupancy and availability. Infrastructure-based detectors and/or connected vehicles may be used to monitor parking occupancy. The service package shares collected parking information with local drivers and information providers for broader distribution.

The City of Bellingham is contracting with a vendor to manage parking spaces in the city. The system will eventually allow users to identify where available parking stalls are located.

PM02: Smart Park and Ride System (Planned)

Stakeholders: WTA

This service package provides real-time information on Park and Ride capacity and supports traveler's decision-making on where best to park and make use of transit alternatives. Transit operators are provided arrival information to support efficient pickup and drop offs and drivers switching to transit are offered current transit information.

WTA is planning to improve some of its key park and ride locations and hopes to include ITS solutions

that will assist in more efficient usage of these facilities.

PM03: Parking Electronic Payment Management (Existing)

Stakeholders: City of Bellingham

This service package supports electronic collection of parking fees. This includes all types of parking fee collection including short term and long-term parking and pay-for-use loading zones. It collects parking fees from in-vehicle equipment, contact or proximity cards, or any smart payment device. This service package supports both payment via a local point of sale in the parking area or direct payment via wide area wireless communications. User accounts may be established to facilitate secure payment using only a secure ID and enhance services offered to frequent customers.

The City of Bellingham works with Pay by Phone currently and will also work with the vendor Park Mobile in the near future. Both services allow drivers to pay for parking via smart phone apps.

Public Safety

This area addresses the management by public safety agencies of emergencies or incidents in the transportation network including those relating to HAZMAT materials that are transported through the transportation network. It covers public safety (police, fire, and emergency medical services) agencies using emergency management services to improve their response to emergency situations. The area also addresses how emergency operations centers interact with transportation and public safety agencies to support response to disasters and for evacuations impacting the transportation network.

PS01: Emergency Call-Taking and Dispatch Vehicle Tracking (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package provides basic public safety call-taking and dispatch services. It includes emergency vehicle equipment, equipment used to receive and route emergency calls, and wireless communications that enable safe and rapid deployment of appropriate resources to an emergency. Coordination between Emergency Management Centers supports emergency notification between agencies. Wide area wireless communications between the Emergency Management Center and an Emergency Vehicle supports dispatch and provision of information to responding personnel. This service package also provides information to support dynamic routing of emergency vehicles. Traffic information, road conditions, and weather advisories are provided to enhance emergency vehicle routing. The Emergency Management Center provides routing information based on real-time conditions and has the option to request an ingress/egress route from the Traffic Management Center.

The Whatcom Unified Emergency Operations Center (WUEOC) coordinates emergency dispatching and vehicle tracking at its shared facility.

PS02: Emergency Response (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package supports emergency/ incident response by personnel in the field. It includes emergency vehicle equipment used to provide response status as well as video or images from either the vehicle or from

emergency personnel in the field. Wide area wireless communications between the Emergency Management Center, Emergency Personnel and Emergency Vehicles supports a sharing of emergency response information. The service package also includes tactical decision support, resource coordination, and communications integration for Incident Commands that are established by first responders at or near the incident scene to support local management of an incident, including the functions and interfaces commonly supported by a mobile command center.

The WUEOC have an incident management system to manage and track emergency incident response. They also have access to WA State's Emergency Management Division to request additional supplies or resources as needed. The Whatcom County Sheriff's Office Division of Emergency Management also manages all law enforcement radio systems in the County and works hand in hand with the City of Bellingham radio shop to manage radio infrastructure.

PS03: Emergency Vehicle Preemption (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center, City of Bellingham

This service package provides signal preemption for public safety-first responder vehicles. Both traditional signal preemption systems and new systems based on connected vehicle technology are covered. In more advanced systems, movement of public safety vehicles through the intersection can be facilitated by clearing queues and holding conflicting phases. In addition, this SP also covers the transition back to normal traffic signal operations after providing emergency vehicle preemption.

Signals in Whatcom County allow for emergency vehicle preemption.

PS06: Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package will provide situational awareness to and coordination among emergency responders - upon dispatch, while en route to establish incident scene work zones, upon initial arrival and staging of assets, and afterward if circumstances require additional dispatch and staging. It collects a variety of data from emergency, traffic, and maintenance centers. It includes a vehicle and equipment staging function that supplies the en route responders with additional information about the scene of an incident that they can use to determine where to stage personnel and equipment prior to their arrival on-scene. The service package also includes a dynamic routing function which provides emergency responders with real-time navigation instructions to travel from their base to the incident scene, accounting for traffic conditions, road closures, and snowplow reports if needed. In addition, it includes an emergency responder status reporting function which continuously monitors the location of the en route responder vehicles as well as the vehicles already on-scene. The function develops and maintains the current position of the responder's vehicles and provides updates for estimated time of arrival (ETA).

The WUEOC operations include a mobile communications van that can be dispatched to emergency scenes to support tactical dispatching and on-scene interagency communications.

PS09: Transportation Infrastructure Protection (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package includes the monitoring of transportation infrastructure (e.g., bridges, tunnels and management centers) for potential threats using sensors and surveillance equipment and barrier and

safeguard systems to control access, preclude an incident, and mitigate the impact of an incident if it occurs. Threats can result from acts of nature (e.g., hurricanes, earthquakes), terrorist attacks or other incidents causing damage to the infrastructure (e.g., stray barge hitting a bridge support). Infrastructure may be monitored with acoustic, environmental threat (such as nuclear, biological, chemical, and explosives), infrastructure condition and integrity, motion and object sensors and video and audio surveillance equipment. Data from such sensors and surveillance equipment may be processed in the field or sent to a center for processing. The data enables operators at the center to detect and verify threats. When a threat is detected, agencies are notified. Detected threats or advisories received from other agencies result in an increased level of system preparedness. In response to threats, barrier and safeguard systems may be activated to deter an incident, control access to an area or mitigate the impact of an incident. Barrier systems include gates, barriers and other automated and remotely controlled systems that manage entry to transportation infrastructure. Safeguard systems include blast shields, exhaust systems and other automated and remotely controlled systems that mitigate impact of an incident.

WUEOC has monitors and cameras for sensitive infrastructure that can report back threats in real time. They are considering additional camera monitoring locations in key areas that are at risk.

PS10: Wide-Area Alert (Existing, Planned)

Stakeholders: Whatcom Unified Emergency Operations Center, WTA

This service package uses ITS driver and traveler information systems to alert the public in emergency situations such as child abductions, severe weather events, civil emergencies, and other situations that pose a threat to life and property. The alert includes information and instructions for transportation system operators and the traveling public, improving public safety and enlisting the public's help in some scenarios. The ITS technologies will supplement and support other emergency and homeland security alert systems such as the Emergency Alert System (EAS). When an emergency situation is reported and verified and the terms and conditions for system activation are satisfied, a designated agency broadcasts emergency information to traffic agencies, transit agencies, information service providers, toll operators, and others that operate ITS systems. The ITS systems, in turn, provide the alert information to transportation system operators and the traveling public using ITS technologies such as dynamic message signs, highway advisory radios, in-vehicle displays, transit displays, 511 traveler information systems, and traveler information websites.

In WA State the AHAB (All Hazard Alert Broadcast) outdoor siren systems are in coastal areas and can be activated by WA State Emergency Management and the Whatcom County Sheriff's Office Division of Emergency Management for all of Whatcom County. The system is managed from the WUEOC and can be used for other purposes such as train derailments or other emergency incidents around the siren locations. Both Bellingham and the Sheriff's Office also use an emergency messaging system called AlertSense that citizens can sign up for to get notifications.

They plan to install additional sirens in Everson and Sumas for flood evacuation warnings when funding is available.

WTA hopes to connect with the wide-area alert system in order to more quickly be notified of emergencies for both passengers currently on board and to best use the bus network to help get people out of dangerous zones.

PS11: Early Warning System (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package monitors and detects potential, looming, and actual disasters including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and acts of terrorism including nuclear, chemical, biological, and radiological weapons attacks). The service package monitors alerting and advisory systems, ITS sensors and surveillance systems, field reports, and emergency call-taking systems to identify emergencies and notifies all responding agencies of detected emergencies.

The WUEOC also manages a tsunami warning system. They are able to send emergency alerts to television and radio stations (EAS Alerts) as well as emergency alerts to cell phone (WEA Alerts). AlertSense is utilized to send emergency messages for all hazards, including tsunamis.

They are looking to expand monitoring around Mount Baker for seismic data relating to potential eruptions (in partnership with USGS).

PS12: Disaster Response and Recovery (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package monitors and detects potential, looming, and actual disasters including natural

This service package enhances the ability of the surface transportation system to respond to and recover from disasters. It addresses the most severe incidents that require an extraordinary response from outside the local community. All types of disasters are addressed including natural disasters (hurricanes, earthquakes, floods, winter storms, tsunamis, etc.) and technological and man-made disasters (hazardous materials incidents, nuclear power plant accidents, and national security emergencies such as nuclear, chemical, biological, and radiological weapons attacks).

In addition to the alert and notification tools already mentioned, the City and County use their incident management software system for disaster response and recovery.

PS13: Evacuation and Reentry Management (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package supports evacuation of the general public from a disaster area and manages subsequent reentry to the disaster area. The service package addresses evacuations for all types of disasters, including disasters like hurricanes that are anticipated and occur slowly, allowing a well-planned orderly evacuation, as well as disasters like terrorist acts that occur rapidly, without warning, and allow little or no time for preparation or public warning.

This service is party of the WUEOC disaster response and recovery operations.

PS14: Disaster Traveler Information (Existing)

Stakeholders: Whatcom Unified Emergency Operations Center

This service package uses ITS to provide disaster-related traveler information to the general public, including evacuation and reentry information and other information concerning the operation of the transportation system during a disaster. This service package collects information from multiple sources including traffic, transit, public safety, emergency management, shelter provider, and travel service provider organizations.

The collected information is processed and the public is provided with real-time disaster and evacuation information using ITS traveler information systems.

WUEOC has a direct working relationship with WSDOT and this includes notification of the need for use of the variable message signage (VMS) in the county. They may also request resources from the State, including use of their variable message signs.

Public transportation

This area addresses the management, operations, maintenance, and security of public transportation to enable them to provide transit services that operate in a timely and efficient manner, delivering operational information, including multimodal information to the operators and users. This area covers both fixed route and demand response systems, as well as those passenger rail systems operated by transit agencies.

PT01: Transit Vehicle Tracking (Existing)

Stakeholders: WTA

This service package monitors current transit vehicle location using an Automated Vehicle Location System. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time.

WTA has installed an AVL system that allows their TMC, end users using apps on smart phones, and the internal bus system to know where a bus is located at any given time. Stations and stops are automatically announced. And the system has expanded to include both fixed route and paratransit service.

PT02: Transit Fixed-Route Operations (Existing)

Stakeholders: WTA

This service package performs automated dispatch and system monitoring for fixed-route and flexible-route transit services. This service performs scheduling activities including the creation of schedules, blocks and runs, as well as operator assignment. This service monitors the transit vehicle trip performance against the schedule and provides information displays at the Transit Management Center.

WTA operates its fixed route schedule using a variety of technologies and performance measures that are categorized in this service.

PT03: Dynamic Transit Operations (Existing)

Stakeholders: WTA

The Dynamic Transit Operations service package allows travelers to request trips and obtain itineraries using a personal device such as a smart phone, tablet, or personal computer. The trips and itineraries cover multiple transportation services (public transportation modes, private transportation services, shared-ride, walking and biking). This service package builds on existing technology systems such as computer-aided dispatch/ automated vehicle location (CAD/AVL) systems and automated scheduling software, providing a coordination function within and between transit providers that would dynamically schedule and dispatch or

modify the route of an in-service vehicle by matching compatible trips together. TI06 covers other shared use transportation options.

WTA offers dynamic transit requests for paratransit and for on-demand services.

PT04: Transit Fare Collection Management (Existing)

Stakeholders: WTA

This service package manages transit fare collection on-board transit vehicles and at transit stops using electronic means. It allows transit users to use a traveler card or other electronic payment device such as a smart phone. Readers located either in the infrastructure or on-board the transit vehicles enable electronic fare payment. Data is processed, stored, and displayed on the transit vehicle and communicated as needed to the Transit Management Center. This service supports ad-hoc payments to the transport provider (typically through the 'payment' and 'fare' flows), payments using a transport provider's account system using account-based tokens or integrated multi-provider account systems (typically through the 'account', 'secureID' and 'authorization' flows).

WTA uses the UMO fare system to provide multiple ways for riders to pay fares, including smart phones and pass cards.

PT05: Transit Security (Existing)

Stakeholders: WTA

This service package provides for the physical security of transit passengers and transit vehicle operators. On-board equipment performs surveillance and sensor monitoring in order to identify potentially hazardous situations. The surveillance equipment includes video (e.g., CCTV cameras), audio systems and/or event recorder systems. The sensor equipment includes threat sensors (e.g., chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors) and object detection sensors (e.g., metal detectors). Transit user or transit vehicle operator activated alarms are provided on-board. Public areas (e.g., transit stops, park and ride lots, stations) are also monitored with similar surveillance and sensor equipment and provided with transit user activated alarms. In addition this service package provides surveillance and sensor monitoring of non-public areas of transit facilities (e.g., transit yards) and transit infrastructure such as bridges, tunnels, and transit railways or bus rapid transit (BRT) guideways. The surveillance equipment includes video and/or audio systems. The sensor equipment includes threat sensors and object detection sensors as described above as well as, intrusion or motion detection sensors and infrastructure integrity monitoring (e.g., rail track continuity checking or bridge structural integrity monitoring).

WTA has cameras in both their vehicles and at its stations to provide security for passengers and employees. There are also silent alarms installed on board the vehicles.

PT06: Transit Fleet Management (Planned)

Stakeholders: WTA

This service package supports automatic transit maintenance scheduling and monitoring. On-board condition sensors monitor system status and transmit critical status information to the Transit Management Center. The Transit Management Center processes this data and schedules preventative and corrective maintenance. The service package also supports the day to day management of the transit fleet inventory, including the assignment of specific transit vehicles to blocks and the assignment of transit vehicle operators

to runs.

WTA will be installing technology to remotely track the status of its fleet vehicles remotely and in real-time, as part of its overall computer-aided dispatch system.

PT07: Transit Passenger Counting (Existing)

Stakeholders: WTA

This service package counts the number of passengers entering and exiting a transit vehicle using sensors mounted on the vehicle and communicates the collected passenger data back to the management center. The collected data can be used to calculate reliable ridership figures and measure passenger load information at particular stops.

WTA has installed this service to assist in counting passengers that ride for free (i.e. anyone aged 18 and younger).

PT08: Transit Traveler Information (Existing)

Stakeholders: WTA

This service 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 service package.

WTA's traveler information system provides on-board audio announcements as well as on-board real-time passenger information signage. Signage will be added at stations in the next few years. The system also pushes notifications to travelers based on their inputs for specific stations. And the public can track the location of every fixed route bus via the WTA app and online.

PT09: Transit Signal Priority (Existing)

Stakeholders: WTA

The Transit Signal Priority service package uses transit vehicle to infrastructure communications to allow a transit vehicle to request priority at one or a series of intersections. The service package provides feedback to the transit driver indicating whether the signal priority has been granted or not. This service package can contribute to improved operating performance of the transit vehicles by reducing the time spent stopped at a red light.

TSP technology has been installed at intersections within the city and is being used at some locations.

PT10: Intermittent Bus Lanes (Planned)

Stakeholders: WTA

This service package provides dedicated bus lanes during peak demand times to enhance transit operations mobility. An intermittent bus lane is a lane that can change its status from regular lane (accessible for all vehicles) to bus lane, for the time strictly necessary for a bus or set of buses to pass. The status of the IBL is communicated to drivers using roadside message signs and through in-vehicle signage. The creation and removal of dedicated bus lanes is managed through coordination between traffic and transit centers.

WTA has an increase of bus rapid transit routes included in its strategic plan, and one component of this may be the use of intermittent bus lanes.

PT14: Multi-modal Coordination (Planned)

Stakeholders: WTA

This service package establishes two way communications between multiple transit and traffic agencies to improve service coordination. Multimodal coordination between transit agencies can increase traveler convenience at transit transfer points and clusters (a collection of stops, stations, or terminals where transfers can be made conveniently) and also improve operating efficiency.

WTA routes provide intermodal connectivity with Skagit Station in Mt. Vernon, with the Bellingham International Airport, with the Greyhound bus station, with the Amtrak Cascades rail station, and with the Alaska Ferry terminal. A service like this may be beneficial when buses are picking up/dropping off passengers for other modes that are delayed, and likely to miss the bus.

PT15: Transit Stop Request (Planned)

Stakeholders: WTA

This service package allows a transit passenger to send a stop request to an approaching transit vehicle. The transit vehicle receives the request and notifies the vehicle operator of the stop request.

This service package may be beneficial for rural fixed-route services.

PT16: Route ID for the Visually Impaired (Planned)

Stakeholders: WTA

This service package assists visually impaired travelers to identify the appropriate bus and route to their intended destination. It provides information from bus stop infrastructure to visually impaired travelers portable devices that can be converted to audible information regarding the appropriate bus and route. It also allows the visually impaired traveler to query the portable device to identify route options.

As part of WTA's efforts to provide service that is accessible and equitable, they are looking to install equipment at specific locations that will assist visually impaired travelers.

PT17: Transit Connection Protection (Planned)

Stakeholders: WTA

This service package allows travelers to initiate a request for connection protection anytime during the trip using a personal device or on-board equipment and receive a confirmation indicating whether the request is accepted. Connection protection uses real time data to examine the arrival status of a transit vehicle and to transmit a hold message to a vehicle or other mode of transportation (e.g. rail) in order for the traveler to make a successful transfer from one vehicle to another. Connection protection can be performed within a single agency, across multiple agencies, and across multiple modes. In an intermodal, multimodal or interagency environment, a transfer request brokerage system, represented by the Transit Management System, can be used to determine the feasibility of a connection protection request and support schedule coordination between agencies.

WTA currently uses an informal system to hold buses for the Lummi ferry, and a system between Skagit Transit for the 80x route is also in place. This service package may provide additional benefits for these connections.

PT18: Integrated Multi-Modal Electronic Payment (Existing)

Stakeholders: WTA

The Integrated Multi-Modal Electronic Payment (IMMEP) service package provides electronic payment capability for transit fares, tolls, road use, parking, and other areas requiring electronic payments. IMMEP enables the provision of payment for transportation services using a single account for multiple public transportation providers. The transportation user establishes an account with a financial service provider (modeled as the Payment Administration Center (PAC)), and the PAC communicates with various public transportation providers to coordinate charges. IMMEP also supports the management of transportation user access rights (i.e., this user can use the subway but not the bus). Payment transactions are centralized; the user provides only a secure, registered token (the 'secureID') to the transportation provider's access control equipment. The transportation provider uses that token and context to initiate transactions with the PAC.

WTA currently has an electronic payment system integrated between itself and Skagit Transit for riders on the 80x. There has also been high-level initial concepts of possibly tying Skagit Transit and WTA passes with the ORCA card that is used for multiple transportation options in the greater Seattle region.

Sustainable Travel

This area addresses the management, operations, maintenance, and security of public transportation to This area addresses the operation of transportation system to minimize the environmental impact. It promotes a transportation system that balances accessibility, mobility, protection of human safety and environment. It covers all aspects of transportation system from optimizing traffic signals and ramp

meters to managing HOV/HOT lanes, monitoring vehicle emissions and managing vehicle electric charging stations.

ST05: Electric Charging Stations Management (Planned)

Stakeholders: City of Bellingham, WTA

The Electric Charging Station Management service package provides an exchange of information between the electric vehicle and charging station to manage the charging operation. The agency or company operating the charging station can use vehicle information such as the capability of the vehicle (e.g. operational status of the electrical system, how many amps can the vehicle handle, and % charge complete) to determine that the charge is being properly applied and determine an estimated time to complete charging.

The City of Bellingham intends to work with a vendor to install nearly 100 electric charging stations across the city in addition to the ones already in place. This network will be managed though the city.

WTA will be using some form of electric charging station management in the future for its fleet of electric vehicles.

Traffic Management

This area addresses the management of the movement of all types of vehicles, travelers and pedestrians throughout the transportation network. It deals with information collection, dissemination, and processing for the surface transportation system. It covers both automated monitoring and control activities as well as decision-making processes (both automated and manual) that address real-time incidents and other disturbances on the transportation network, as well as managing travel demand as needed to maintain overall mobility.

TM01: Infrastructure-Based Traffic Surveillance (Existing)

Stakeholders: WTA

This service package includes traffic detectors, other surveillance equipment, the supporting field equipment, and Center to Field communications to transmit the collected data back to the Traffic Management Center. 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 Center). The data generated by this service 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 Traveler Information Center physical object.

WTA has cameras in buses and stations which transmit data to their transit management center.

TM03: Traffic Signal Control (Existing)

Stakeholders: City of Bellingham, WSDOT

This service package provides the central control and monitoring equipment, communication links, and the signal control equipment that support traffic control at signalized intersections. A range of traffic signal control systems are represented by this service package ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic

conditions and priority requests. This service package is generally an intra-jurisdictional package. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would also be represented by this package. Coordination of traffic signal systems using real-time communications is covered in the TM07-Regional Traffic Management service package. This service package is consistent with typical traffic signal control systems.

The City of Bellingham controls intersection signals for Bellingham, Ferndale, Lynden, and unincorporated Whatcom County. It also has controls for WSDOT signals at certain intersections.

WSDOT controls signals at interchanges on State Routes and for on-ramps and off-ramps to I-5.

TM05: Traffic Metering (Planned)

Stakeholders: WSDOT

This service package provides central monitoring and control, communications, and field equipment that support metering of traffic. It supports the complete range of metering strategies including ramp, interchange, and mainline metering. This package incorporates the instrumentation included in the TM01 service package (traffic sensors are used to measure traffic flow and queues) to support traffic monitoring so responsive and adaptive metering strategies can be implemented. Also included is configurable field equipment to provide information to drivers approaching a meter, such as advance warning of the meter, its operational status (whether it is currently on or not, how many cars per green are allowed, etc.), lane usage at the meter (including a bypass lane for HOVs) and existing queue at the meter.

WSDOT's I-5 plan for Bellingham includes the future installation of ramp metering during peak commute hours. There is no set timeline.

TM06: Traffic Information Dissemination (Existing)

Stakeholders: WSDOT

This service package provides driver information using roadway equipment such as dynamic message signs or highway advisory radio. A wide range of information can be disseminated including traffic and road conditions, closure and detour information, travel restrictions, incident information, and emergency alerts and driver advisories. This package provides information to drivers at specific equipped locations on the road network. 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, Emergency Management, and Transportation Information Centers. A link to the Maintenance and Construction Management Center allows real time information on road/bridge closures and restrictions due to maintenance and construction activities to be disseminated.

WSDOT provides real-time traffic information to the public and partner agencies in multiple ways, including but not limited to traffic maps online, 511 traffic updates, variable message signing, and traffic apps for smart phones.

TM07: Regional Traffic Management (Existing)

Stakeholders: City of Bellingham, WSDOT

This service package provides for the sharing of information and control among traffic management centers to support regional traffic management strategies. Regional traffic management strategies that are

supported include inter-jurisdictional, real-time coordinated traffic signal control systems and coordination between freeway operations and traffic signal control within a corridor. This service package advances the TM03-Traffic Signal Control and TM05-Traffic Metering service packages by adding the communications links and integrated control strategies that enable integrated, interjurisdictional traffic management. 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 Traffic Signal Control and Traffic Metering service packages and adds hardware, software, and fixed-point communications capabilities to implement traffic management strategies that are coordinated between allied traffic management centers. Several levels of coordination are supported from sharing of information through sharing of device control between traffic management centers.

Both the City of Bellingham and WSDOT have Traffic Management Centers (TMCs) where traffic operations are coordinated both within each system and between the centers.

TM13: Standard Railroad Grade Crossing (Existing)

Stakeholders: City of Bellingham, Whatcom County

This service 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 ITS Roadway Equipment and the Driver in the physical view.) These traditional HRI warning systems may also be augmented with other standard traffic management devices. The warning systems are activated on notification of an approaching train by interfaced wayside equipment. The equipment at the HRI may also be interconnected with adjacent signalized intersections so that local control can be adapted to highway-rail intersection activities. Health monitoring of the HRI equipment and interfaces is performed; detected abnormalities are reported to both highway and railroad officials through wayside interfaces and interfaces to the Traffic Management Center.

Railroad crossings in Whatcom County are not integrated into the TMC or operations centers at this time. Crossing gates and signals are managed by in-field equipment only, communicating between the train and trackside controls.

TM23: Border Management Systems (Existing)

Stakeholders: CBP, CBSA, BCMOT, WSDOT

This service package provides international border crossing management for passenger vehicles and other non-commercial travelers crossing the border. This service package manages traffic at the border crossing, provides technology to support expedited processing of trusted travelers, and collects and disseminates border wait times.

Both CBP and CBSA provide expedited crossing for passenger vehicles through the NEXUS program. CBP also provides a Ready Lane at certain ports-of-entry for travelers carrying RFID-enhanced identification (i.e., enhanced drivers licenses).

BCMOT and WSDOT both operate advanced traveler information systems (ATIS) providing border wait time information for travelers at most regional ports-of-entry (not including Pt. Roberts/Boundary Bay).

Traveler Information

This area addresses the provision of both static and dynamic information about the transportation network to users both prior to and during their trips. It includes information about multi-modal options and transfers and the status of other transportation modes for use by the users. Providing static and dynamic signage information directly to drivers through in-vehicle devices is also covered by this area.

TI01: Broadcast Traveler Information (Existing)

Stakeholders: BCMOT, WSDOT

This service package provides a digital broadcast service that disseminates traveler information to all equipped travelers within range. It collects traffic conditions, advisories, general public transportation, toll and parking information, incident information, roadway maintenance and construction information, air quality and weather information, and broadcasts the information to travelers using technologies such as FM subcarrier, satellite radio, cellular data broadcasts, and Internet streaming technologies.

This service package also provides location-specific or situation-relevant information to travelers in vehicles using Dedicated Short Range Communications (DSRC) infrastructure supporting mobility service packages for connected vehicles. DSRC is used to deliver real-time traveler information including travel times, incident information, road conditions, and emergency traveler information to vehicles as they pass connected vehicle roadside equipment along their route. This service package provides public information that is available to all equipped vehicles in the vicinity of the roadside equipment.

WSDOT provides traveler information through multiple formats including online, via 511, through apps, and using variable message signage.

BCMOT provides border wait time information online, through apps, and on variable message signs as well.

TI02: Personalized Traveler Information (Existing)

Stakeholders: WTA

This service 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, roadway maintenance and construction, transit services, ride share/ride match, parking management, detours and pricing information. Although the Internet is the predominate network used for traveler information dissemination, a range of two-way wide-area wireless and fixed-point to fixed-point communications systems may be used to support the required data communications with the traveler. A variety of interactive devices may be used by the traveler to access information prior to a trip or en route including phone via a 511-like portal and web pages via smart phone, tablet, personal computer, and a variety of in-vehicle devices.

WTA's app allows for riders to select specific stops and have notifications pushed to them regarding the upcoming arrival of buses.

TI04: Infrastructure-Provided Trip Planning and Route Guidance (Planned)

Stakeholders: WTA

This service package offers the user trip planning and en route guidance services. It generates a trip plan, including a multimodal route and associated service information (e.g., parking information), based on traveler preferences and constraints. Routes may be based on static information or reflect real time network conditions. Unlike TI03, where the user equipment determines the route, the route determination functions are performed by the center in this service package. The trip plan may be confirmed by the traveler and advanced payment and reservations for transit and alternate mode (e.g., airline, rail, and ferry) trip segments, and ancillary services are accepted and processed. The confirmed trip plan may include specific routing information that can be supplied to the traveler as general directions or as turn-by-turn route guidance depending on the level of user equipment.

WTA continues to develop its route guidance and planning tools, and this includes real-time vehicle-based guidance.

TI06: Dynamic Ridesharing and Shared Use Transportation (planned)

Stakeholders: WTA

This service package addresses dynamic ridesharing/ride matching services to travelers and other forms of shared use transportation. Dynamic ridesharing allows travelers to arrange carpool trips through a personal device with a wireless connection to a ride matching system (e.g., a web-based application). It uses inputs from both passengers and drivers pre-trip, during the trip, and post-trip . These inputs are then translated into "optimal" pairings between passengers and drivers to provide both with a convenient route between their two origin and destination locations. After the trip, information is provided back to the service package to improve the user's experience for future trips.

The shared use aspect of the service package addresses three types of shared use that may be arranged using an internet connected personal device. In the first type, a traveler arranges for the temporary use of a vehicle. In the second type of shared use, a traveler arranges for a vehicle to pick them up at a specific location and take them to another location. The second type of shared use may be implemented as a ride matching or ridesharing service, including those provided by Uber and Lyft. The third type of shared use is a bikeshare capability.

WTA provides some tools now for carpooling and ridesharing through their vanpool services. This service package may be used in the future for greater usability of these resources.

Weather

This area addresses activities that monitor and notify users and transportation network managers of weather and environmental conditions that have an impact on the road transportation network and its users.

WX01: Weather Data Collection (Existing)

Stakeholders: Whatcom County

This service package collects current road and weather conditions using data collected from environmental sensors deployed on and about the roadway. It also collects data from vehicles in the road network that can be used to directly measure or infer current environmental conditions. It leverages vehicle on-board systems

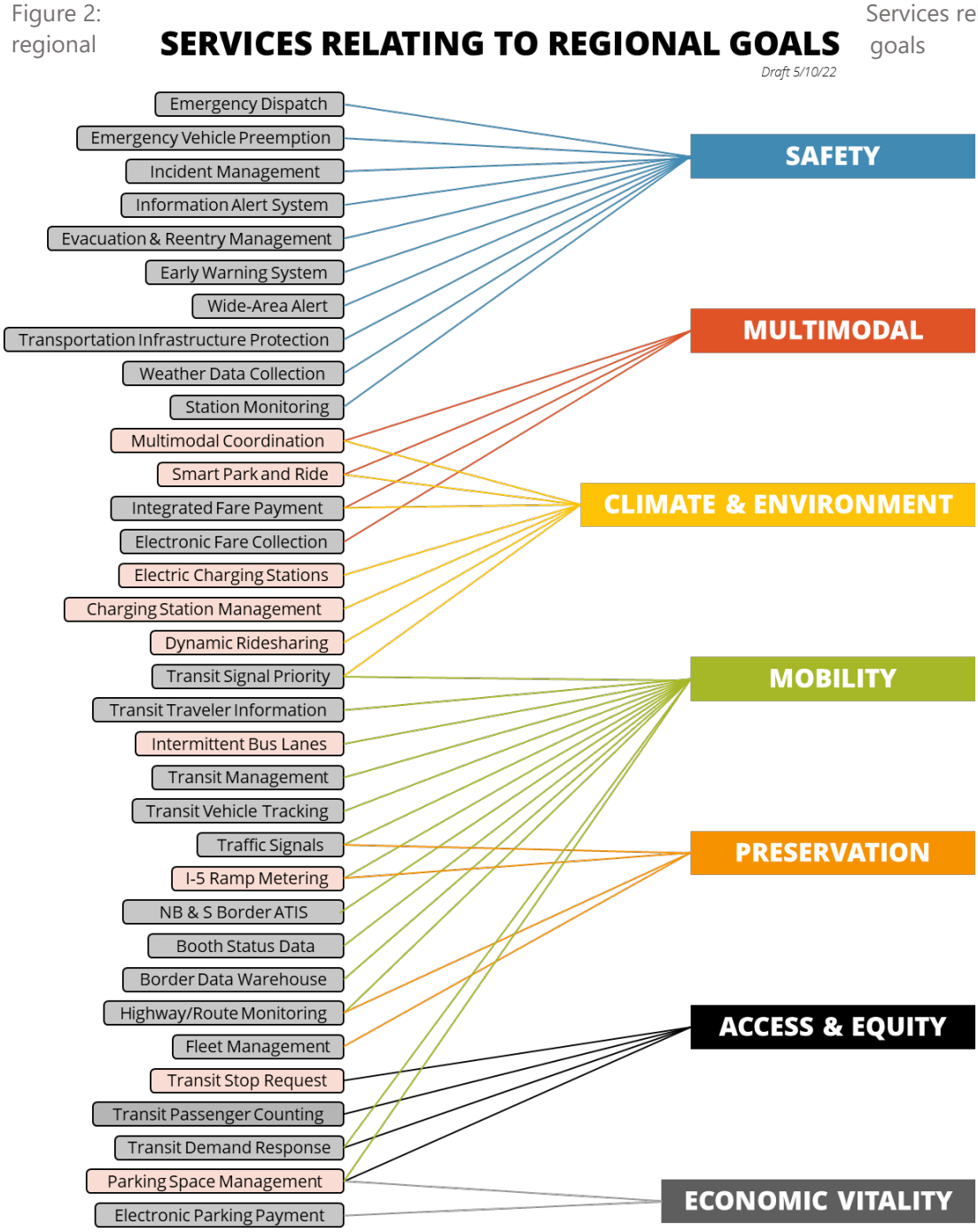
that measure temperature, sense current weather conditions (rain and sun sensors) and also can monitor aspects of the vehicle operational status (e.g., use of headlights, wipers, and traction control system) to gather information about local environmental conditions. In addition, environmental sensor systems located on Maintenance and Construction Vehicles are also potential data sources. The collected environmental data is used by the Weather Information Processing and Distribution service package to process the information and make decisions on operations. The collected environmental data may be aggregated, combined with data attributes and sent to meteorological systems for data qualification and further data consolidation. The service package may also request and receive qualified data sets from meteorological systems.

Whatcom County has installed infrastructure censors monitoring certain routes to determine if they need to be closed during weather events. The system collects current temperature of soils beneath the roadways using data collected from environmental sensors deployed outside the shoulders of the roadways. Collected environmental data are used by the Whatcom County Engineer's office to post weight restrictions. Data are transmitted directly from sensors to the Whatcom County Engineer's office.

7. Relationship of services to regional planning goals

The service packages listed above all address one or more of the planning goals for Whatcom County. How they relate to planning objectives is shown below.

Figure 2: Services relating to regional goals



8. Needs, responsibilities, and functions

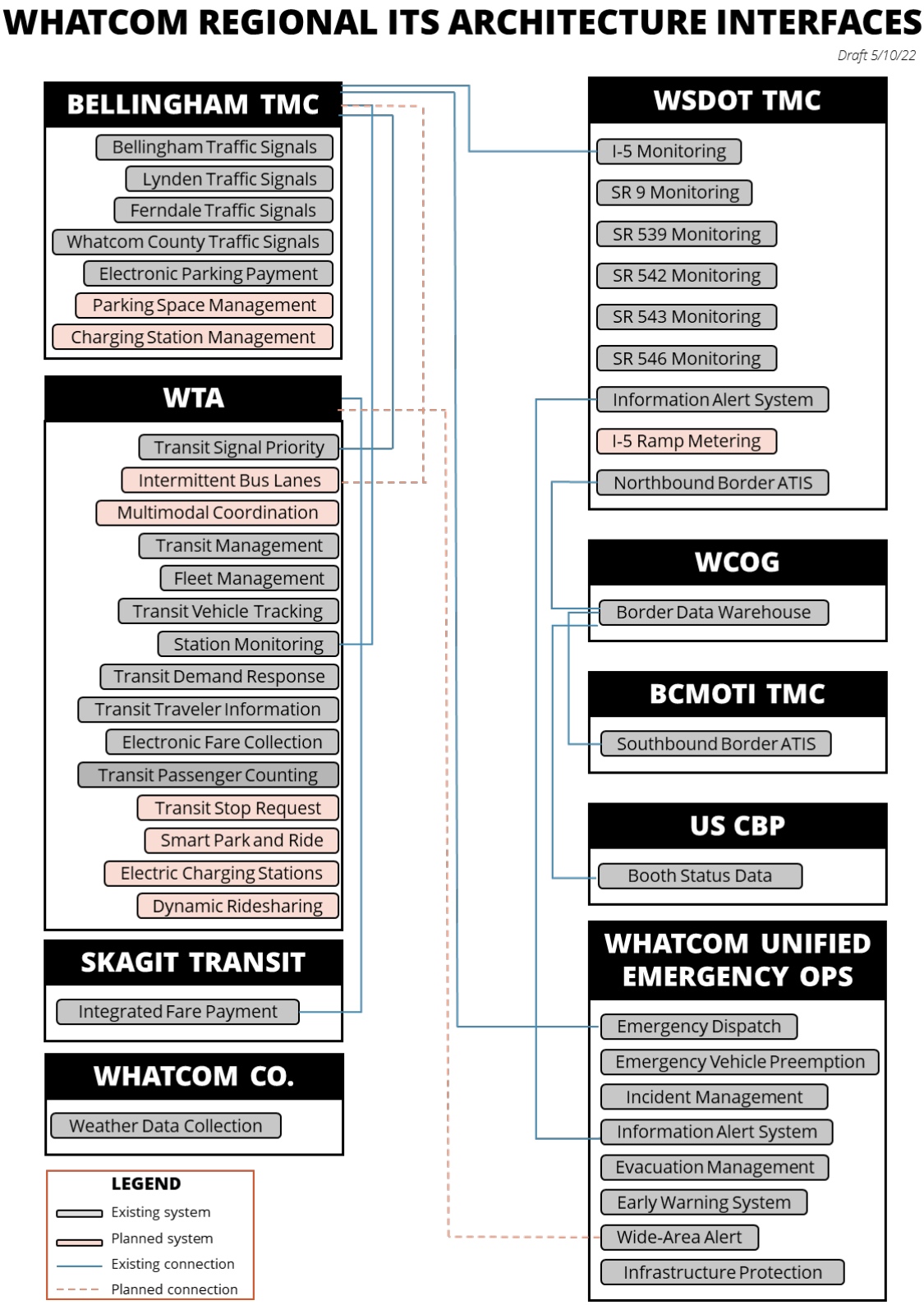
There are components of the national architecture that are not used by stakeholders in the Whatcom region. These include user needs, roles and responsibilities, and functional objects. Because they are not used, they have been developed using the default outputs from RAD-IT and are only included in the appendices. To view these outputs, see **Appendix A: User needs**; **Appendix B: Roles and responsibilities**; and **C: Functional objects**.

9. Interfaces supporting regional ITS services

Figure 3 shows the systems within Whatcom County and how they interface with one another. Both existing and planned connections are included.

Note: This is a simplified schematic that is used in place of the automatically-generated interfaces and flows from the RAD-IT tool.

Figure 3: Interfaces



10. Standards

Identifying which ITS standards to use in a region helped with overall interoperability of the systems deployed among different agencies. With this in mind, the City of Bellingham uses WSDOT's selected standards for their deployments.

For the Cascade Gateway Border Data Warehouse, the ATIS General Use Standards Group is used.

11. Interagency agreements

The following table includes the interagency agreements known that have an ITS component here in Whatcom County. There may be others that the individuals involved in the development of this architecture are not familiar with.

Agreement Title	Associated Stakeholders
Data Sharing Agreement between WSDOT and WSP	WSDOT, WA State Highway Patrol (WSP)
Interlocal Agreement between Bellingham and Ferndale for Signal Control	City of Bellingham, City of Ferndale
Interlocal Agreement between Bellingham and Lynden for Signal Control	City of Bellingham, City of Lynden
Interlocal Agreement between Bellingham and Whatcom County for Signal Control	City of Bellingham, Whatcom County
Interlocal Agreement between the Bellingham and Whatcom County for the Whatcom Unified Emergency Operations Center	City of Bellingham Office of Emergency Management and Whatcom County Sheriff's Office Division of Emergency Management
Interlocal Agreement between WTA and Bellingham for Signal Preemption, Joint Agreement between Bellingham and WSDOT for Signal Control	City of Bellingham, WTA
MOU Between WCOG and BCMOT on Exchange of Border Data for the BDW	WCOG, BC Ministry of Transportation and Infrastructure (BCMOTI)
MOU Between WCOG and CBP on Exchange of Border Data for the BDW	WCOG, U.S. Customs and Border Protection (USCBP)
MOU Between WCOG and WSDOT on Exchange of Border Data for the BDW	WCOG, WA State Department of Transportation (WSDOT)

12. Sequence of regional ITS projects

The sequence of projects can be found in the Transportation Infrastructure Program (TIP) and the Statewide Transportation Improvement Program (STIP), as well as the individual plans of each jurisdiction.

Stakeholder agencies work together at regional planning meetings like the WCOG's Transportation Technical Advisory Group (TTAG), a monthly forum where stakeholders analyze and discuss regional transportation planning issues, including requests for project funding, and make recommendations to the Whatcom Transportation Policy Board. As part of this effort, project sequencing may also be discussed to take best advantage of agency investments.

Below are the ITS services that have been marked as planned. These are elements that agencies are hoping to implement in the next 5-10 years.

Service Package	Stakeholder Agency	Timeframe
PS10 – Wide-Area Alert (WTA link to existing system)	Whatcom Transportation Authority	Unspecified
PS11 – Early Warning System (Additional equipment to existing system)	Whatcom Unified Emergency Operations Center	1-5 years
PM01 – Parking Space Management	City of Bellingham	1-5 years
PM02 – Smart Park and Ride System	Whatcom Transportation Authority	Unspecified
PM03 – Parking Electronic Payment (Additional vendor to existing system)	City of Bellingham	1-5 years
PT06 – Transit Fleet Management	Whatcom Transportation Authority	1-5 years
PT10 – Intermittent Bus Lanes	Whatcom Transportation Authority	Unspecified
PT14 – Multimodal Coordination	Whatcom Transportation Authority	Unspecified
PT15 – Transit Stop Request	Whatcom Transportation Authority	1-5 years
PT16 – Route ID for the Visually Impaired	Whatcom Transportation Authority	1-5 years
PT17 – Transit Connection Protection	Whatcom Transportation Authority	Unspecified
ST05 – Electric Charging Stations Management	City of Bellingham	1-5 years
TI04 – Infrastructure-Provided Trip Planning (Additional tools to existing in-bus guidance)	Whatcom Transportation Authority	1-5 years
TI06 – Dynamic Ridesharing and Shared Use Transportation	Whatcom Transportation Authority	Unspecified
TM05 – Traffic Metering	WA State Dept. of Transportation	Unspecified

13. Architecture maintenance

WCOG may add to this plan as stakeholders need. WCOG will update the architecture in conjunction with the MPO and RTPO long-range transportation planning cycle.

A version of the architecture is available as a RAD-IT file. To download this file or view specific outputs from the tool, contact Melissa Fanucci at melissa@wcog.org.

Need Area	Type	Need	
CVO20: International Border Registration	Mobility	1	Border Administration needs to administratively support electronic registration for programs for expedited border crossing for travelers and shipments.
CVO21: International Border Electronic Clearance	Safety	1	Commercial Vehicle Administration and Border Administration need to collect transportation related data, including border crossing data to support planning and research activities that span land border crossings.
		2	Commercial Vehicle Administration and Border Administration need to be able to verify that vehicles, freight equipment, cargo, and drivers coming into the country are admissible and comply with federal laws and regulations.
		3	Commercial Vehicle Administration and Border Administration need to exchange commercial vehicle records with other agencies and stakeholders along a border including credentials, status of the credentials, and records of fuel tax payments.
		4	Commercial Vehicle Administration and Border Administration need to provide electronic communications with commercial vehicles to support security inspections and weigh-in-motion detection.
CVO22: International Border Coordination	Mobility	1	Border Administration needs to exchange data with other Border Administrations in order to support international coordination for expedited border clearance programs, including credentials, applications, supporting information, and registration details.
		2	Border Inspection Operations need to exchange data with other Border Inspection Operations in order to support coordination across international borders, including, inspection results, and surveillence data.
DM01: ITS Data Warehouse	Informational	1	System operators need to be able to store data for long term access by themselves and other operators.
		2	System operators need to be able to query for and receive archive data products containing freeway data, tolling data, arterial data, parking data, transit and ridesharing data, incident management data, safety-related data, CVO data, environmental and weather data, vehicle and passenger data and intermodal operations data.
		3	System operators need to be able to manage data processing with regard to data archive functions, including data aggregation, data tagging (processed, edited, raw, transformed, etc.), data storage timing and longevity, data quality analysis, data formatting and metadata assignments.
DM02: Performance Monitoring	Informational	1	System operators need to be able to store vehicle data, transit data, weather data, freight data and other transportation-related data to support traffic data analysis, transportation network performance monitoring, transportation planning, safety analyses and research.
		2	System operators need to be able to process vehicle data sourced by themselves and other system operators to support performance monitoring, infrastructure conditions reporting, and environmental monitoring. This supports system operator reporting needs and provides the source data and metrics for government reports.

Need Area	Type	Need	
PM01: Parking Space Management	Management	1	Parking operators need to be able to collect information from Infrastructure-based detectors and/or connected vehicles in order to monitor parking lot ingress and egress, and availability in lots, garages, and other parking areas and facilities.
		2	Parking operators need to be able to determine availability of parking spaces.
		3	Parking operators need to be able to share the collected parking information with local drivers and other centers for broader distribution.
PM02: Smart Park and Ride System	Mobility	1	Parking operators need to be able to monitor the number of available spaces in part and ride lots.
		2	Parking operators need to be able to provide available space information to travelers requesting that information in order to assist their decision-making on where best to park and make use of transit alternatives.
		3	Parking operators need to be able to provide available space information to transit systems operating near to those spaces.
		4	Transit operations need to be able to provide transit information to nearby parking operations.
		5	Parking operators need to be able to provide available space information to traveler information providers.
PM03: Parking Electronic Payment	Mobility	1	Parking operators need to be able to support electronic collection of parking fees from in-vehicle equipment, contact or proximity cards, or any smart payment device.
		2	Parking operators need to be able to set up and manage electronic user accounts for customers.
		3	Parking operators need to be able to provide notification to an enforcement agency of a parking payment violation.
PS01: Emergency Call-Taking and Dispatch	Safety	1	Emergency Management needs to provide basic public safety call-taking and dispatch of emergency vehicles in order to provide safe and rapid deployment of appropriate resources to an emergency.
		2	Emergency Management needs to coordinate with other emergency management operations in order to support emergency notification between agencies.
		3	Emergency Management needs to process current and historical weather and road conditions data from multiple sources in order to generate warnings and route advisories for individual emergency responders or emergency response dispatchers.
		4	Emergency Management needs to provide emergency responders with road weather warnings and advisories.
		5	Emergency Management needs to provide routing information to the emergency responders.

Need Area	Type	Need	
PS03: Emergency Vehicle Preemption	Safety	1	Emergency Management needs to be able to request signal preemption from Traffic Operations for a specific emergency vehicle.
		2	Emergency Management needs to be able request signal preemption locally for one or more signals the vehicle is approaching so that it may quickly and safely cross the intersections.
		3	Traffic Management needs to be able to adjust signal timing to provide signal preemption for an emergency vehicle based upon a request from Emergency Management.
		4	Traffic Management needs to be able to support local adjustments to signal timing based upon a local preemption request and transition back to normal traffic signal operations after providing emergency vehicle preemption.
PS06: Incident Scene Pre-Arrival Staging Guidance for Emergency Responders	Safety	1	Emergency Management needs to be able to collect information external to the incident scene to support staging of emergency responder personnel and their equipment.
		2	Emergency Management needs to be able to provide situational awareness information to emergency responders about an incident to support decisions of how to stage the personnel and their equipment.
		3	Emergency Management needs to be able to provide emergency responders with real-time navigation instructions that use all available data sources to quickly and efficiently route the responder.
		4	Emergency Management needs to be able to maintain location and situational information about the emergency vehicles responding to or on the scene of an incident in order to provide a complete picture of the response and share the status with other responding vehicles en route.
PS09: Transportation Infrastructure Protection	Safety	1	Traffic Operations and Emergency Management need to be able to monitor transportation infrastructure (e.g., bridges, tunnels and management centers) for potential threats in order to control access, preclude an incident, and mitigate the impact of an incident if it occurs.
		2	Traffic Operations and Emergency Management need to be able to notify agencies if a threat is detected.
		3	Traffic Operations and Emergency Management need to be able to collect advisories from other agencies related to detected threats.
		4	Traffic Operations in response to threats needs to be able to activate the barrier and/or safeguard systems in order to deter an incident, control access to an area or mitigate the impact of an incident.

Need Area	Type	Need	
PS10: Wide-Area Alert	Safety	1	Emergency Management needs to be able to verify the reported emergency situation in order to activate the alert system.
		2	Emergency Management needs to be able to alert the public in emergency situations such as child abductions, severe weather events, civil emergencies, and other situations that pose a threat to life and property, using ITS technologies such as dynamic message signs, highway advisory radios, in-vehicle displays, transit displays, 511 traveler information systems, and traveler information web sites.
		3	Emergency Management needs to be able to broadcast emergency information to traffic agencies, transit agencies, information service providers, toll operators, and others that operate ITS systems.
PS11: Early Warning System	Safety	1	Emergency Management needs to be able to collect potential threats, alerts, and advisories from various ITS systems to identify emergencies.
		2	Emergency Management needs to be able to alert all relevant agencies of detected emergencies.
PS12: Disaster Response and Recovery	Safety	1	Emergency Management needs to support integration between transportation systems and the public safety, emergency management, public health, and other allied organizations that form the overall disaster response.
		2	Emergency Management needs to support coordination of emergency response plans issued by various agencies in order plan for regional response to disasters.
		3	Emergency Management needs to be able to track and coordinate the transportation professionals, equipment, and materials that constitute the disaster response in order to respond to and recover from disasters.
		4	Emergency Management needs to be able to provide to other regional centers information about the transportation system in the vicinity of the disaster.
PS13: Evacuation and Reentry Management	Safety	1	Emergency Management needs to support evacuation of the general public from disaster area.
		2	Emergency Management needs to coordinate evacuation plans among the federal, state, and local transportation, emergency, and law enforcement agencies that may be involved in a large-scale evacuation.
		3	Emergency Management needs to share evacuation information with traffic management agencies in order to implement special traffic control strategies to control evacuation traffic.
		4	Emergency Management needs to share evacuation information with transit agencies in order to remove people from an evacuated area while making efficient use of limited capacity.
		5	Emergency Management needs to manage subsequent reentry of the general public to the disaster area.

Need Area	Type	Need	
PS14: Disaster Traveler Information	Safety	1	Emergency Management and Traveler Information need to be able to provide general public real-time disaster and evacuation information using ITS traveler information systems.
		2	Traveler Information needs to be able to collect disaster related information from multiple sources including traffic, transit, public safety, emergency management, shelter provider, and travel service provider organizations.
		3	Emergency Management and Traveler Information need to be able to provide evacuees with information including a shelter that matches their needs, including location, availability, and routing.
		4	Emergency Management and Traveler Information need to be able to provide information concerning roadside resources including information provided by other evacuees to help understand availability of resources.
		5	Emergency Management and Traveler Information need to be able to provide evacuees with information regarding when they can return to their area, including routes and road conditions.
PT01: Transit Vehicle Tracking	Mobility	1	Transit Operations needs to be able to monitor the location of transit vehicles in order to improve decision making by transit operators and provide more accurate information to travelers .
		2	Transit Operations needs to be able to determine whether each transit vehicle is adhering to its schedule.
		3	Transit Operations needs to be able to send transit vehicle location and schedule adherence data to other centers in order to support traveler information and traffic operations.
PT02: Transit Fixed-Route Operations	Mobility	1	Transit Operations needs to be able to create and update schedules for fixed route or flexible route transit routes in order to plan transit operations.
		2	Transit Operations needs to be able to disseminate transit schedules for fixed route or flexible route transit routes to traveler information centers.
		3	Transit Operations needs to be able to dispatch transit vehicles for fixed route or flexible route runs.
		4	Transit Operations need to be able to schedule blocks (vehicle assignments) and runs (operator assignments) for fixed route or flexible route transit operations.
		5	Transit Operations need to be able to monitor transit vehicle schedule adherence in order to manage fixed route or flexible route transit operations.
		6	Transit Operations need to have real time information about the road network in order to increase the effectiveness of operations for fixed route or flexible route transit.

Need Area	Type	Need	
PT03: Dynamic Transit Operations	Mobility	1	Transit Operations needs to be able to take reservations for demand response trips that include the travelers' origin, destination, and departure time in order to do demand response scheduling.
		2	Transit Operations needs to be able to schedule demand response transit vehicles based upon travelers trip requests.
		3	Transit Operations needs to provide and update manifests to properly manage demand response transit vehicles based upon traveler requests.
		4	Transit Operations needs to be able to monitor the real-time location of demand response transit vehicles.
		5	Transit Operations need to have real time information about the road network in order to increase the effectiveness of operations for demand response transit.
PT04: Transit Fare Collection Management	Mobility	1	Transit Operations needs to be able to collect transit fares on-board transit vehicles using electronic payment methods in order to improve transit operation.
		2	Transit Operations needs to be able to collect transit fares at transit stations using electronic payment methods in or der to support bus rapid transit or train systems.
		3	Transit Operations needs to be able to download transit fare collection information from transit vehicles or transit fare gates at stations in order to manage the fare collection operations.
		4	Travelers need to be able to add value to payment instruments in order to use them as part of fare collection systems.
		5	Transit Operations needs to be able to support transit fare reconciliation with other transit agencies participating in a regional fare collection system.
		6	Transit operations needs to be able to share fare information with traveler information systems and other transit operations.
PT05: Transit Security	Mobility	1	Transit Operations needs to be able to monitor conditions on a transit vehicle in order to provide a secure environment for travelers.
		2	Transit Operations needs to be able to monitor transit stops and transit stations in order to provide a secure environment for travelers.
		3	Transit Operations needs to be able to monitor transit secure areas such as bus or rail yards and transit infrastructure such as tracks and tunnels in order to provide security for transit assets.
		4	Transit Operations needs to be able to authenticate operators of transit vehicles and perform remote disabling of vehicles if necessary in order to ensure secure operation of the vehicles.
		5	Transit Operations needs to be able to alert emergency services to incidents on vehicles, at stations/stops, or other monitored assets.
		6	Transit Operations needs to be able to inform traveler information systems or the media regarding transit related incidents in order to keep the traveling public informed of the impacts these incidents may have on their trips.

Need Area	Type	Need	
PT06: Transit Fleet Management	Mobility	1	Transit Operations needs to able to remotely monitor transit vehicle operating conditions in order to determine if maintenance of the vehicle is needed.
		2	Transit Operations needs to be able to perform maintenance scheduling of transit vehicles including real time requests for actions by the vehicle operator.
		3	Transit Operations needs to be able to assign specific vehicles to blocks in order to perform vehicle allocation.
		4	Transit Operations needs to be able to assign transit operators to runs.
PT07: Transit Passenger Counting	Mobility	1	Transit Operations needs to be able to count the passengers entering or exiting a transit vehicle in order to support efficient operations.
PT08: Transit Traveler Information	Mobility	1	Transit Operations needs to be able to provide static and real time transit information to traveler information systems and the media in order to increase travelers' ability to plan and manage their trips.
		2	Transit Operations needs to be able to provide static and real time transit information directly to travelers either pre-trip or en route in order to support traveler trip decisions.
		3	Transit Operations needs to be able to share static and real time transit information with other transit operations in order to facilitate multisystem trip planning.
PT09: Transit Signal Priority	Mobility	1	Transit Operations needs to provide approaching Transit Vehicle location and heading to the roadside signal controller so that the controller can modify signal timing in favor of the transit vehicle.
		2	Transit Operations needs to provide approaching Transit Vehicle location and heading to traffic operations so that they can adjust the signal controller signal timing in favor of the transit vehicle.
		3	Transit Operations needs to provide transit vehicle data to Traffic Operations including loading information and schedule performance in order to support decision making regarding whether to give the transit vehicle priority at the intersection.
		4	The Transit Vehicle Operator needs to progress through his arterial route safely and efficiently.
PT10: Intermittent Bus Lanes	Mobility	1	Traffic Operations needs to be able to open and close intermittent bus lanes based on fixed times or based on request from Transit Operations in order to improve the efficiency of transit operations.
		2	Traffic Operations needs to be able to notify drivers regarding the status of the intermittent bus lane.
		3	Traffic Operations needs to be able to notify enforcement of vehicle violations in the bus lanes.

Need Area	Type	Need	
PT14: Multi-modal Coordination	Mobility	1	Transit Operations needs to be able to coordinate service information with other Transit Operations in order to improve operations.
		2	Transit Operations needs to be able to coordinate with other transportation modes (e.g. ferry operations, airports) in order to improve service connections with these other modes.
		3	Transit Operations needs to coordinate with other centers (e.g. traffic, parking, and event promoters) in order to share system information.
PT15: Transit Stop Request	Mobility	1	Transit Operations needs to be able to accept stop requests from transit users at roadside stops or directly from their personal devices.
		2	Transit Vehicles Operators need to be able to receive transit stop requests submitted from the roadside or from Transit Operations.
PT16: Route ID for the Visually Impaired	Mobility	1	Transit Operations needs to know the location and destination of the visually impaired traveler in order to identify the correct route and stop information to provide to the traveler via their personal device.
		2	Transit Operations needs to be able to provide transit vehicle route and stop information to the traveler via their personal device.
		3	Transit Operations needs to provide bus arrival information at the stop to support visually impaired travelers.
PT17: Transit Connection Protection	Mobility	1	Transit Operations needs to be able to determine when connections between transit routes are in jeopardy due to late arrival of one transfer vehicle in order to develop corrective actions to prevent missed connections.
		2	Transit Operations needs to be able to adjust the real time schedule of a transit vehicle in order to protect the connections made from other transit vehicles to the subject vehicle at a station or stop.
		3	Transit Travelers need to be able to provide a trip plan to Transit Operations and request they be provided with connection protection for the trip.
		4	Transit Operations needs to be able to track a specific traveler's trip through the system and provide connection protection actions to give the traveler the best chance of making their trip connections.
		5	Transit Operations needs to be able to adjust the real time schedule of a transit vehicle in order to provide connection protection for a traveler's trip.
		6	Transit Operations needs to be able to provide a traveler with updates regarding their transit trip, including connection protection actions taken by Transit Operations.
PT18: Integrated Multi-Modal Electronic Payment	Mobility	1	Regional Transportation Operations need to have an electronic payment functionality that operates across different modes or systems.
		2	Travelers need to be able to set up and update user accounts for a regional multimodal payment system.
		3	Regional Transportation Agencies need to be able to perform payment reconciliation in order to obtain their share of payments from the regional payment system.

Need Area	Type	Need	
ST05: Electric Charging Stations Management	Environmental	1	Electric Charging Station Operators need to be able to provide electric charging of vehicles at designated charging stations.
		2	Traveler Information needs to be able to provide electric charging station information to travelers.
TI01: Broadcast Traveler Information	Mobility	1	Traveler Information needs to be able to collect timely, accurate, and reliable traffic, transit, and other road conditions data from multiple sources in order to broadcast the latest conditions affecting travelers.
		2	Traveler Information needs to be able to inform as much of the traveling public as possible using any available broadcast media to increase mobility and safety through better information.
		3	Travelers need access to timely, accurate, and reliable traffic, transit, and other travel conditions in order to make informed decisions about their travel.
		1	Traveler Information needs to be able to collect timely, accurate, and reliable traffic, transit, and other road conditions data from multiple sources in order to inform individual travelers of the latest conditions affecting their travel.
		2	Traveler Information needs to be able to inform as much of the traveling public as possible using any available interactive media to increase mobility and safety through better information.
		3	Travelers, including drivers or passengers, need access to timely, accurate, and reliable traffic, transit, and other travel conditions in order to make informed decisions about their travel.
		4	Travelers, including drivers or passengers, need to be able to request specific and customized information concerning current and future travel conditions in order to make decisions about their own travel.
TI04: Infrastructure-Provided Trip Planning and Route Guidance	Mobility	1	Traveler Information needs access to timely, accurate, and reliable traffic, transit, and other road conditions data from multiple sources in order to generate accurate and appropriate routes for travelers.
		2	Travelers need guidance to their destination that is timely, accurate, and reliable in order for them to arrive safely in as little time as possible.
		3	Traveler Information needs travel parameters from a traveler in order to develop dynamic routes.
TI06: Dynamic Ridesharing and Shared Use Transportation	Mobility	1	Traveler Information needs access to timely, accurate, and reliable transit and multimodal operations data, including available parking, in order to support ride matching by locating and managing meeting and drop-off points.
		2	Traveler Information needs to accept commuter and driver information for ridesharing, including preferences, payment options, origin/destination, arrival time, departure time, number of riders, number of available passenger spaces.
		3	Traveler Information needs to match riding commuters to drivers.
		4	Commuters need to be able to request and confirm shared use transportation.
		5	Traveler information needs to provide a mechanism for the confirmation of ride matching.

Need Area	Type	Need	
TM01: Infrastructure-Based Traffic Surveillance	Informational	1	Traffic Operations need to be able to monitor the road network using infrastructure devices in order to detect and verify incidents and support implementation of traffic operational strategies.
		2	Traffic Operations need to be able to monitor the infrastructure devices used for road network monitoring in order to detect faults in equipment or communications.
		3	Traffic Operations need to be able to send network monitoring data to other centers in order to support traveler information.
TM03: Traffic Signal Control	Mobility	1	Traffic Operations need to be able to remotely control traffic signals at intersections under their jurisdiction
		2	Traffic Operations need to be able to manage and implement control plans in order to coordinate signalized intersections.
		3	Traffic Operations need to be able to monitor and control pedestrian crossing aspects of traffic signals in order to facilitate safe pedestrian crossings at the intersection.
		4	Traffic Operations need to monitor the status of traffic signal control equipment.
TM05: Traffic Metering	Mobility	1	Traffic Operations need to be able to monitor and control traffic metering equipment in order to regulate the flow of traffic on ramps, interchanges, and the mainline.
		2	Traffic Operations need to monitor the status of traffic metering equipment.
		3	Traffic Operations need to be able to implement control strategies utilizing the traffic metering equipment on ramps, interchanges, and on the mainline.
TM06: Traffic Information Dissemination	Informational	1	Traffic Operations need to be able to provide traffic and incident information to drivers using roadside devices such as dynamic message signs and highway advisory radio.
		2	Traffic Operations need to be able to monitor roadside devices used to provide traffic and traveler information to drivers.
		3	Traffic Operations need to be able to provide traffic and incident information, including images to the media.
		4	Traffic Operations need to be able to provide traffic and incident information, including images to traveler information, transit, maintenance and emergency centers.
TM07: Regional Traffic Management	Management	1	Traffic Operations need to exchange traffic and incident data with other Traffic Management Centers in order to support regional coordination spanning jurisdictional boundaries.
		2	Traffic Operations need to exchange traffic control data with other traffic management centers to support inter-jurisdictional, real-time coordinated traffic signal control systems and coordination between freeway operations and traffic signal control within a corridor.

Need Area	Type	Need	
TM13: Standard Railroad Grade Crossing	Safety	1	Traffic Operations need to be able to warn drivers of crossing closures in time for the driver to take appropriate action.
		2	Traffic Operations need to be able to modify traffic signal timing in order to allow safe movement of vehicles away or towards a highway rail intersection when a train is approaching.
TM23: Border Management Systems	Mobility	1	Traffic Operation needs to be able to collect transportation related data, including border crossing data in order to support planning and research activities that span the US land border crossings.
		2	Border Inspection Operations need to be able to verify if the people crossing into the country have proper credentials to allow them to enter.
		3	Border Inspection Operations need to be able to verify if the vehicle coming into the country have proper credentials to allow them to enter and comply with federal laws and regulations.
		4	Traffic Operations need to be able to provide border status for drivers approaching the border crossing or planning to cross.
		5	Traffic Operation centers, and other border stakeholders need to be able to monitor the traffic flow data at or near a border crossing using data from vehicles and mobile devices.
WX01: Weather Data Collection	Environmental	1	Traffic operations or maintenance and construction operations need be able to collect road conditions and weather data from environmental sensors on or in the vicinity of the roadway.
		2	Traffic operations need to be able to collect road conditions and weather data from vehicle on-board sensors.
		3	Traffic operations and maintenance and construction operations need to share collected environmental data with each other.
		4	Traffic operations and Maintenance and construction need to be able to receive environmental data from Weather operations.
		5	Maintenance and construction operations need to be able to collect road conditions and weather data from maintenance vehicle on-board sensors.
		6	Weather Systems need be able to collect road conditions and weather data from environmental sensors on or in the vicinity of the roadway.

RR Area Name	Stakeholder	RR Description
Cascade Gateway Border Data Warehouse	BC Ministry of Transportation and Infrastructure (BCMOTI)	Provide XML data from Border ATIS to the archive every minute.
	U.S. Customs and Border Protection (USCBP)	Provide booth status XML data from VPC system to the archive every five minutes.
	WA State Department of Transportation (WSDOT)	Provide XML data from Border ATIS to the archive every minute.
	Whatcom Council of Governments (WCOG)	Develop and maintain the data warehouse.
Commercial Vehicle Operations for Whatcom Regional ITS Architecture -	U.S. Customs and Border Protection (USCBP)	
Data Management for Whatcom Regional ITS Architecture - 2022	BC Ministry of Transportation and Infrastructure (BCMOTI)	
	City of Bellingham	
	City of Ferndale	
	City of Lynden	
	U.S. Customs and Border Protection (USCBP)	
	WA State Department of Transportation (WSDOT)	
	Whatcom Council of Governments (WCOG)	
	Whatcom County	
	Whatcom Transportation Authority (WTA)	
	Whatcom Unified Emergency Operations Center	
Emergency Management for Whatcom Regional ITS Architecture - 2022	BC Ministry of Transportation and Infrastructure (BCMOTI)	
	City of Bellingham	
	City of Ferndale	
	City of Lynden	
	WA State Department of Transportation (WSDOT)	
	Whatcom County	
	Whatcom Transportation Authority (WTA)	
	Whatcom Unified Emergency Operations Center	

RR Area Name	Stakeholder	RR Description
Freeway Management for Whatcom Regional ITS Architecture - 2022	WA State Department of Transportation (WSDOT)	All maintenance and operations
International Border for Whatcom Regional ITS Architecture - 2022	BC Ministry of Transportation and Infrastructure (BCMOTI)	
	City of Bellingham	
	U.S. Customs and Border Protection (USCBP)	
	WA State Department of Transportation (WSDOT)	
	Whatcom Transportation Authority (WTA)	
Parking Management for Whatcom Regional ITS Architecture - 2022	BC Ministry of Transportation and Infrastructure (BCMOTI)	
	City of Bellingham	
	WA State Department of Transportation (WSDOT)	
	Whatcom Transportation Authority (WTA)	
Surface Street Management for Whatcom Regional ITS Architecture - 2022	City of Bellingham	Operate and maintain signalization for City of Bellingham
	City of Bellingham	Operate and maintain signalization for City of Ferndale
	City of Bellingham	Operate and maintain signalization for City of Lynden
	City of Bellingham	Operate and maintain signalization for unincorporated Whatcom County
	City of Bellingham	Oversee parking system payment management for City of Bellingham
	City of Bellingham	Oversee parking space management system for City of Bellingham
	City of Bellingham	Oversee charging station management system for City of Bellingham
	WA State Department of Transportation (WSDOT)	Share signaliation controls at specific intersections with City of Bellingham
Sustainable Travel for Whatcom Regional ITS Architecture - 2022	City of Bellingham	
	WA State Department of Transportation (WSDOT)	
	Whatcom Transportation Authority (WTA)	

RR Area Name	Stakeholder	RR Description
Transit Services for Whatcom Regional ITS Architecture - 2022	Lummi Transit	Share transit schedule information with GTFS
	Skagit Transit	Coordinate electronic fare payment system with WTA
	Whatcom Transportation Authority (WTA)	Manage and maintain transit operations within Whatcom County
	BC Ministry of Transportation and Infrastructure (BCMOTI)	
	City of Bellingham	
	City of Ferndale	
	City of Lynden	
	WA State Department of Transportation (WSDOT)	
	Whatcom County	
	Whatcom Transportation Authority (WTA)	
	Whatcom Unified Emergency Operations Center	
Traveler Information for Whatcom Regional ITS Architecture - 2022	BC Ministry of Transportation and Infrastructure (BCMOTI)	
	City of Bellingham	
	U.S. Customs and Border Protection (USCBP)	
	WA State Department of Transportation (WSDOT)	
	Whatcom Transportation Authority (WTA)	
	Whatcom Unified Emergency Operations Center	
Weather for Whatcom Regional ITS Architecture - 2022	Whatcom County	Collect in-field weather information.

Element Name	Functional Object	Functional Object Description
BCMOTI Traffic Management Center (BCMOTI)	TMC Regional Traffic Management	TMC Regional Traffic Management' supports coordination between Traffic Management Centers in order to share traffic information between centers as well as control of traffic management field equipment. This coordination supports wide area optimization and regional coordination that spans jurisdictional boundaries; for example, coordinated signal control in a metropolitan area or coordination between freeway operations and arterial signal control within a corridor.
	TMC Traffic Information Dissemination	TMC Traffic Information Dissemination' disseminates traffic and road conditions, closure and detour information, incident information, driver advisories, and other traffic-related data to other centers, the media, and driver information systems. It monitors and controls driver information system field equipment including dynamic message signs and highway advisory radio, managing dissemination of driver information through these systems.
	TMC Basic Surveillance	TMC Basic Surveillance' remotely monitors and controls traffic sensor systems and surveillance (e.g., CCTV) equipment, and collects, processes and stores the collected traffic data. Current traffic information and other real-time transportation information is also collected from other centers. The collected information is provided to traffic operations personnel and made available to other centers.
	TMC Regional Traffic Management	TMC Regional Traffic Management' supports coordination between Traffic Management Centers in order to share traffic information between centers as well as control of traffic management field equipment. This coordination supports wide area optimization and regional coordination that spans jurisdictional boundaries; for example, coordinated signal control in a metropolitan area or coordination between freeway operations and arterial signal control within a corridor.
	TMC Roadway Equipment Monitoring	TMC Roadway Equipment Monitoring' monitors the operational status of field equipment and detects failures. It presents field equipment status to Traffic Operations Personnel and reports failures to the Maintenance and Construction Management Center. It tracks the repair or replacement of the failed equipment. The entire range of ITS field equipment may be monitored including sensors (traffic, infrastructure, environmental, security, speed, etc.) and devices (highway advisory radio, dynamic message signs, automated roadway treatment systems, barrier and safeguard systems, cameras, traffic signals and override equipment, ramp meters, beacons, security surveillance equipment, etc.).
	TMC Signal Control	TMC Signal Control' provides the capability for traffic managers to monitor and manage the traffic flow at signalized intersections. This capability includes analyzing and reducing the collected data from traffic surveillance equipment and developing and implementing control plans for signalized intersections. Control plans may be developed and implemented that coordinate signals at many intersections under the domain of a single Traffic Management Center and are responsive to traffic conditions and adapt to support incidents, preemption and priority requests, pedestrian crossing calls, etc.

Element Name	Functional Object	Functional Object Description
Bellingham Traffic Signals	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Field Management Station Operation	Roadway Field Management Station Operation' supports direct communications between field management stations and the local field equipment under their control.
	Roadway Signal Control	Roadway Signal Control' includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, detectors, conflict monitors, signal heads, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. It represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians. In advanced, future implementations, environmental data may be monitored and used to support dilemma zone processing and other aspects of signal control that are sensitive to local
	Roadway Signal Preemption	Roadway Signal Preemption' includes the field elements that receive signal preemption requests from emergency vehicles approaching a signalized intersection and overrides the current operation of the traffic signals to stop conflicting traffic and grant right-of-way to the approaching vehicle.
Cascade Gateway Border Data Warehouse	Archive Data Repository	Archive Data Repository' collects data and data catalogs from one or more data sources and stores the data in a focused repository that is suited to a particular set of ITS data users. It includes capabilities for performing quality checks on the incoming data, error notification, and archive to archive coordination. It includes the capability to define a data registry that allows registration of data identifiers or data definitions for interoperable use throughout a region. It supports a broad range of implementations, ranging from simple data marts that collect a focused set of data and serve a particular user community to large-scale data warehouses that collect, integrate, and summarize transportation data from multiple sources and serve a broad array of users within a region. Repositories may be established to support operations planning, performance monitoring and management, and policy and investment decisions.
	Archive Situation Data Archival	Archive Situation Data Archival' collects and archives traffic, roadway, and environmental information for use in off-line planning, research, and analysis. It controls and collects information directly from equipment at the roadside, reflecting the deployment of traffic detectors that are used primarily for traffic monitoring and planning purposes, rather than for traffic management. It also collects situation data from connected vehicles. The data collected, quality checks performed, and aggregation strategies are defined to support transportation system performance monitoring and management.

Element Name	Functional Object	Functional Object Description
CBP Border Administration System	Border Inspection Administration	Border Inspection Administration' performs administrative functions relating to the inspection of goods and vehicles at the border.
	Border Registration	Border Registration' performs administrative functions relating to the electronic registration for credentials relating to border crossing.
CBP Border Inpsection System	Border Inspection	Border Inspection' manages and supports primary and secondary inspections at the border crossing.
Early Warning System		
Electric Charging Stations Management	Electric Charging Station Management	Electric Charging Station Management' manages vehicle charging. It communicates with the vehicle during charging and provides charge status information to the driver. A connection with Connected Vehicle Roadside Equipment provides the capability to integrate charging station coordination and communication into the broader Connected Vehicle Environment.
Emergency Dispatch	Emergency Call-Taking	Emergency Call-Taking' supports the emergency call-taker, collecting available information about the caller and the reported emergency, and forwarding this information to other objects that formulate and manage the emergency response. It receives 9-1-1, 7-digit local access, and motorist call-box calls and interfaces to other agencies to assist in the verification and assessment of the emergency and to forward the emergency information to the appropriate response agency.
	Emergency Dispatch	Emergency Dispatch' tracks the location and status of emergency vehicles and dispatches these vehicles to incidents. Pertinent incident information is gathered from the public and other public safety agencies and relayed to the responding units. Incident status and the status of the responding units is tracked so that additional units can be dispatched and/or unit status can be returned to available when the incident is cleared and closed.
	Emergency Early Warning System	Emergency Early Warning System' monitors alerting and advisory systems, information collected by ITS surveillance and sensors, and reports from other agencies and uses this information to identify potential, imminent, or in-progress major incidents or disasters. Notification is provided to initiate the emergency response, including public notification using ITS traveler information systems, where appropriate.
	Emergency Environmental Monitoring	Emergency Environmental Monitoring' collects current and forecast road conditions and surface weather information from a variety of sources. The collected environmental information is monitored and presented to the operator and used to more effectively manage incidents.
	Emergency Routing	Emergency Routing' supports routing of emergency vehicles and enlists support from the Traffic Management Center to facilitate travel along these routes. Routes may be determined based on real-time traffic information and road conditions or routes may be provided by the Traffic Management Center on request. Vehicles are tracked and routes are based on current vehicle location. It may coordinate with the Traffic Management Center to provide preemption or otherwise adapt the traffic control strategy along the selected route.

Element Name	Functional Object	Functional Object Description
Emergency Mobile Communications		
Emergency Vehicle Preemption		
Ferndale Traffic Signals	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Field Management Station Operation	Roadway Field Management Station Operation' supports direct communications between field management stations and the local field equipment under their control.
	Roadway Signal Control	Roadway Signal Control' includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, detectors, conflict monitors, signal heads, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. It represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians. In advanced, future implementations, environmental data may be monitored and used to support dilemma zone processing and other aspects of signal control that are sensitive to local environmental conditions.
I-5 Monitoring System	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Data Collection	Roadway Data Collection' collects traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications where data quality and completeness take precedence over real-time performance. It includes the sensors, supporting roadside infrastructure, and communications equipment that collects and transfers information to a center for archival.
	Roadway Field Device Support	Roadway Field Device Support' monitors the operational status of field devices and detects and reports fault conditions. Consolidated operational status (device status, configuration, and fault information) are reported for resolution and repair. A local interface is provided to field personnel for local monitoring and diagnostics, supporting field maintenance, upgrade, repair, and replacement of field devices.

Element Name	Functional Object	Functional Object Description
Incident Management Center	Emergency Commercial Vehicle Response	Emergency Commercial Vehicle Response' identifies and initiates a response to commercial vehicle and freight equipment related emergencies. These emergencies may include incidents involving hazardous materials as well as the detection of non-permitted transport of security sensitive hazmat. It identifies the location of the vehicle, the nature of the incident, the route information, and information concerning the freight itself. The information supports the determination of the response and identifies the responding agencies to notify.
	Emergency Dispatch	Emergency Dispatch' tracks the location and status of emergency vehicles and dispatches these vehicles to incidents. Pertinent incident information is gathered from the public and other public safety agencies and relayed to the responding units. Incident status and the status of the responding units is tracked so that additional units can be dispatched and/or unit status can be returned to available when the incident is cleared and closed.
	Emergency Early Warning System	Emergency Early Warning System' monitors alerting and advisory systems, information collected by ITS surveillance and sensors, and reports from other agencies and uses this information to identify potential, imminent, or in-progress major incidents or disasters. Notification is provided to initiate the emergency response, including public notification using ITS traveler information systems, where appropriate.
	Emergency Environmental Monitoring	Emergency Environmental Monitoring' collects current and forecast road conditions and surface weather information from a variety of sources. The collected environmental information is monitored and presented to the operator and used to more effectively manage incidents.
	Emergency Evacuation Support	Emergency Evacuation Support' coordinates evacuation plans among allied agencies and manages evacuation and reentry of a population in the vicinity of a disaster or other emergency that poses a risk to public safety. Where appropriate, the affected population is evacuated in shifts, using more than one evacuation route, and including several evacuation destinations to spread demand and thereby expedite the evacuation. All affected jurisdictions (e.g., states and counties) at the evacuation origin, evacuation destination, and along the evacuation route are informed of the plan. The public is provided with real-time evacuation guidance including basic information to assist potential evacuees in determining whether evacuation is necessary. Resource requirements are forecast based on the evacuation plans, and the necessary resources are located, shared between agencies if necessary, and deployed at the right locations at the appropriate times. The evacuation and reentry status are monitored and used to refine the plan and resource allocations during the evacuation and subsequent reentry. It communicates with public health systems to develop evacuation plans and recommended strategies for disasters and evacuation scenarios involving biological or other medical hazards.

Element Name	Functional Object	Functional Object Description
	Emergency Incident Command	Emergency Incident Command' provides tactical decision support, resource coordination, and communications integration for Incident Commands that are established by first responders at or near the incident scene to support local management of an incident. It supports communications with public safety, emergency management, transportation, and other allied response agency centers, tracks and maintains resource information, action plans, and the incident command organization itself. Information is shared with agency centers including resource deployment status, hazardous material information, traffic, road, and weather conditions, evacuation advice, and other information that enables emergency or maintenance personnel in the field to implement an effective, safe incident response. It supports the functions and interfaces commonly supported by a mobile command center.
	Emergency Response Management	Emergency Response Management' provides the strategic emergency response capabilities and broad inter-agency interfaces that are implemented for extraordinary incidents and disasters that require response from outside the local community. It provides the functional capabilities and interfaces commonly associated with Emergency Operations Centers. It develops and stores emergency response plans and manages overall coordinated response to emergencies. It monitors real-time information on the state of the regional transportation system including current traffic and road conditions, weather conditions, special event and incident information. It tracks the availability of resources and assists in the appropriate allocation of these resources for a particular emergency response. It also provides coordination between multiple allied agencies before and during emergencies to implement emergency response plans and track progress through the incident. It also coordinates with the public through the Emergency Telecommunication Systems (e.g., Reverse 911). It coordinates with public health systems to provide the most appropriate response for emergencies involving biological or other medical hazards.
	Emergency Routing	Emergency Routing' supports routing of emergency vehicles and enlists support from the Traffic Management Center to facilitate travel along these routes. Routes may be determined based on real-time traffic information and road conditions or routes may be provided by the Traffic Management Center on request. Vehicles are tracked and routes are based on current vehicle location. It may coordinate with the Traffic Management Center to provide preemption or otherwise adapt the traffic control strategy along the selected route.
	Emergency Secure Area Sensor Management	Emergency Secure Area Sensor Management' manages sensors that monitor secure areas in the transportation system, processes the collected data, performs threat analysis in which data is correlated with other sensor, surveillance, and advisory inputs, and then disseminates resultant threat information to emergency personnel and other agencies. In response to identified threats, the operator may request activation of barrier and safeguard systems to preclude an incident, control access during and after an incident or mitigate impact of an incident. The sensors may be in secure areas frequented by travelers (i.e., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities, on-board a transit vehicle, etc.) or around transportation infrastructure such as bridges, tunnels and transit railways or guideways. The types of sensors include acoustic, threat (e.g. chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors), infrastructure condition and integrity, motion and object sensors.

Element Name	Functional Object	Functional Object Description
	Emergency Secure Area Surveillance	Emergency Secure Area Surveillance' monitors surveillance inputs from secure areas in the transportation system. The surveillance may be of secure areas frequented by travelers (i.e., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities, on-board a transit vehicle, etc.) or around transportation infrastructure such as bridges, tunnels and transit railways or guideways. It provides both video and audio surveillance information to emergency personnel and automatically alerts emergency personnel of potential incidents.
Lynden Traffic Signals	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Field Management Station Operation	Roadway Field Management Station Operation' supports direct communications between field management stations and the local field equipment under their control.
	Roadway Signal Control	Roadway Signal Control' includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, detectors, conflict monitors, signal heads, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. It represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians. In advanced, future implementations, environmental data may be monitored and used to support dilemma zone processing and other aspects of signal control that are sensitive to local environmental conditions.
Northbound Border Traveler Information System	Roadway Data Collection	Roadway Data Collection' collects traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications where data quality and completeness take precedence over real-time performance. It includes the sensors, supporting roadside infrastructure, and communications equipment that collects and transfers information to a center for archival.
Parking Electronic Payment	PAC Payment Administration	PAC Payment Administration' provides administration and management of payments associated with electronic toll collection, parking payments, and other e-payments. It provides the back office functions that support enrollment, pricing, payment reconciliation with financial institutions, and violation notification to enforcement agencies. It also supports dynamic pricing to support demand management. Secure communications with the financial infrastructure and distributed payment infrastructure, including toll plazas, support electronic payments and other ancillary requirements such as lost payment device identification and management.

Element Name	Functional Object	Functional Object Description
Parking Space Management System	Parking Coordination	Parking Coordination' supports communication and coordination between equipped parking facilities and also supports regional coordination between parking facilities and traffic management systems. Coordination with traffic management supports local traffic control coordination in and around the parking facility and broader regional coordination. It also shares information with transit management systems and information providers to support multimodal travel planning, including parking reservations capabilities. Information including current parking availability, system status, and operating strategies are shared to enable local parking facility management that supports regional transportation strategies.
	Parking Management	Parking Management' monitors parking area operations for one or more parking areas, monitoring current operational status including current parking occupancy and rates supporting back office operations.
Smart Park and Ride	Parking Area Park and Ride Operations	Parking Area Park and Ride Operations' manages parking lots specifically to support park and ride operations, providing additional coordination with transit operations on parking arrivals and transit arrivals and departures, smoothing the transition between parking and riding for park and ride customers.
Southbound Border Traveler Information System	Roadway Data Collection	Roadway Data Collection' collects traffic, road, and environmental conditions information for use in transportation planning, research, and other off-line applications where data quality and completeness take precedence over real-time performance. It includes the sensors, supporting roadside infrastructure, and communications equipment that collects and transfers information to a center for archival.
Transportation Infrastructure Protection		
WA State Route 539 Monitoring System	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Field Management Station Operation	Roadway Field Management Station Operation' supports direct communications between field management stations and the local field equipment under their control.

Element Name	Functional Object	Functional Object Description
	Roadway Signal Control	Roadway Signal Control' includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, detectors, conflict monitors, signal heads, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. It represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians. In advanced, future implementations, environmental data may be monitored and used to support dilemma zone processing and other aspects of signal control that are sensitive to local environmental conditions.
WA State Route 542 Monitoring System	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Field Management Station Operation	Roadway Field Management Station Operation' supports direct communications between field management stations and the local field equipment under their control.
	Roadway Signal Control	Roadway Signal Control' includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, detectors, conflict monitors, signal heads, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. It represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians. In advanced, future implementations, environmental data may be monitored and used to support dilemma zone processing and other aspects of signal control that are sensitive to local environmental conditions.
WA State Route 543 Monitoring System	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Field Management Station Operation	Roadway Field Management Station Operation' supports direct communications between field management stations and the local field equipment under their control.

Element Name	Functional Object	Functional Object Description
	Roadway Signal Control	Roadway Signal Control' includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, detectors, conflict monitors, signal heads, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. It represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians. In advanced, future implementations, environmental data may be monitored and used to support dilemma zone processing and other aspects of signal control that are sensitive to local environmental conditions.
WA State Route 9 Monitoring System	Roadway Basic Surveillance	Roadway Basic Surveillance' monitors traffic conditions using fixed equipment such as loop detectors and CCTV cameras.
	Roadway Field Management Station Operation	Roadway Field Management Station Operation' supports direct communications between field management stations and the local field equipment under their control.
	Roadway Signal Control	Roadway Signal Control' includes the field elements that monitor and control signalized intersections. It includes the traffic signal controllers, detectors, conflict monitors, signal heads, and other ancillary equipment that supports traffic signal control. It also includes field masters, and equipment that supports communications with a central monitoring and/or control system, as applicable. The communications link supports upload and download of signal timings and other parameters and reporting of current intersection status. It represents the field equipment used in all levels of traffic signal control from basic actuated systems that operate on fixed timing plans through adaptive systems. It also supports all signalized intersection configurations, including those that accommodate pedestrians. In advanced, future implementations, environmental data may be monitored and used to support dilemma zone processing and other aspects of signal control that are sensitive to local environmental conditions.
Weather Data Collection	Roadway Environmental Monitoring	Roadway Environmental Monitoring' measures environmental conditions and communicates the collected information back to a center where it can be monitored and analyzed or to other field devices to support communications to vehicles. A broad array of weather and road surface information may be collected. Weather conditions that may be measured include temperature, wind, humidity, precipitation, and visibility. Surface and sub-surface sensors can measure road surface temperature, moisture, icing, salinity, and other metrics.
Wide-Area Alert System		
WTA Automatic Vehicle Location	Transit Center Vehicle Tracking	Transit Center Vehicle Tracking' monitors transit vehicle location. The location information is collected via a data communication link between the transit vehicles and the transit center. The location information is presented to the transit operator on a digitized map of the transit service area. The location data may be used to determine real time schedule adherence and update the transit system's schedule in real-time. The real-time schedule information is disseminated to other information providers, which furnish the information to travelers.

Element Name	Functional Object	Functional Object Description
WTA Demand Response	Transit Center Information Services	Transit Center Information Services' collects the latest available information for a transit service and makes it available to transit customers and to Transportation Information Centers for further distribution. Customers are provided information at transit stops and other public transportation areas before they embark and on-board the transit vehicle once they are en route. Information provided can include the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents, weather conditions, yellow pages, and special events. In addition to general service information, tailored information (e.g., itineraries) are provided to individual transit users.
	Transit Center Operator Assignment	Transit Center Operator Assignment' automates and supports the assignment of transit vehicle operators to runs. It assigns operators to runs in a fair manner while minimizing labor and overtime services, considering operator preferences and qualifications, and automatically tracking and validating the number of work hours performed by each individual operator. It also provides an exception handling process for the operator assignment function to generate supplemental operator assignments when required by changes during the operating day.
	Transit Center Paratransit Operations	Transit Center Paratransit Operations' manages demand responsive transit services, including paratransit services. It supports planning and scheduling of these services, allowing paratransit and other demand response transit services to plan efficient routes and better estimate arrival times. It also supports automated dispatch of paratransit vehicles and tracks passenger pick-ups and drop-offs. Customer service operator systems are updated with the most current schedule information.
WTA Intermittent Bus Lanes	Transit Vehicle Schedule Management	Transit Vehicle Schedule Management' monitors schedule performance and identifies corrective actions when a deviation is detected. It provides two-way communication between the transit vehicle and center, enabling the center to communicate with the vehicle operator and monitor on-board systems.
WTA Transit Electronic Fare Collection Management	Transit Center Fare Management	Transit Center Fare Management' manages fare collection and passenger load management at the transit center. It provides the back office functions that support transit fare collection, supporting payment reconciliation with links to financial institutions and enforcement agencies for fare violations. It collects data required to determine accurate ridership levels, establish fares, and distribute fare information. It loads fare data into the vehicle prior to the beginning of normal operations and unloads fare collection data from the vehicle at the close out of normal operations.
WTA Transit Fleet Management		

Element Name	Functional Object	Functional Object Description
WTA Transit Information System		
WTA Transit Management	Transit Center Connection Protection	Transit Center Connection Protection' manages the coordination of transit transfers between routes within a single transit agency, between routes of different transit agencies, or between different modes (e.g. a bus transit route and a ferry route). This functional object also supports the capability for an individual traveler to obtain connection protection throughout a specific transit trip. This application may be implemented through peer-to-peer sharing between agencies control systems or as a central transit transfer request brokerage that facilitates the management and coordination of transfers across multiple agencies and control systems.
	Transit Center Fixed-Route Operations	Transit Center Fixed-Route Operations' manages fixed route transit operations. It supports creation of schedules, blocks and runs for fixed and flexible route transit services. It allows fixed-route and flexible-route transit services to disseminate schedules and automatically updates customer service operator systems with the most current schedule information. It also supports automated dispatch of transit vehicles. Current vehicle schedule adherence and optimum scenarios for schedule adjustment are also provided. It also receives and processes transit vehicle loading data.
	Transit Center Information Services	Transit Center Information Services' collects the latest available information for a transit service and makes it available to transit customers and to Transportation Information Centers for further distribution. Customers are provided information at transit stops and other public transportation areas before they embark and on-board the transit vehicle once they are en route. Information provided can include the latest available information on transit routes, schedules, transfer options, fares, real-time schedule adherence, current incidents, weather conditions, yellow pages, and special events. In addition to general service information, tailored information (e.g., itineraries) are provided to individual transit users.
	Transit Center Multi-Modal Coordination	Transit Center Multi-Modal Coordination' supports transit service coordination between transit properties and coordinates with other surface and air transportation modes. As part of service coordination, it shares schedule and trip information, as well as transit transfer cluster (a collection of stop points, stations, or terminals where transfers can be made conveniently) and transfer point information between Multimodal Transportation Service Providers, Transit Agencies, and ISPs. An interface to Traffic Management also supports demand management strategies.
	Transit Center Operator Assignment	Transit Center Operator Assignment' automates and supports the assignment of transit vehicle operators to runs. It assigns operators to runs in a fair manner while minimizing labor and overtime services, considering operator preferences and qualifications, and automatically tracking and validating the number of work hours performed by each individual operator. It also provides an exception handling process for the operator assignment function to generate supplemental operator assignments when required by changes during the operating day.

Element Name	Functional Object	Functional Object Description
	Transit Center Passenger Counting	Transit Center Passenger Counting' receives and processes transit vehicle loading data using two-way communications from equipped transit vehicles.
	Transit Center Vehicle Assignment	Transit Center Vehicle Assignment' assigns individual transit vehicles to vehicle blocks and downloads this information to the transit vehicle. It also provides an exception handling process for the vehicle assignment function to generate new, supplemental vehicle assignments when required by changes during the operating day. It provides an inventory management function for the transit facility which stores functional attributes about each of the vehicles owned by the transit operator. These attributes permit the planning and assignment functions to match vehicles with routes based on suitability for the types of service required by the particular routes.
	Transit Garage Maintenance	Transit Garage Maintenance' provides advanced maintenance functions for the transit property. It collects operational and maintenance data from transit vehicles, manages vehicle service histories, and monitors operators and vehicles. It collects vehicle mileage data and uses it to automatically generate preventative maintenance schedules for each vehicle by utilizing vehicle tracking data. In addition, it provides information to service personnel to support maintenance activities and records and verifies that maintenance work was performed.
WTA Transit Security	Field Secure Area Sensor Monitoring	Field Secure Area Sensor Monitoring' includes sensors that monitor conditions of secure areas including facilities (e.g. transit yards), transportation infrastructure (e.g. Bridges, tunnels, interchanges, and transit railways or guideways), and public areas (e.g., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities). A range of acoustic, environmental threat (e.g. Chemical agent, toxic industrial chemical, biological, explosives, and radiological sensors), infrastructure condition and integrity and motion and object sensors are included.
	Field Secure Area Surveillance	Field Secure Area Surveillance' includes video and audio surveillance equipment that monitors conditions of secure areas including facilities (e.g. transit yards), transportation infrastructure (e.g. as bridges, tunnels, interchanges, and transit railways or guideways), and public areas (e.g., transit stops, transit stations, rest areas, park and ride lots, modal interchange facilities). It provides the surveillance information to the Emergency Management Center for possible threat detection. It also provides local processing of the video or audio information, providing processed or analyzed results to the Emergency Management Center.
WTA Transit Signal Priority	Transit Vehicle Signal Priority	Transit Vehicle Signal Priority' provides the capability for transit vehicles to determine eligibility for priority and request signal priority at signalized intersections, ramps, and interchanges through short range communication with traffic control equipment at the roadside.