VANCOUVER AREA SMART TREK

REGIONAL COMMUNICATIONS PLAN

SEPTEMBER 2016

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ACKNOWLEDGEMENTS

City of Vancouver
Chris Christofferson
Bill Gilchrist

Clark County
Richard Gamble
Rob Klug
Alan Lichty
Mike Vidito

Washington State Department of Transportation
Stan Markuson
Scott Mercer
Todd Turner

Regional Transportation Council
Bob Hart

Consulting Team
Adrian Pearmine, DKS Associates, Project Manager
Eric Albright, IBI Group
Randy Knapick, IBI Group
Tegan Enloe, DKS Associates
Jim Peters, DKS Associates

1 INTRODUCTION

1.1 OVERVIEW

This plan presents a strategy to meet the regional communications needs of the transportation system serving Clark County, Washington. The communications network is a critical component of the regional transportation system and is fundamental to connecting management centers with field equipment that facilitate regional mobility.

The rapid growth and development of communications infrastructure has led to a greater capacity and assortment of communications supporting Intelligent Transportation Systems (ITS). New ITS capabilities provide agencies with the ability to provide a greater level-of-service to roadway users. For instance, access to high quality detection data and real-time surveillance improve response time to incidents and other changing traffic conditions. Real-time passenger information and integrated corridor management expand mobility. Vehicle-to-vehicle and vehicle-to-infrastructure communications have the potential to increase vehicle safety and decrease emergency and transit vehicle delays.

The C-TRAN Fourth Plain Bus Rapid Transit (BRT) system is an example of a project that benefits from regional collaboration to deploy and manage communications infrastructure and ITS equipment. C-TRAN is installing new BRT stations on City and State rights-of-way that require greater communications connectivity than traditional bus stations. In order to backhaul video and fare information, C-TRAN will leverage the existing fiber optic networks of both the City of Vancouver and WSDOT. In turn, the DOT's will benefit from the re-testing and configuration of the communications hubs and fiber segments by C-TRAN. This asset sharing has saved between $6 to 10.5 million in costs if C-TRAN had constructed the fiber separately.

This plan focuses on recommended actions and standards to maintain and enhance the regional communications network's ability to contribute to an efficient, accessible, and connected transportation system. It has been developed through a collaborative effort led by the Southwest Washington Regional Transportation Council (RTC) and the Vancouver Area Smart Trek (VAST).

Vancouver Area Smart Trek (VAST)

The VAST Program has been managed by RTC since 2001 and is one of RTC's ongoing programs. VAST program activities include regional collaboration on transportation system management and operations (TSMO) and on intelligent transportation systems (ITS). VAST is a coalition of state, regional and local agencies which have been working actively together implementing ITS and operations solutions to address the region's transportation needs. RTC implements the program in coordination with: the City of Vancouver, WSDOT, Clark County, C-TRAN, and the City of Camas. The partnership has been an effective way for the agencies to coordinate project delivery, joint project funding, monitoring project development, and project integration to improve transportation

1.2 DESCRIPTION OF THE REGION AND STAKEHOLDERS

This communication plan addresses the area bounded by Clark County, WA. Clark County is located in the southwest region of Washington and borders Cowlitz and Skamania Counties in Washington and Multnomah and Washington Counties in Oregon.

The county has 8 cities and towns, and the most urbanized area is centered in Vancouver, WA adjacent to the Portland, OR metro area. A majority of the existing communications network infrastructure is located in the urbanized areas. However, the plan anticipates future development and collaboration amongst other isolated, rural, or urbanizing areas. A map of the County is shown in Figure 1-1.

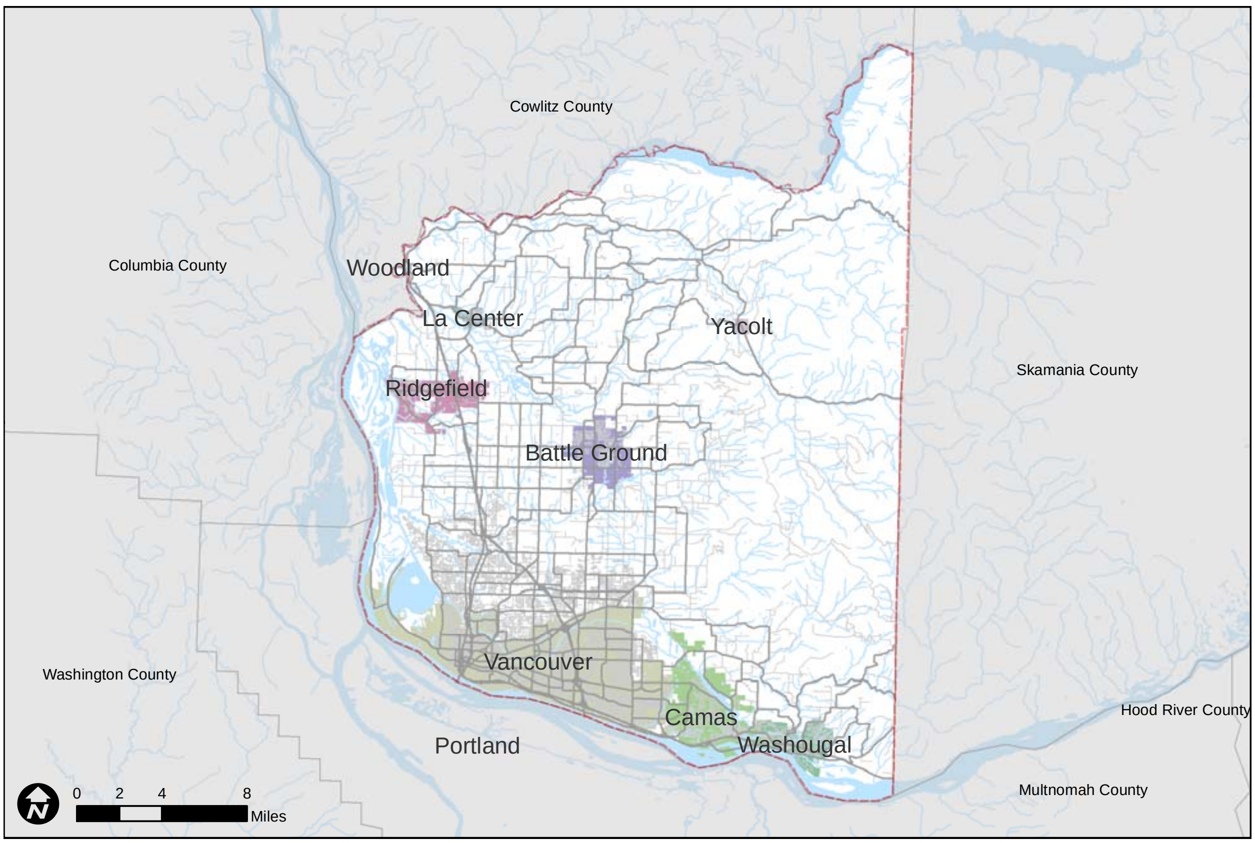

Figure 1-1 Clark County, Washington

Throughout the development of the plan, meetings and workshops were conducted with staff from various public agencies, as shown in Table 1-1. The participation of these agencies was vital to the successful development of this plan and valuable to the implementation of the recommendations contained within it.

Table 1-1 Participating Agencies

Participating Agencies
City Of Vancouver
Clark County
C-TRAN
Regional Transportation Council (RTC)
Washington State Department of Transportation Southwest Region (WSDOT)

1.3 PURPOSE OF THE PLAN

The purpose of this plan is to provide the VAST partner agencies with a strategy for meeting current and future communications infrastructure needs. The goals and objectives of the Regional Communications Plan are:

- Document existing conditions
- Determine agency/regional goals and needs
- Identify any network gaps
- Recommend next steps, standards, and best practices
- Identify potential project opportunities
- Investigate funding opportunities
- Review other regional communications networks

Communications infrastructure planning provides the region with the following benefits:

- Enables the best performance of existing system
- Ensures the needs of the current system and future deployments are met
- Outlines a robust network with redundant paths capable of withstanding outages
- Provides a platform for future intelligent transportation infrastructure
- Enables enhanced operations and cost savings through shared systems

1.4 APPROACH OF THE PLAN

The approach for this plan was to utilize the Open Systems Interconnect (OSI) model to conceptually categorize the features of the communications network and further guide the evaluation of the existing networks and planning of future infrastructure.

As shown in Figure 1-2, the OSI model was used to guide the overall process of the plan's development. First, a baseline was found by documenting the conditions of the existing physical infrastructure. Second, user inputs were gathered through workshops with agency transportation professionals to identify the needs of users at the application and presentation layer. Third, network administration personnel were interviewed to verify the network, data link, and physical layers. Fourth, network engineering and user inputs were used to confirm that the baseline conditions of the communications network would meet the current and future needs of the transportation network. The process concluded with the development of recommendations that meet and gaps or unmet user needs.

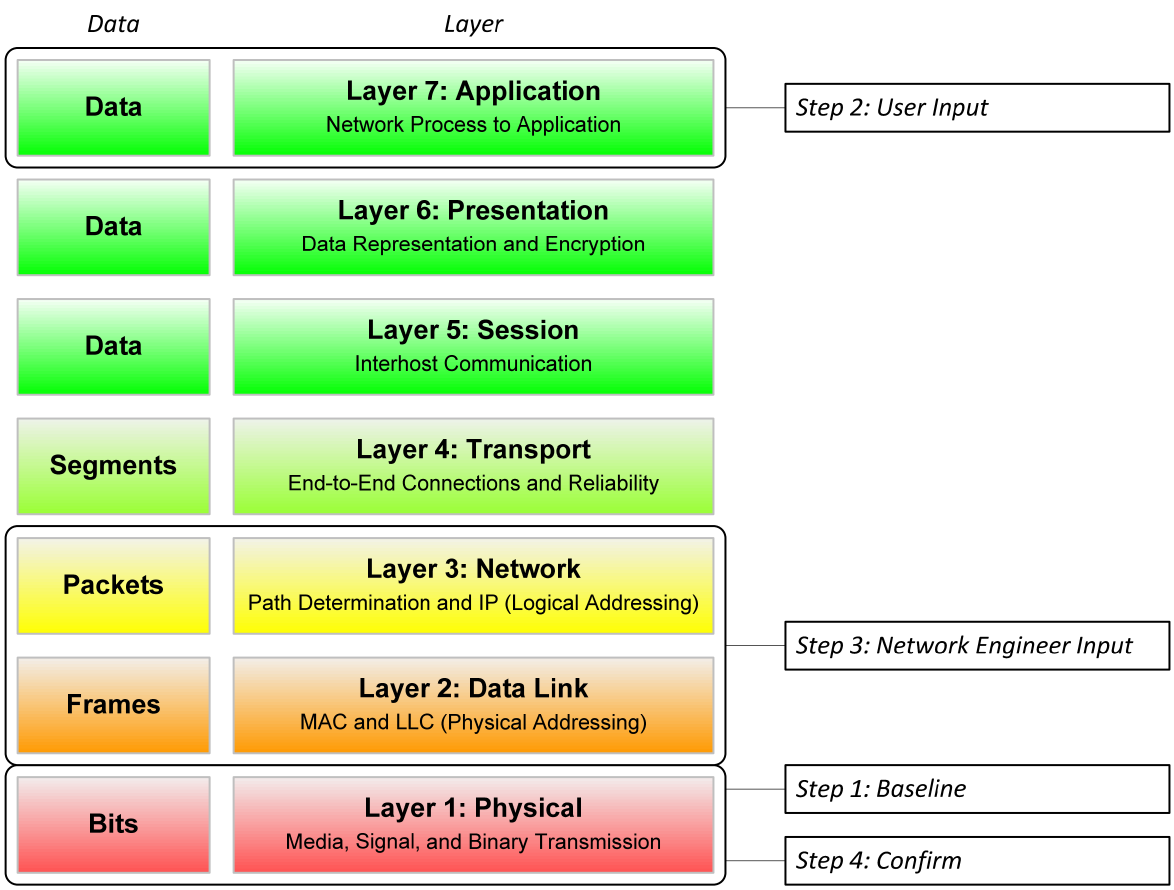

Figure 1-2 OSI Model Approach

1.5 USING THIS DOCUMENT

The intent of this document is that it be used by stakeholders as a reference for making communications infrastructure decisions in the future.

A snapshot of the existing conditions of the regional communications network is found in Chapter 2. This chapter focuses on the current wireline and wireless infrastructure in the region and how regional partners have increased the utility of their individual systems by sharing fiber infrastructure.

Network architectures in the region are discussed in Chapter 3. Here the organization of the physical components of the network are documented.

Chapter 4 details the user needs of the communications network. This chapter identifies user needs based on existing conditions and specific transportation systems in the region.

The recommendations for the region are presented in Chapter 5. Recommendations are organized into four categories: physical infrastructure, network infrastructure, services, and network security.

Appendices are provided in Chapter 6. These include a review of other regional transportation communication networks, a review of potential funding opportunities for communications projects, and a set of enlarged maps presented earlier in the plan.

2 EXISTING NETWORK CONDITIONS

2.1 COMMUNICATIONS INFRASTRUCTURE

The fiber optic communications network makes up the backbone of the regional communications infrastructure and the first or physical layer of the OSI model. This fiber network makes it possible to remotely manage devices in the field for routine maintenance and incident response. It also allows for data to be backhauled to agency centers for operational analysis and long term planning.

The fiber network is comprised of fiber optic cables owned by individual agencies, and joined at hubs and switches in the region. Public agencies who own fiber infrastructure in Clark County include:

- City of Vancouver
- Clark County
- WSDOT
- City of Camas

Figure 2-1 shows the extents of the existing, programmed, and planned fiber network. In this map existing, programmed, and planned fiber are defined as follows:

- Existing – fiber optic cable is installed along this corridor
- Programmed – fiber optic cable has been programmed for installation and funding is complete; installation is eminent
- Planned – these corridors have been identified as likely candidates for new fiber installation, but are not programmed or funded at this time

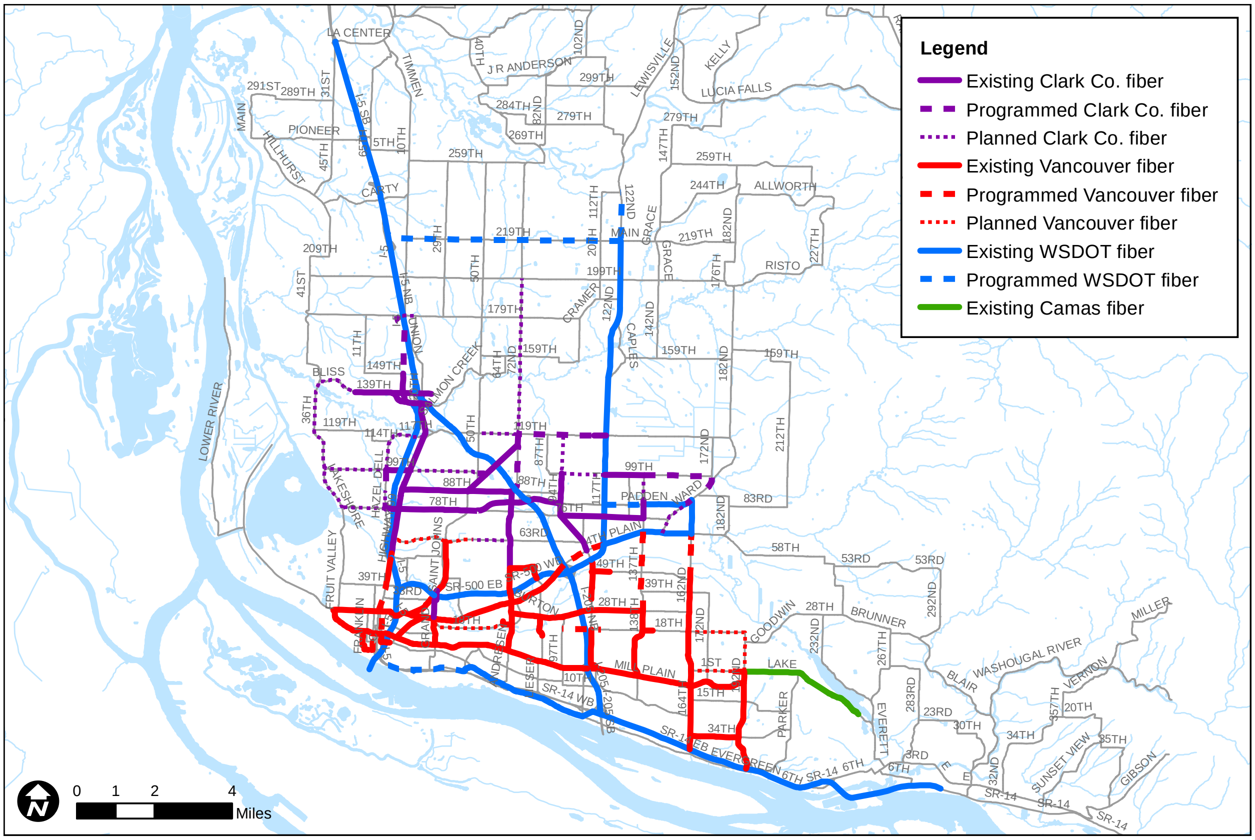

Figure 2-1 Existing and Planned Fiber Optic Cable Infrastructure

Both the City of Vancouver and Clark County use fiber to connect agency centers, traffic signals, and ITS devices along major arterials. Key arterials in the city of Vancouver are Mill Plain Rd., 4th Plain Blvd., Andresen Rd., 136th Ave. and 164th/162nd Ave. In the county key corridors are Hwy. 99,78th St., 88th St., 139th St., and Andresen Rd.

WSDOT operates and maintains fiber along each of the interstate highways, I-5 and I-205, to connect to a network of highway detection equipment including loop detectors, Wavetronix radar devices, and Variable Message Signs. WSDOT also maintains fiber along the state highways SR-14, SR-500, SR-501, SR-502, and SR-503.

In addition to the network created by these three agencies, the City of Camas owns a fiber segment on Lake Blvd. from 192nd Avenue to NW Lacamas Lane.

Fiber optic cable in the region has been installed through a number of separate transportation projects that span many years. Therefore, the fiber optic media across the region varies both in media type and quality. In Figure 2-2 the bandwidth capabilities of fiber corridors in the region are shown.

Note that trunk routes such as Mill Plain may consist of higher bandwidth than shown. The figure identifies where communications to V-LANs, traffic signals, and other ITS equipment are limited by outdated network equipment as well as antiquated and poor quality fiber optic plant.

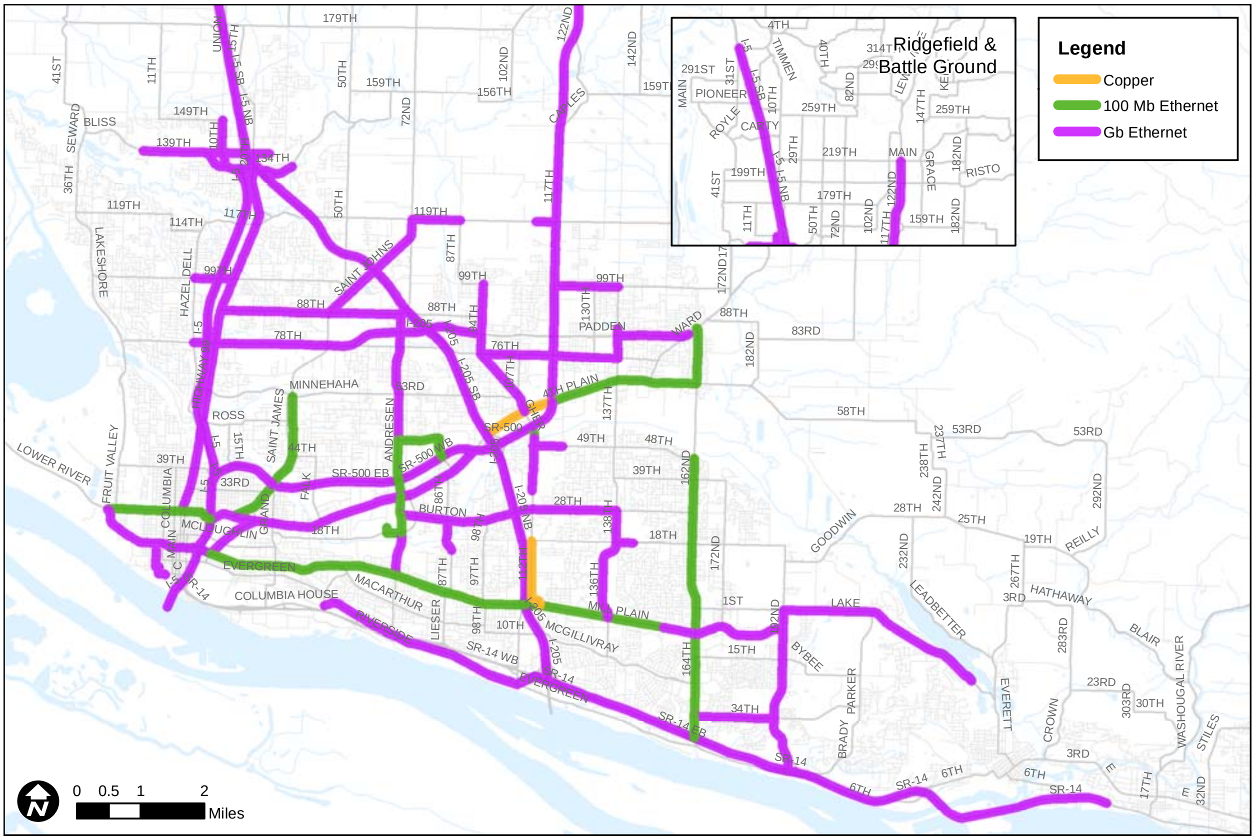

Figure 2-2 Primary Distribution Network Bandwidth

Fiber optic cables are a communications media made up of multiple fiber strands. Clark County has installed 48-count single-mode fiber optic cable for trunk-line communications, and will install 96-count single mode fiber optic cable for communications along some corridors. For branch connections, a minimum of 48-count single-mode fiber optic cable has typically been installed. Older installations including 12 or 36-count fiber optic cable are being phased out.

Inside fiber optic cables, fiber strands are separated into tubes (each holding twelve strands) that are used to physically separate communications traffic between uses and users[1]. Fiber tubes are color-coordinated and VAST had undertaken an effort initially to standardize on the use of the colored tubes to standardize on fiber sharing rules between the agencies utilizing these color codes. As documented in the original VAST Communications Plan, the VAST partners had original planned to use the following tube color assignments:

[1] This is how VAST has configured the network. It should be noted, that there are transport layer technologies that can support multiple uses and even multiple users, to share an individual fiber in secure and isolated network and subnetwork connections.

- Blue Tube: City of Vancouver Transportation
- Orange Tube: Clark County Transportation
- Green Tube: WSDOT Transportation
- Brown Tube: Clark County Information Services
- Other Tubes: All other tubes are reserved

WSDOT is currently in the process of re-assigning color tubes in its fiber network. WSDOT will use the following assignments:

- Blue and Orange Tube: WSDOT Transportation
- Other Tubes: All other tubes are available for sharing

The VAST partner agencies have not have not standardized on tube assignments, but have agreed to make individual fibers available for other vast agency use. Fiber optic cables are installed in larger diameter conduit tubing in order to protect the cables and facilitate new installations by pulling additional cable through the conduit. In recent fiber installations, Clark County has been using one 3-inch tube while has been WSDOT has been using three 1 ¼-inch tubes.

In addition to fiber optic cable, agencies in the region are using a variety of other media for communications between agency centers and the field. As a majority of ITS devices in the field are connected to traffic signals, it is important for agencies to establish connectivity to signals through the fiber network or other communications media.

Ethernet communications over fiber optic cable is the preferred communications media to connect traffic signals to the network. Wireless links and Ethernet over copper are acceptable, but not preferred options. New installations and corridor modifications typically include fiber optic cable.

The existing Clark County copper infrastructure is generally 20-gage twisted pair copper, which has limited ability to transmit high speed Ethernet communications. Ultimately Clark County plans to use Ethernet communications to all traffic signal cabinets. Most of the existing twisted pair copper cables include two or four pairs of wires, which are installed underground in varying conduit size typically ranging from one to two inches.

2.2 COMMUNICATION DEVICES

Fiber optic cables in the region are connected at the Data link (2^{nd}) and Network (3^{rd}) layers of the OSI model through a series of hubs (which include both routers and switches) deployed throughout the network. Major communications router locations are shown in Figure 2-3.

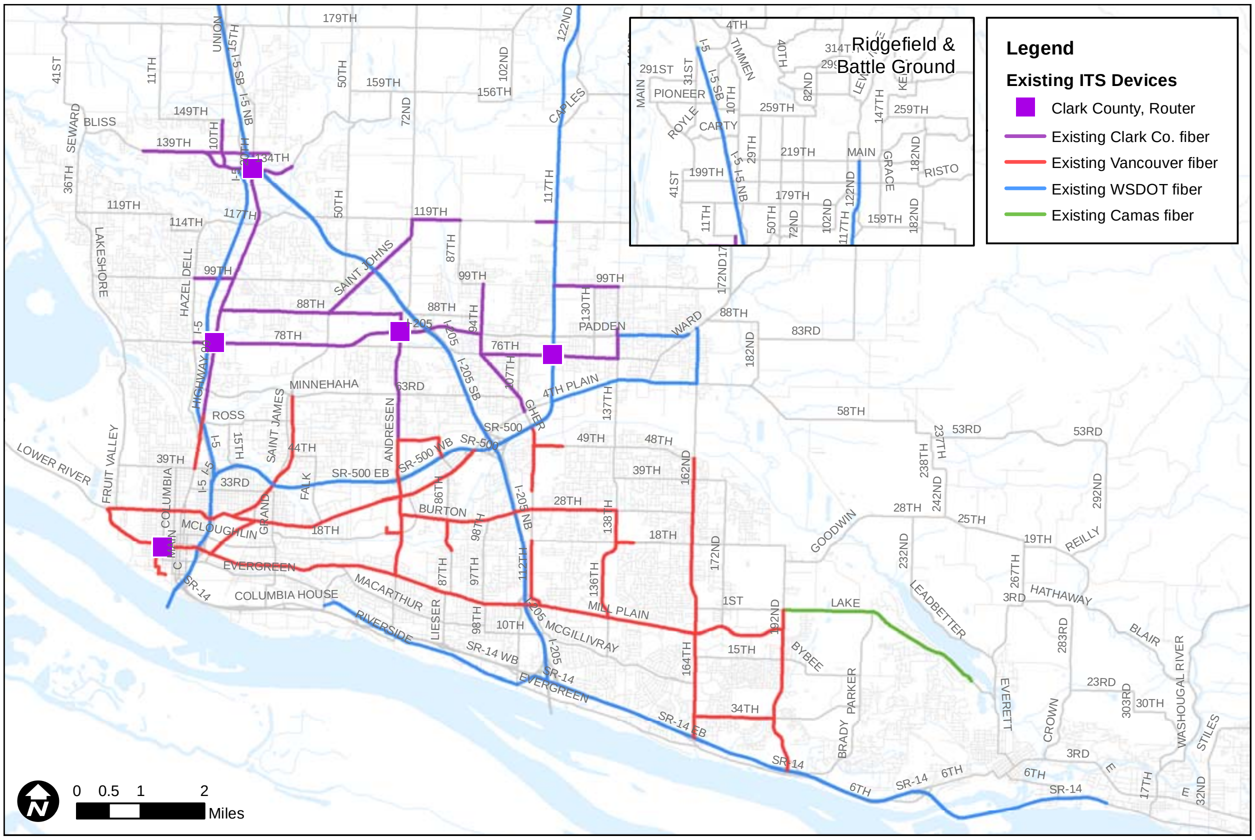

Figure 2-3 Primary Network Transportation Devices (Routers)

At each of the router locations, a layer 3 router (RUGGEDCOM RX1500 or equivalent) is deployed. At this time only Clark County has finished implementing a routed layer 3 network, and the City of Vancouver and WSDOT have begun planning similar improvements to their networks.

Cross connect points represent locations where major fiber lines intersect and interagency communications are possible. These locations are identified in Figure 2-4.

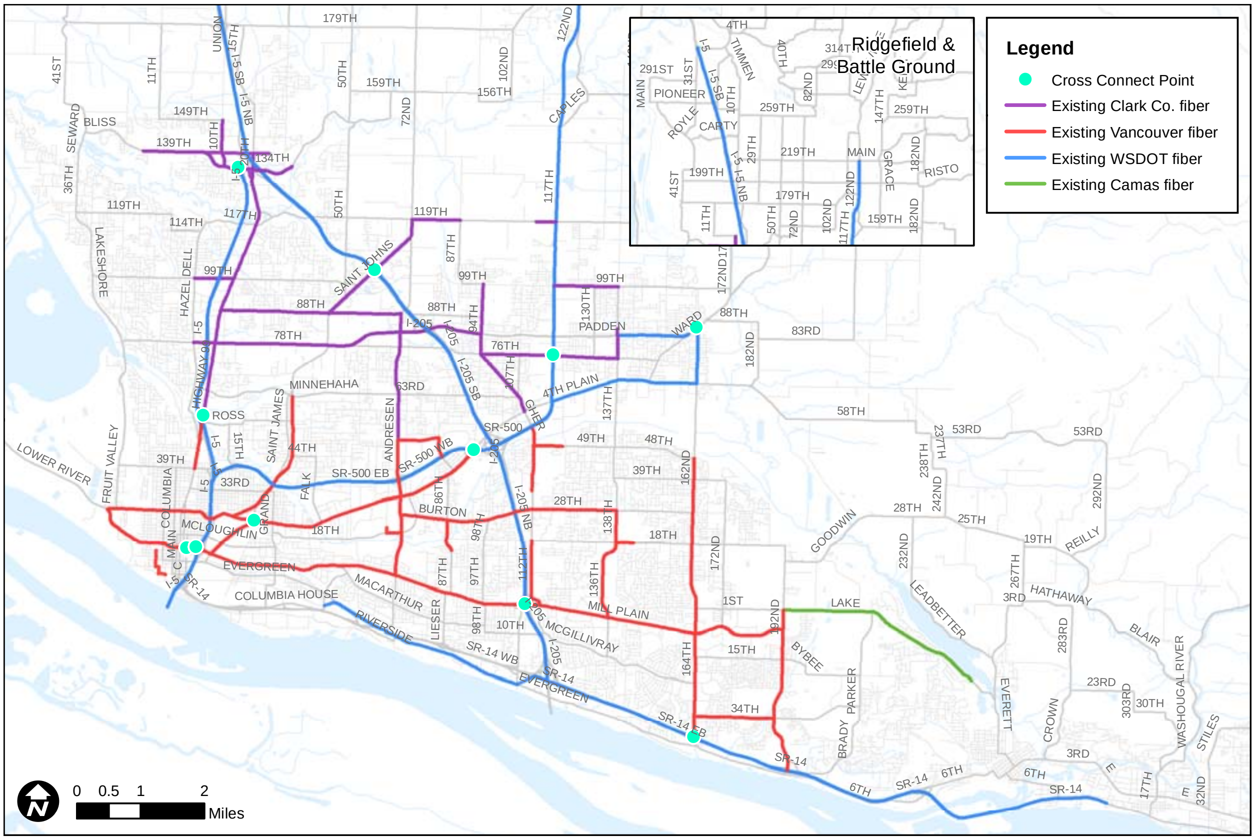

Figure 2-4 Primary Network Transportation Devices (Cross Connect Points)

2.3 COMMUNICATIONS INFRASTRUCTURE SHARING

A major success in the region for the VAST partners has been the sharing of communications infrastructure between agencies. Over 100 miles of shared fiber has led to savings of more than $15M in design, construction, oversight, and contingency costs.

Sharing fiber has been used to allow the backhaul of field video, communication service to public safety offices, creation of redundant network paths, and connection of agency centers. The network of shared fiber is shown in Figure 2-5.

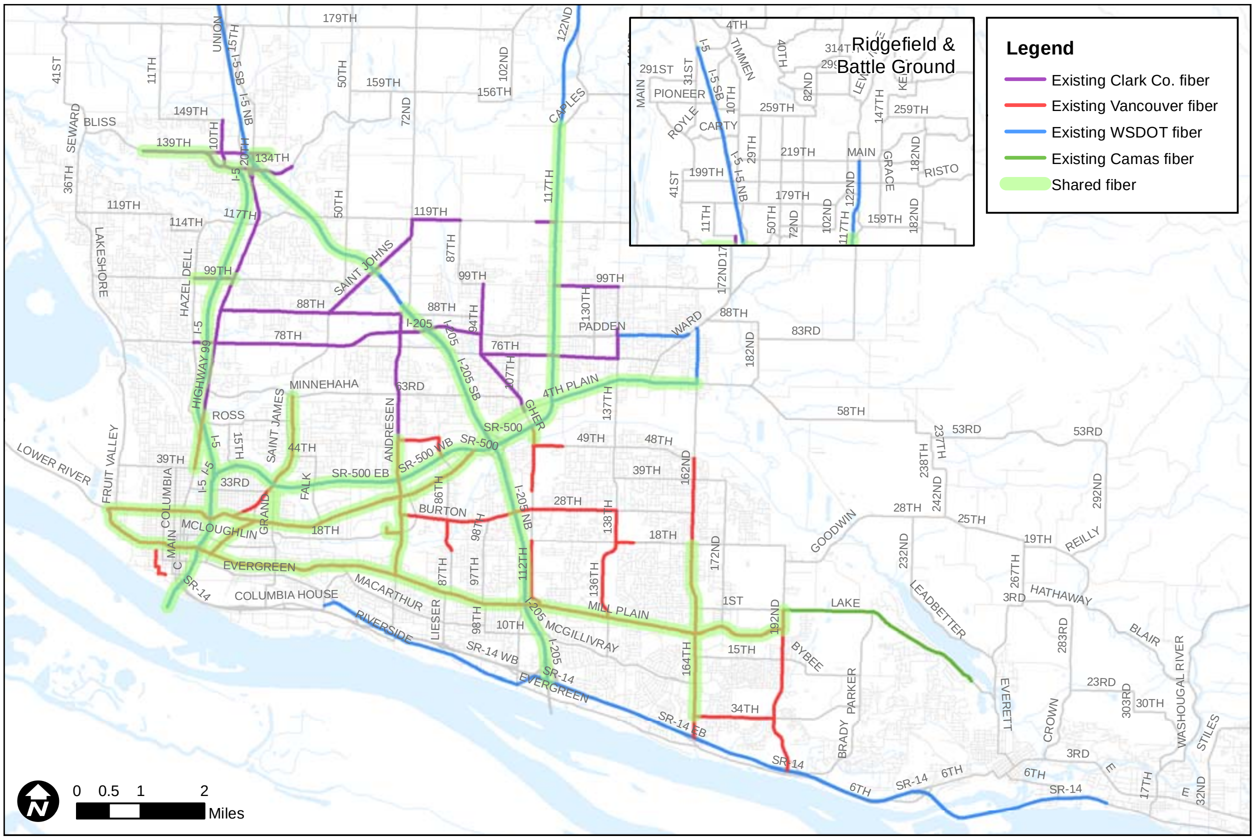

Figure 2-5 Regional Shared Fiber

Fiber sharing is coordinated through a permit process. This process is documented in the Communications and Interoperability Agreement what was put in place in July 2006, and it authorizes the partner agencies to enter into fiber assets sharing agreements.

At the time of this plan, 29 permits affecting 101 miles of fiber were active sharing fiber between 8 agencies. Current fiber sharers and potential opportunities are shown in Table 2-1.

Table 2-1 Agency Fiber Sharing

Agency Fiber Sharing			
Agency	VAST Partner	Currently Sharing	Future Sharing Opportunity
City of Camas	X		
City of Vancouver Transportation	X	X	
Clark County Transportation	X	X	
C-TRAN	X	X	
RTC	X	X	
WSDOT	X	X	
City of Vancouver Fire Department		X	
City of Vancouver Information Services		X	
City of Vancouver Information Technology		X	
City of Vancouver Police Department		X	
Clark County Information Services		X	
Clark Regional Emergency Services Agency (CRESA)		X	
Clark County Public Works			X
Other Cities (Battle Ground, Washougal, etc.)			X

2.4 INFRASTRUCTURE NEEDS

Based on the existing network conditions defined above the following gaps and needs have been found:

- Several corridors in the region need to be replaced due to low quality fiber or low bandwidth.
- New, planned fiber installations are needed to extend current network, connect additional ITS devices and to create redundant paths.
- Clark County depends on the City of Vancouver and WSDOT's fiber networks to establish connection between the County operations center at the Clark county Public Service Center (PSC), Operations Center 78th and St. Johns, and County field assets. Several arterial segments exist that are not currently identified as planned fiber locations could be used strategically to create network redundant paths.
- Agencies are currently defining their own standards for fiber installations. The region would benefit from a set of minimum standards for fiber installations including:
    - Conduit sizes and numbers
    - Fiber counts
    - Installation
    - Equipment
- Regional partners have a central location for storing and retrieving network information and OSP Insight is considered as the database of record for the regional fiber infrastructure, but has a backlog of project data not entered in the database. Current efforts to add information and improve accuracy of the database should be continued.

3 NETWORK ARCHITECTURE

The purpose of the communications network is to connect different systems in the regional transportation network. The National ITS Architecture, shown in Figure 3-1, can be used to identify the different systems and communication types that connect them. According to the architecture, systems are categorized as centers, travelers, vehicles and field entities.

While the regional communications network exists largely to connect centers to centers and centers to field systems it also provides the means to establish connections to vehicles and traveler systems. In the ITS Architecture diagram the four sausage elements identify the communications network between systems. The regional use of fixed point to fixed point and field to vehicle communications, marked in the figure below, are discussed further in this chapter. Note that some Wide Area Wireless communications exist for transit management and are expected in the near future to support new and emerging technologies such as Connected and Autonomous Vehicles (CAV's).

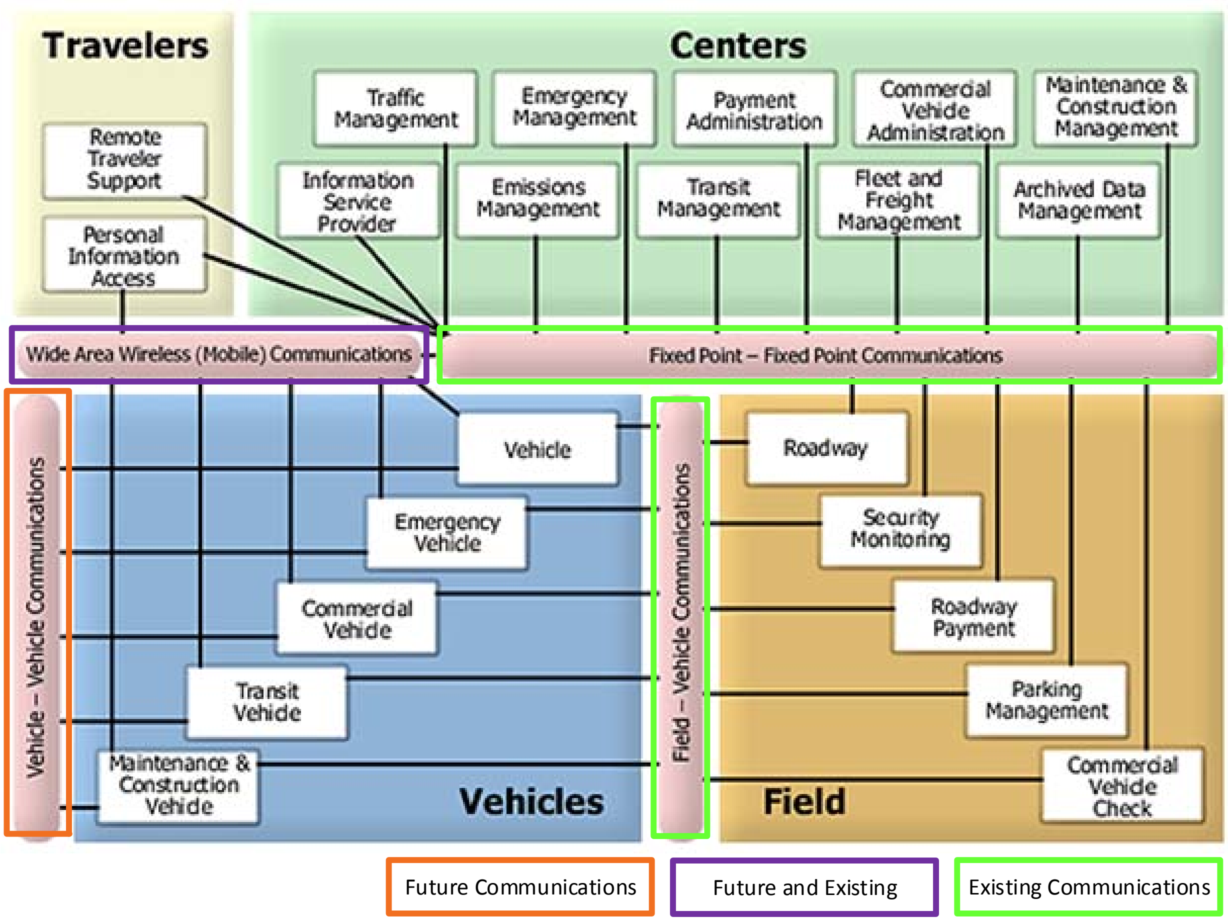

Figure 3-1 National ITS Architecture

3.1 FIXED POINT TO FIXED POINT COMMUNICATIONS

Fixed point to fixed point, namely agency centers to roadway devices, make up the majority of communications in the region. Agencies in Clark County, organize the systems in the network logically through the use of Virtual Local Area Networks (VLAN's). In both the City of Vancouver and Clark County the network is configured similar to the configuration diagram in Figure 3-2 to facilitate communications between agency centers or between agency centers and field devices. A layer 3 switch is used just outside of the internal network firewall, and layer 2 Gigabit switches (RUGGEDCOM RSG2200) are used throughout the external network. VLAN's are connected in sequence from one Gigabit switch to the next.

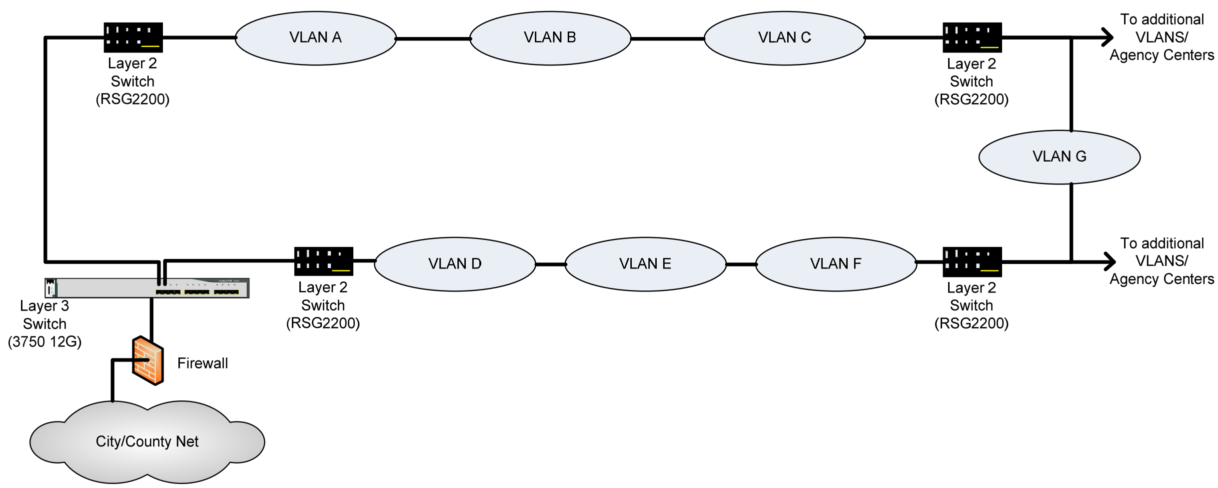

Figure 3-2 High-Level Network Configuration

At the time this plan was developed, Clark County was shifting from a switch based network to a router-based network. Layer 2 switches at four locations are being upgraded to Layer 3 routers (RUGGEDCOM RX1500). The new configuration shown in Figure 3-3 allows data to be automatically be re-routed between routers in the event of outages. Note the removal of the Layer 3 switch, whose functionality is now performed by the Layer 3 router.

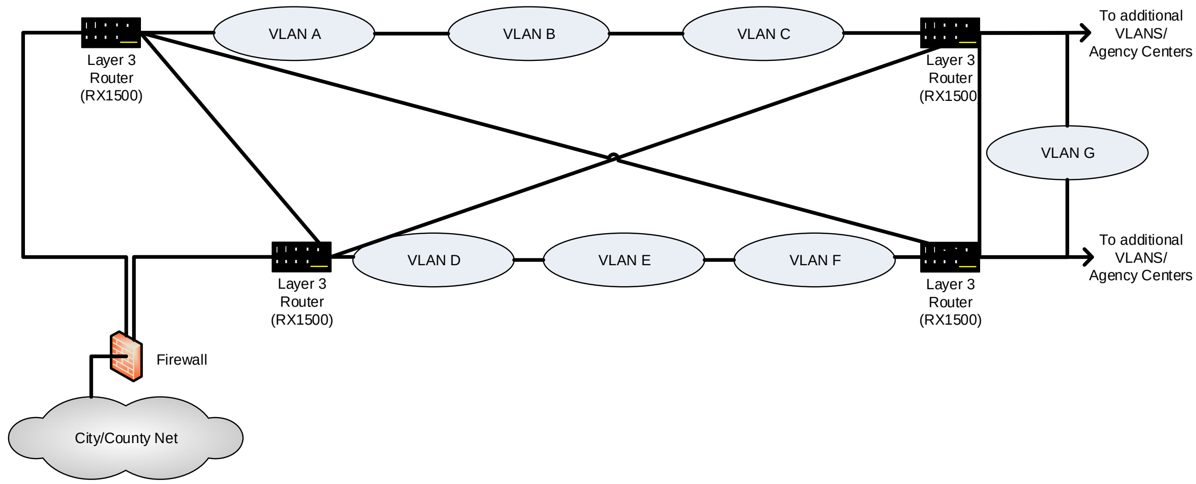

Figure 3-3 Layer 3 Routed Network Configuration

Agencies use VLANs to logically organize devices similar to a Local Area Network (LAN) where physical location is not a constraint. Each VLAN in the network contains a number of switches, typically at traffic signal cabinets, connected in series, as shown in Figure 3-4. At each traffic signal cabinet one or two switches are connected to a set of transportation devices including traffic signal controllers, detection devices, and surveillance devices. Switches can be configured as trunk or edge ports where trunk ports can pass information between switches and edge ports can only pass information within that VLAN.

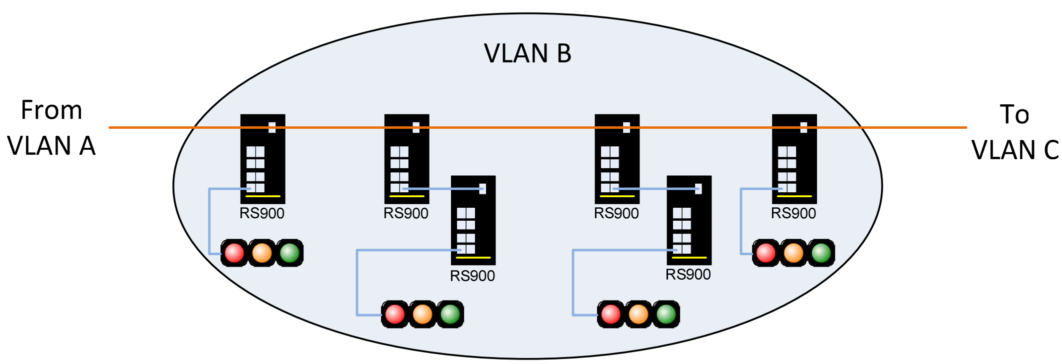

Figure 3-4 Typical VLAN Configuration

A large amount of the ITS systems in the region are based at signalized intersections. Figure 3-5 shows the configuration of a traffic signal and the typical ITS items that may be attached.

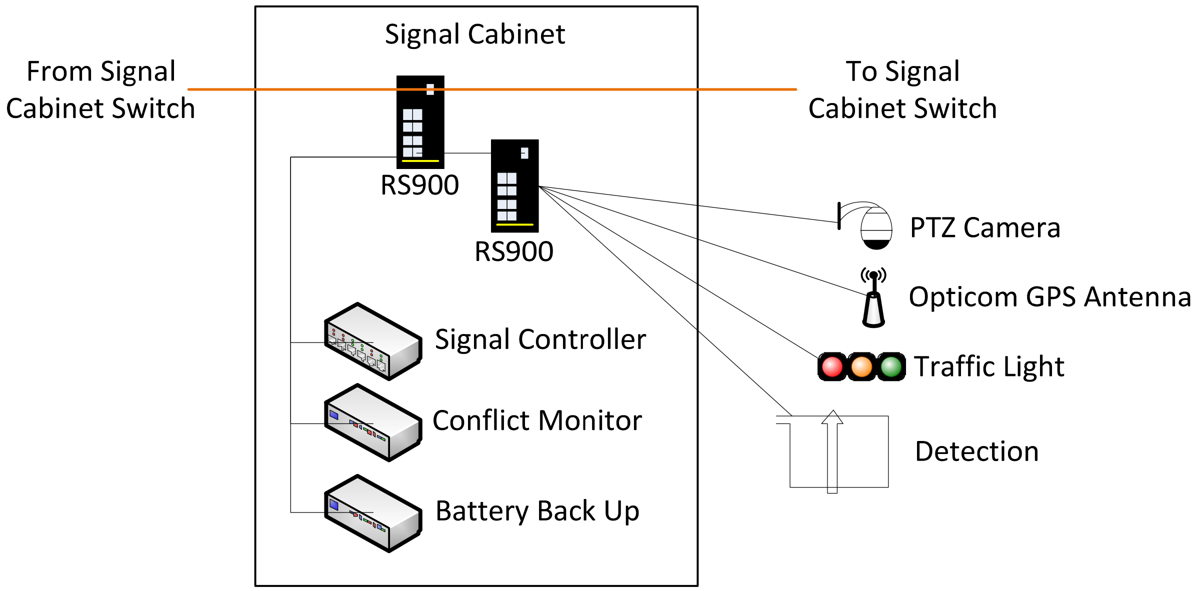

Figure 3-5 Typical Traffic Signal

While wired fiber connections are the preferred communications to ITS devices such as traffic signals, other media, including Ethernet radio links and dial-up CDMA modems, are used where fiber is not available.

3.2 AGENCY CENTER-TO-CENTER COMMUNICATIONS

A major subset of fixed-point to fixed point communications in the region are agency center to agency center communications. Connectivity of agency centers is important for the efficient operation and management of the traffic system and vital to access any jointly operated systems. The Regional Transportation Council, Clark County Public Service Center, WSDOT Southwest Region Center, and C-TRAN are connected to the fiber network. The City of Vancouver Operations Center is not connected to the network at this time; however, fiber is available on Fourth Plain Boulevard and connecting the facility is expected to occur in the near future.

Public safety offices co-located at (or near) agency headquarters locations are connected to the regional communications network. These include the CRESA 911 Center, located next to the Clark County Public Service Center and the Washington State Patrol (WSP) at the WSDOT Southwest Region Headquarters. While some limited fiber network connections support CRESA/WSP backup capabilities, for the most part, CRESA utilizes Clark County's Cat-5e Ethernet system for most communications. The Vancouver Police Department and the Vancouver Fire Department are also connected to the network at separate locations. In addition to the connected facilities, several unconnected facilities have been identified for future fiber network connectivity. These include maintenance facilities, transit centers and other public safety facilities. Connected agency centers are shown in Figure 3-6 along with other agency facilities in the region.

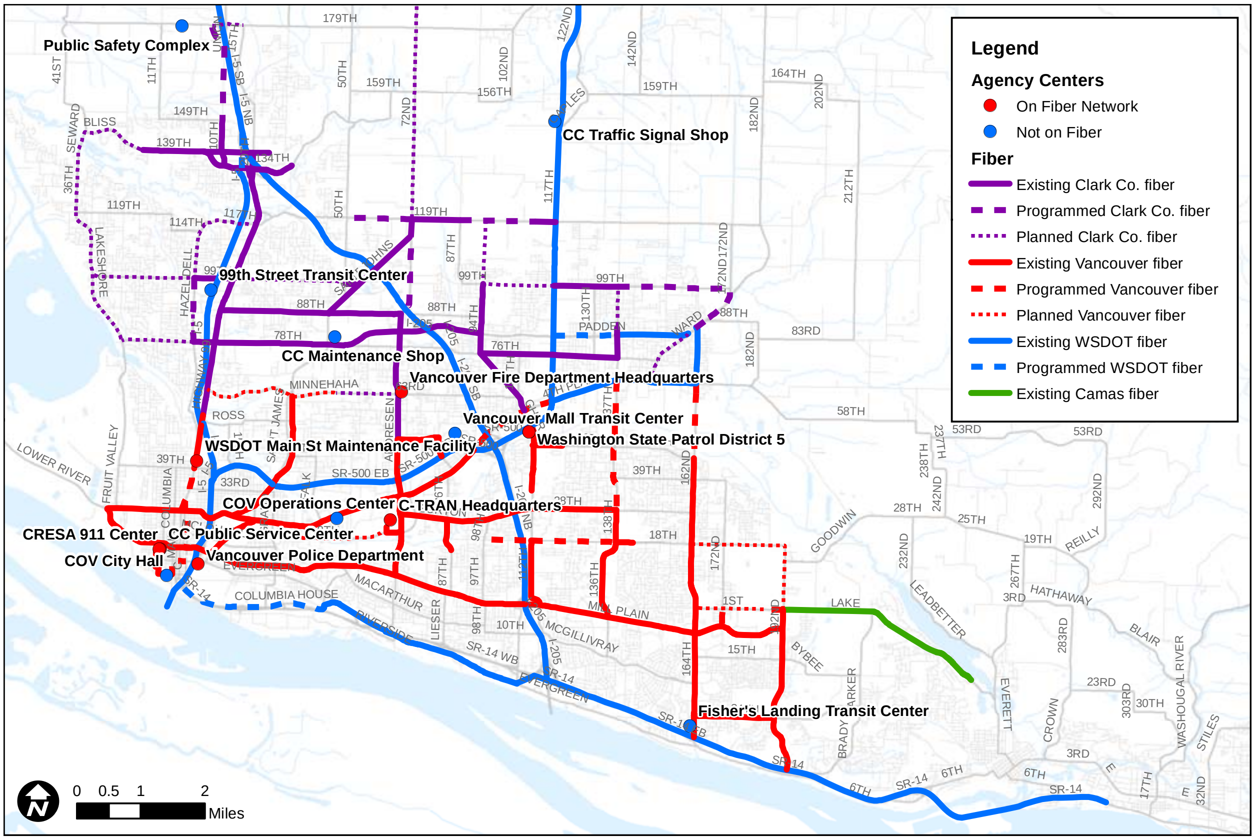

Figure 3-6 Agency Centers

3.3 FIELD TO VEHICLE COMMUNICATIONS

Field to vehicle communications in the region largely consist of emergency vehicle pre-emption and transit signal priority.

Emergency vehicle preemption is a system that aims to reduce traffic signal delay to emergency vehicles actively responding to an incident. Emergency vehicles in the region are equipped with Opticom infrared light emitters. Most traffic signals in the region are equipped with Opticom infrared receivers. The Opticom infrared system requires a line-of-sight infrared light to be received by a receiver at the traffic signal.

Transit signal priority (TSP) is a system that reduces the traffic signal delay for public transportation vehicles by prioritizing transit movements over other vehicle movements. While traditional TSP systems used an infrared light emitter and receiver, C-TRAN's TSP implementation uses an Opticom GPS radio. A select number of C-TRAN transit vehicles are equipped with Opticom GPS radio signal priority units. At the time of this plan, along Mill Plain Blvd. from 164th Ave to Fort Vancouver Way, 22 traffic signals were equipped with Opticom GPS Radio units. C-TRAN is currently in the early planning stages of three additional TSP corridors, on Fourth Plain Boulevard., Highway 99, and 164th Avenue, as well as expansion of TSP on Mill Plain Boulevard.

3.4 NETWORK ARCHITECTURE NEEDS

Based on the network architecture described above, the following needs were identified:

- As Clark County moves toward a router based, layer 3, network, the City of Vancouver and WSDOT should consider similar strategies for ensuring alternative paths between devices are available as networks grow.
- Redundant paths are needed from agency centers to field devices with layer 3 routing capabilities to prevent downtime during infrastructure incidents such as fiber cuts.
- A review and redesign of VLAN's are needed where improvements can be made to connect more VLAN's and VLAN members to the fiber network
- The proliferation of devices on the network requires agencies to ensure the distribution network is designed to responsibly use the growing number of IP addresses.
- Regional Preemption and TSP policies are needed to ensure compatibility between existing and future systems.

4 ADDITIONAL TRANSPORTATION SYSTEMS APPLICATIONS

ITS systems and devices that depend on the communications network such as traffic signals and detection devices have their own set of communications requirements and needs. The VAST region has made considerable investment in traffic signals, detection devices, surveillance devices, and traveler information systems. In this chapter, each of these specific applications are described and the corresponding communications network needs are presented to operate these systems at their fullest potential.

4.1 TRAFFIC SIGNALS

In the regional transportation system over 410 traffic signals are utilized to maintain the safe and efficient movement of people and goods. These traffic signals represent the core interaction between transportation professionals and roadway users.

The reliable operation and maintenance of these signals is highly dependent on the regional communications network. A majority of traffic signals in the region are directly connected to the fiber network, or indirectly through twisted pair copper cable, wireless, or through dial-up connection.

The City of Vancouver uses ATMS.now to operate approximately 220 traffic signals. Clark County operates approximately 120 traffic signals using ATMS.now, and WSDOT operates approximately 70 traffic signals using Streetwise as an ATMS. Partner agencies have adopted a standard of Naztec controllers and software for traffic signals. It is common in the region for agencies to time or operate traffic signals outside their specific jurisdiction and for cities not connected to the regional network, which allows for better signal coordination on arterials across agency boundaries. Figure 4-1 shows the location of traffic signals in the region.

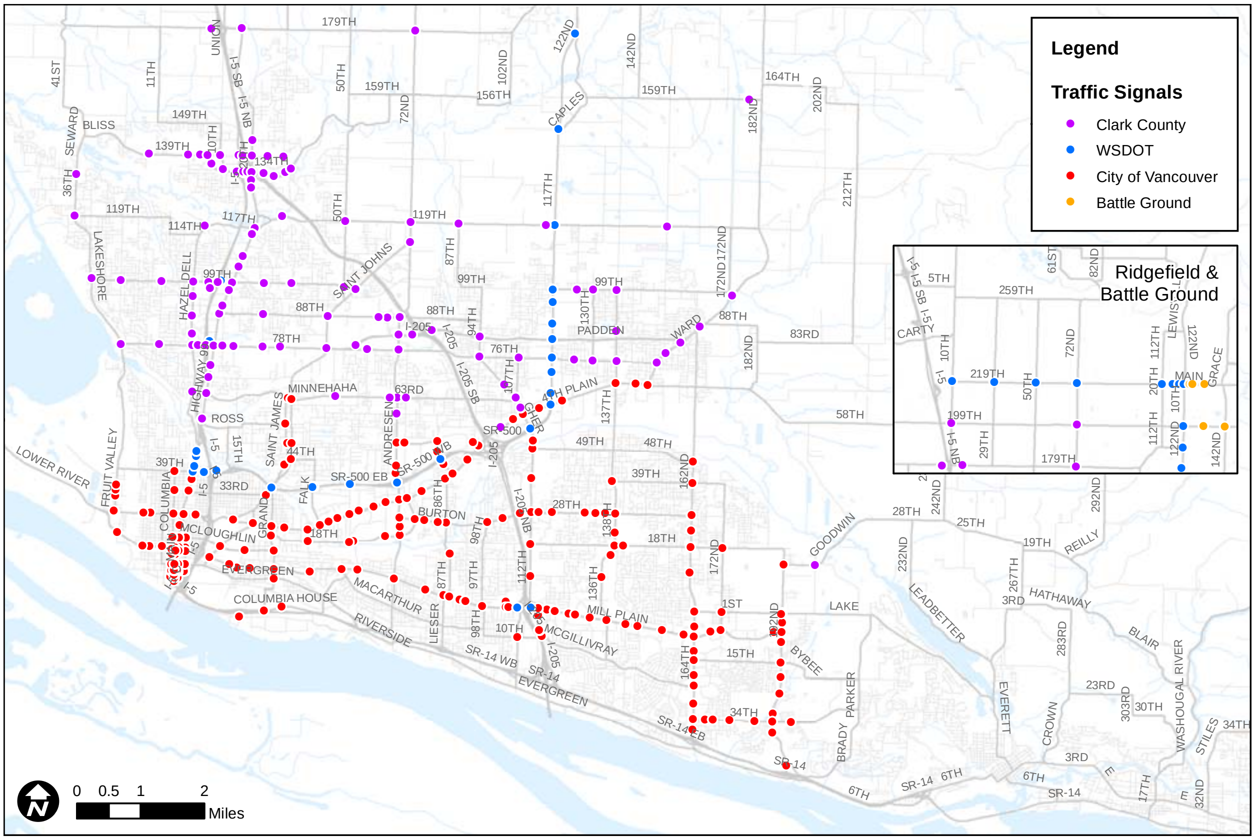

Figure 4-1 Regional Traffic Signals

In addition to providing safe, organized operation of street intersections, traffic signals and cabinets housing the equipment provide locations for a variety of ITS technologies and devices that connect back to agency centers through the fiber network.

Communications to these devices provides administrators with the ability to both remotely manage the devices and monitor the devices' performance. These technologies including current and future project plans are shown in the table below.

Table 4-1 Traffic Signal Technogies and Communications Requirements

Traffic Signal Technologies				
	City of Vancouver	Clark County	WSDOT	Communications Requirements
Remote Access	Some traffic signals are available through ATMS.now. Many downtown Vancouver traffic signals are not connected to the central system.	Most traffic signals are remotely accessible through ATMS.now	WSDOT is currently migrating to ATMS.now as a shared central signal system with Clark County. Some traffic signals are accessible through Streetwise.	Ethernet communications are used to connect signals to the fiber network where available. Remote Access is handled through central management programs including ATMS.now and Streetwise.

Traffic Signal Technologies				
	City of Vancouver	Clark County	WSDOT	Communications Requirements
Emergency Vehicle Preemption	Opticom Infrared receivers are available at all signals.	Opticom Infrared receivers are available at all signals.	Opticom Infrared receivers are available at all SR-500, SR-502, and SR-503 signals, and most other WSDOT signals.	Emergency preemption is typically performed at a local intersection level using the Opticom zone or global positioning system (GPS) detection method. At this time, only Infrared Opticom detection is enabled. The field equipment at the traffic signals will allow for future installation of GPS radio antennas by others. There are no plans for centrally based emergency vehicle preemption. * Required discriminators can support Preemption and TSP in both Infrared and GPS modes.

Traffic Signal Technologies				
	City of Vancouver	Clark County	WSDOT	Communications Requirements
Transit Signal Priority (TSP)	Opticom GPS is available on Mill Plain. Future work includes Bus Rapid Transit on Fourth Plain and filling in gaps on Mill Plain and adding TSP to 164th.	Future work includes Opticom GPS on HWY 99.	Future work may include Opticom GPS on WSDOT signals on Mill Plain and Fourth Plain.	Transit Signal Priority is typically performed at the intersection level, but managed through a Central Management System. At this time C-TRAN has outfitted transit vehicles with Opticom GPS systems. Future signals require a supported GPS receiver and discriminator to be installed. * Required discriminators can support Preemption and TSP in both Infrared and GPS modes.
Accessible Push-buttons		Future work includes pushbuttons at all traffic signals and Ethernet communications for monitoring and diagnostics	Accessible push-buttons are available at newest intersections only.	APS pushbuttons support IP communications and interface to a network switch.

Traffic Signal Technologies				
	City of Vancouver	Clark County	WSDOT	Communications Requirements
Battery Backups (Uninterruptible Power Supply - UPS)	Battery backups exist on all principal arterials.	Battery backups exist at 40 traffic signals now; 60 by end-of-year (2016), and 80 next year (2017) will be available.		Battery back-up units support IP communications and interface to a network switch.

4.1.1 TRAFFIC SIGNAL SYSTEM NEEDS

Based on the traffic signal system requirements above the following needs were observed:

- Moving to a shared traffic signal central system will allow agencies to share the benefits and costs of new modules and functionality.
- Upgrading traffic signal central system software to ATMS.now 2.0 is necessary to take advantage of more functionality and performance measures.
- Compatibility issues exist between agencies using different central systems. Only one central system can exist on a server.

4.2 DETECTION DEVICES

Detection provides critical information necessary for safe and efficient operation of the network. Detection drives the operation of traffic signals, monitors congestion levels on the freeways, and provides travel time information to operators and roadway users.

A wide variety of detection devices are deployed regionally to collect traffic data. The table below summarizes these current and planned detection devices and their uses in the region.

Table 4-2 Detection Systems and Communications Requirements

Detection Systems				
	City of Vancouver	Clark County	WSDOT	Communications Requirements
Loops	Loop detection is available at a majority of traffic signals for vehicle detection.	Future work includes retiring the use of loop detection.	Loop system is used on freeways for volume, occupancy, and speed data and travel time analysis.	Loop detectors support IP communications and interface to a network switch.
Radar	Wavetronix sensors are in limited use.	Future work includes microwave detection for volume, occupancy, speed, and vehicle length classification.	Wavetronix Sensors are used on freeways for volume, occupancy, and speed data and travel time analysis.	Radar detectors support IP communications and interface to a network switch.

Detection Systems				
	City of Vancouver	Clark County	WSDOT	Communications Requirements
Bluetooth	Bluetooth is available at 10 locations on Mill Plain and Andresen Road.	Bluetooth is available at 13 locations for travel time and Origin-and-Destination analysis. Future work includes 10 locations with Barburton TSO, and 56 locations with STEVE project. 6 portables	3 Bluetooth are available on SR-500 for travel time analysis, 10 portables	Bluetooth readers will support IP communications for permanent devices and interface to a network switch or CDMA modem access for portables.
Video	Uses video detection	Grid Smart overhead video detection is being used for traffic movement counts in select locations	Has video surveillance	Grid Smart cameras support IP communications and interface to a network switch.
License Plate Reader			Future work includes LRP systems on SR-502 and SR-503.	License Plate Readers support IP communications and interface to a network switch.
Temporary Data Collection Devices	The Region maintains a set of temporary collection devices including portable Bluetooth detectors (3 VAST, 10 WSDOT, and 6 Clark County detectors) as well as 3 Miovision video data collection devices.			Temporary devices use cellular communications and do no impact communications network requirements

Detection Systems				
	City of Vancouver	Clark County	WSDOT	Communications Requirements
Weather Stations		Pavement temperature sensors are available at 21 locations, and an Ice Sight detector is available for sensing icy conditions on bridges.	RWIS stations are available, but outside the region (Paradise Point and Cape Horn).	Pavement temperature probes support IP communications and interface to a network switch.

4.2.1 DETECTION DEVICE NEEDS

Based on the detection system uses above the following needs were observed:

- The ability to backhaul greater amounts of data to agency centers.
- The ability to feed the detection system data, especially Bluetooth, License Plate Readers, and Wavetronix, to the PORTAL Regional Data Archive for further analysis.

4.3 SURVEILLANCE DEVICES

Surveillance systems provide another key tool in monitoring the transportation system. Video camera systems provide visual monitoring of the transportation system and help understand issues that traffic data alone fail to solve. They can also aid in the identification of traffic incidents, and thus better equip first responders when arriving on scene.

4.3.1 SURVEILLANCE DEVICE NEEDS

Based on the traffic signal system requirements above, the following needs were observed:

- Approximately 200 PTZ cameras may be added to the system in the near future.
- Any amount of new cameras added to the surveillance system will require a significantly higher bandwidth. Agencies must ensure the communications system can handle the new bandwidth, and fiber communications are highly recommended.

- Video sharing between partner agencies is programmed.
- There is interest in sharing video resources with other public safety agencies, e.g. CRESA, Fire Department, and Police Department.

4.4 TRAVELER INFORMATION

Increasing congestion and limited roadway capacity require strategies that minimize the traffic incidents, reduce response time, and encourage the use of alternative transportation modes. Traveler information helps the public make informed decisions regarding trip planning and advises the public of incidents, safety hazards, weather events, and public emergencies. Transit traveler information increases the convenience and appeal of transit service.

On the roadway traffic information is provided for motorists through variable message signs (VMS) and highway advisory radio (HAR). WSDOT operates VMS signs along the I-5, I-205 and SR 14 freeways, and a HAR is located at I-5 and SR-501.

WSDOT provides online traveler information through the WSDOT Traffic website. This website gives roadway users access to traffic flows, traffic cameras, local roadway alerts, and weather information. A screen capture from the WSDOT Traffic and Cameras website zoomed in to the Vancouver area is shown in the figure below. In this image the camera at I-5 and Mill Plain Boulevard has been selected. Traffic camera images are updated at 1 minute intervals.

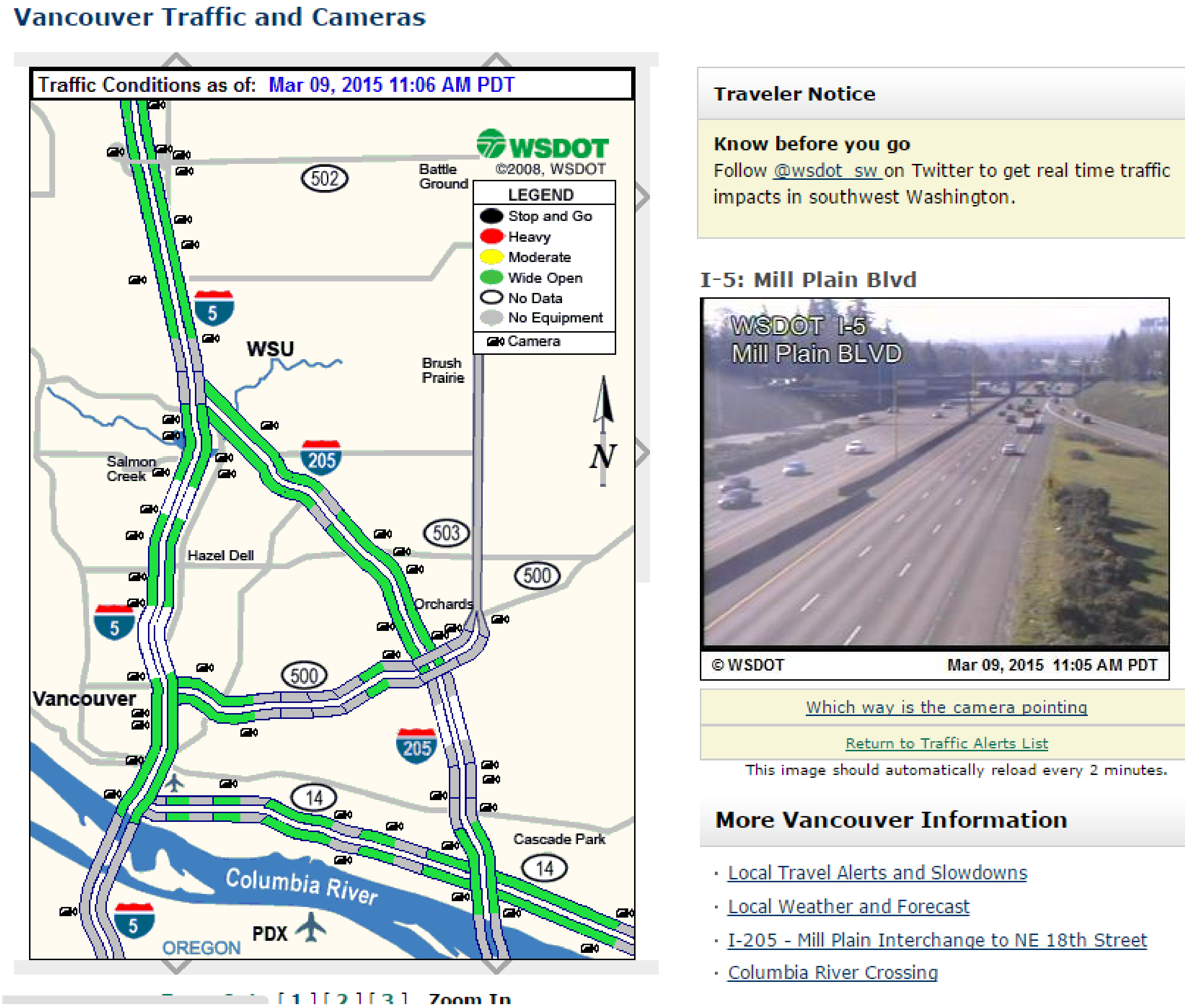

Figure 4-2 WSDOT Trip Check Website

An additional source of regional traveler information is public transportation trip planning. C-TRAN routes and schedule information are published to Google Maps by GTFS feed. This information can be used to plan trips in the Google Maps web application.

This service is also integrated with route and schedule information from TriMet in Portland, OR. This common interface allows transit trips to be planned that utilize both C-TRAN and TriMet service.

This current implementation does not rely on the regional communications network; however, as C-TRAN vehicles move to mobile data routers to transfer on-board vehicle information opportunities to use the regional communication network may emerge.

An example trip planned from Mill Plain and 96th Avenue to Franklin and 12th (Regional Transportation Council office) is shown in the figure below.

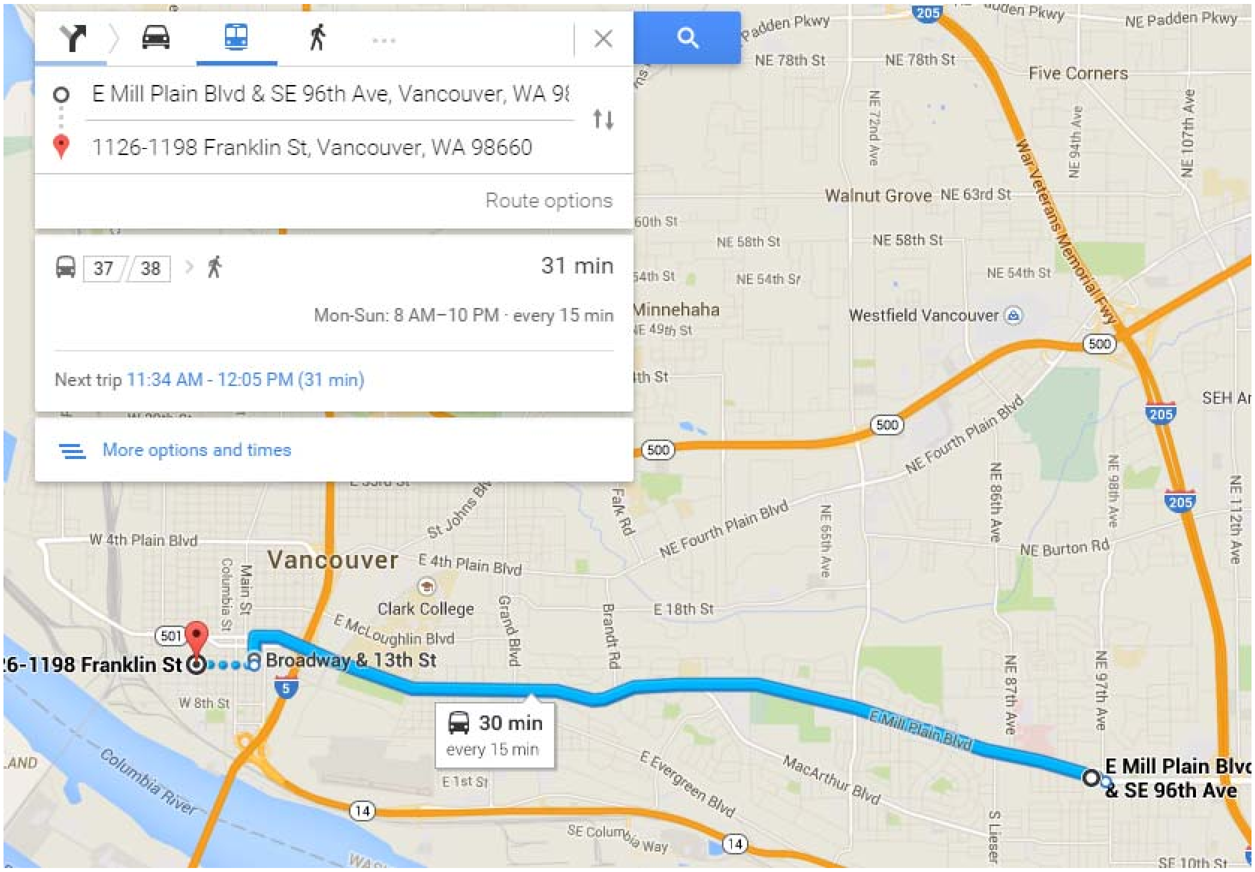

Figure 4-3 C-TRAN Trip Planning with Google Maps

In addition to being consumers of agency data, there is a potential for 3rd parties such as Google and Waze to provide information back to agencies. These 3rd parties can be sources for flow and incident data leveraging their broad data collection systems.

4.4.1 TRAVELER INFORMATION NEEDS

Based on the traveler information systems above the following needs were observed:

- Clark County wants to share camera information on its website available from ATMS.now. 3-5 second clips would be available through an ATMS.now module.
- WSDOT began displaying travel time to destinations in Oregon in 2015 with a bi-state travel time project between Oregon Department of Transportation (ODOT) and WSDOT and is the process of publishing travel time on the WSDOT traveler information page.
- VAST agencies should investigate opportunities for data sharing with private partners to facilitate expanded and improved traveler information.

5 COMMUNICATIONS NETWORK RECOMMENDATIONS

The following actions and strategies are recommended to the VAST agency partners to support the region's transportation communications network.

5.1 PHYSICAL INFRASTRUCTURE

5.1.1 REPLACE, REPAIR, AND UPGRADE FIBER ALONG CERTAIN CORRIDORS

The enhancement of the communications infrastructure quality and reliability should remain a high priority in the region. The routine end-of-life replenishment of field equipment schedule should be maintained. As funding opportunities allow, the region should continue to develop increased network quality and reliability by increasing fiber counts where possible and creating redundant paths and rings where needed.

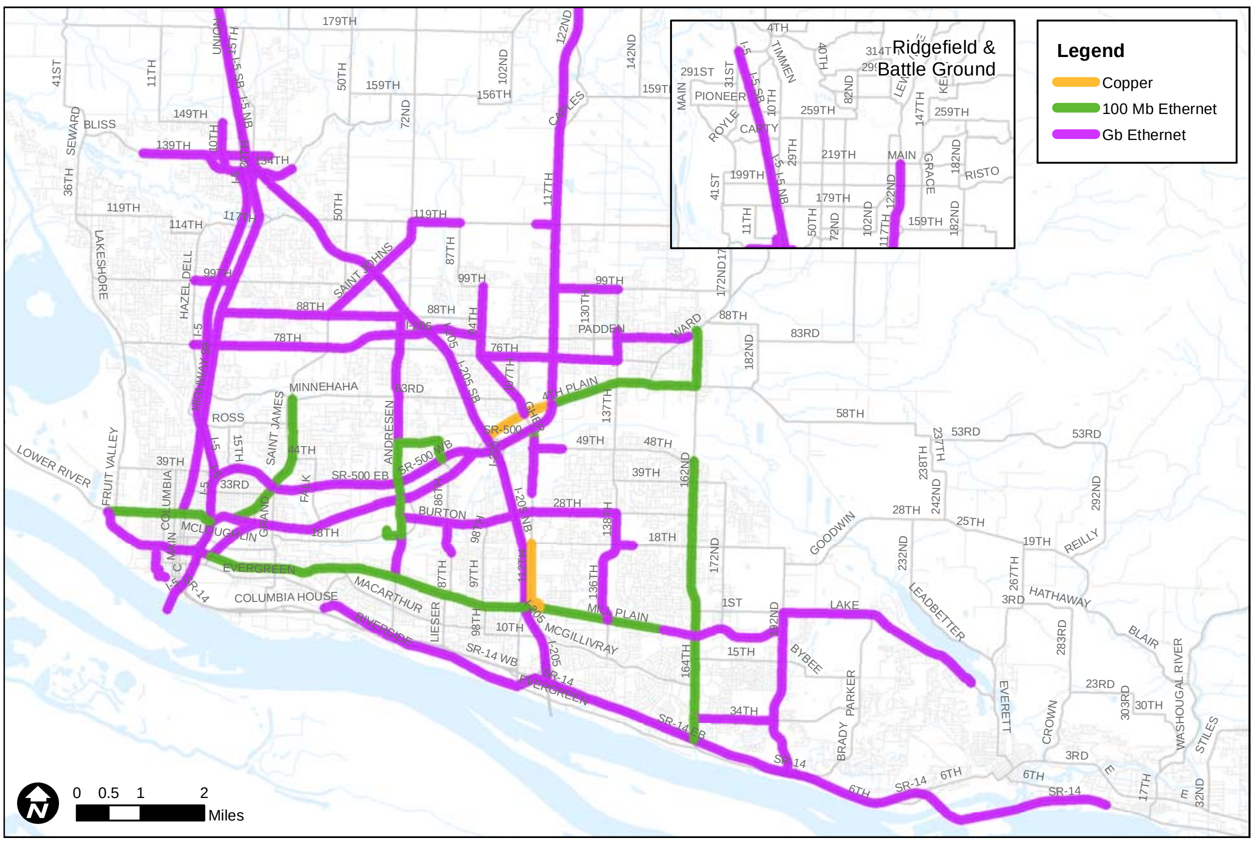

Figure 5-1 Corridor Improvement Locations

In Figure 5-1 corridor improvement locations are identified by bandwidth capability. A significant portion of the network in the City of Vancouver relies on 100 Mb Ethernet communications. While some of the corridors, such as Mill Plain, have Gb Ethernet trunk lines supporting the corridor, the VLAN's, traffic signals, and other devices are limited to 100 Mb Ethernet communications. The region should begin identifying corridors to be replaced and/or upgraded as indicated with copper or low bandwitch Ethernet.

Note that these recommendations do not consider capacity. Capacity recommendations are discussed in section 5.2.1.

5.1.2 COMMUNICATION ROUTES

In addition to repairing and replacing existing fiber corridors, it is important to maintain alternative communication routes in order to provide redundancy in the event of network infrastructure failure. In Figure 5-2 a set of network gaps are identified that if completed with fiber, additional redundant paths would be made available. For instance, Fruit Valley Rd. in west Clark County would provide an additional redundant path for Clark County field devices to communicate with the agency center at the RTC.

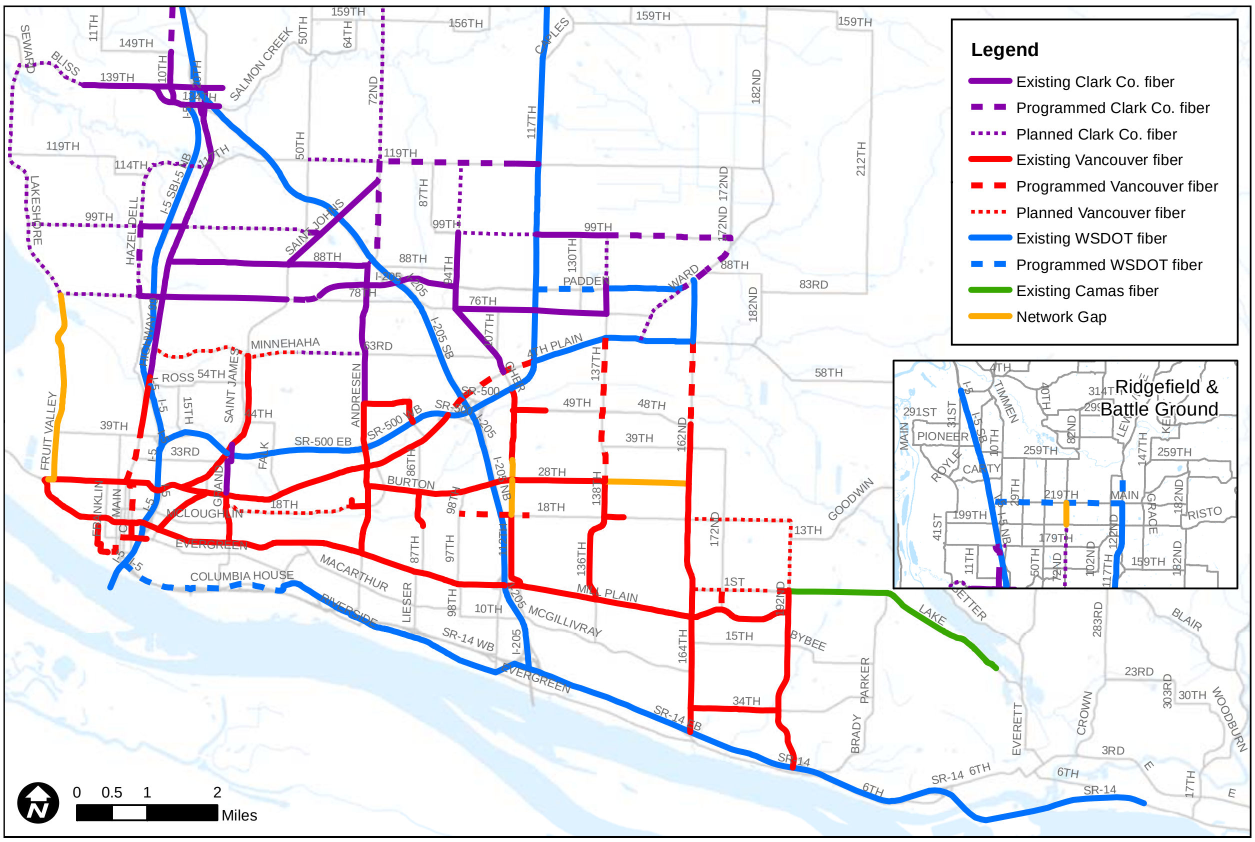

Figure 5-2 Redundant Communication Routes

5.1.3 NETWORK TRANSPORT LAYER

Clark County has recently completed updates to its communication network to add layer 3 routers in key locations. These layer 3 routers have the ability automatically reroute network traffic in the event of a down communication route. At this point the City of Vancouver and WSDOT rely on layer 2 switches that are unable to automatically reroute network traffic in such an incident. As Clark County continues expanding their router based network, the City of Vancouver and WSDOT are also considering similar strategies for ensuring alternative network paths between devices are available as networks grow.

Figure 5-3 identifies potential layer 3 router locations that would provide this redundant communications ability to the City of Vancouver and WSDOT.

5.1.3.1 VLANS AND IP ADDRESS SUPPORT

A review and redesign of VLANs are needed where improvements can be made to connect more VLANs and VLAN members to the fiber network

The proliferation of devices on the network requires agencies to ensure the distribution network is designed to responsibly use the growing number of IP addresses.

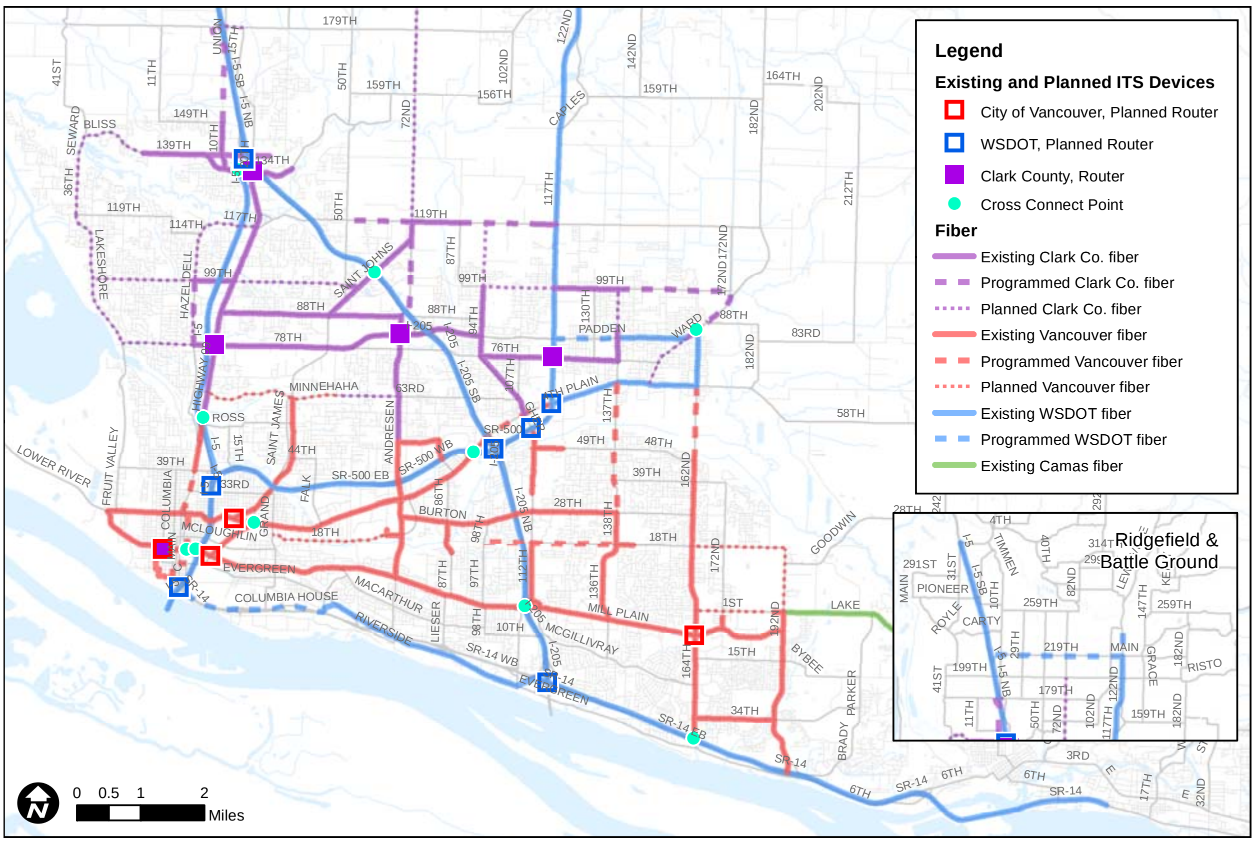

Figure 5-3 Existing and Planned Network Backbone Devices

5.1.4 INSTALLATION AND DEPLOYMENT

Increasing the communications capabilities of the regional network is important to future proof system and meet the bandwidth and fiber needs of new systems and projects. Figure 5-4 defines the minimum fiber counts that should be installed in the Clark County region to meet these needs. In most cases the minimum number of fibers to be installed in the region should be 48 fibers. In areas closer to the downtown core a minimum of 96 fibers should be installed. Agencies performing fiber installation or repair on major arterials should consider using at least 144 fibers.

In the event that fiber is not to be installed during a project, agencies should continue to consider laying conduit along project paths to allow for future fiber installations.

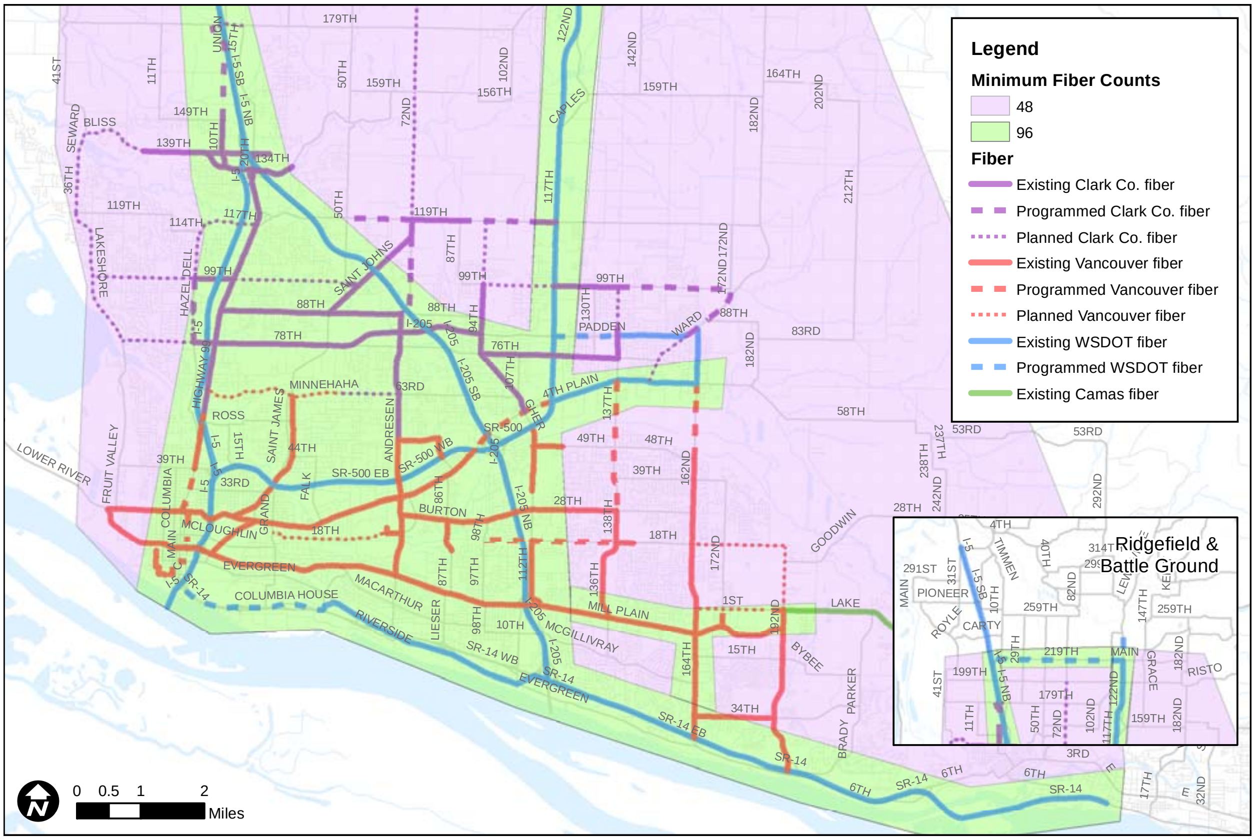

Figure 5-4 Regional Fiber Minimums

5.2 NETWORK INFRASTRUCTURE DOCUMENTATION

5.2.1 DOCUMENT CURRENT FIBER CONDITIONS AND OTHER COMMUNICATIONS INFRASTRUCTURE IN OSP

OSPInSight (OSP) is an extension for ArcGIS systems to combine database and spatial analysis tools to manage fiber optic networks. OSP was chosen by the VAST group as the database-of-record for maintaining up to date fiber network data. Capturing the latest changes in the fiber network is important if OSP is to be a database of record and planning tool.

Currently a backlog of regional OSP updates exists relating to fiber network projects and fiber sharing permits. Recording these updates in OSP is necessary to bring the database up to date. In Figure 5-5 the fiber documented in OSP is shown overlaid on the existing fiber network. Where the existing fiber is not overlaid by documented OPS fiber, there are data missing in the OSP database.

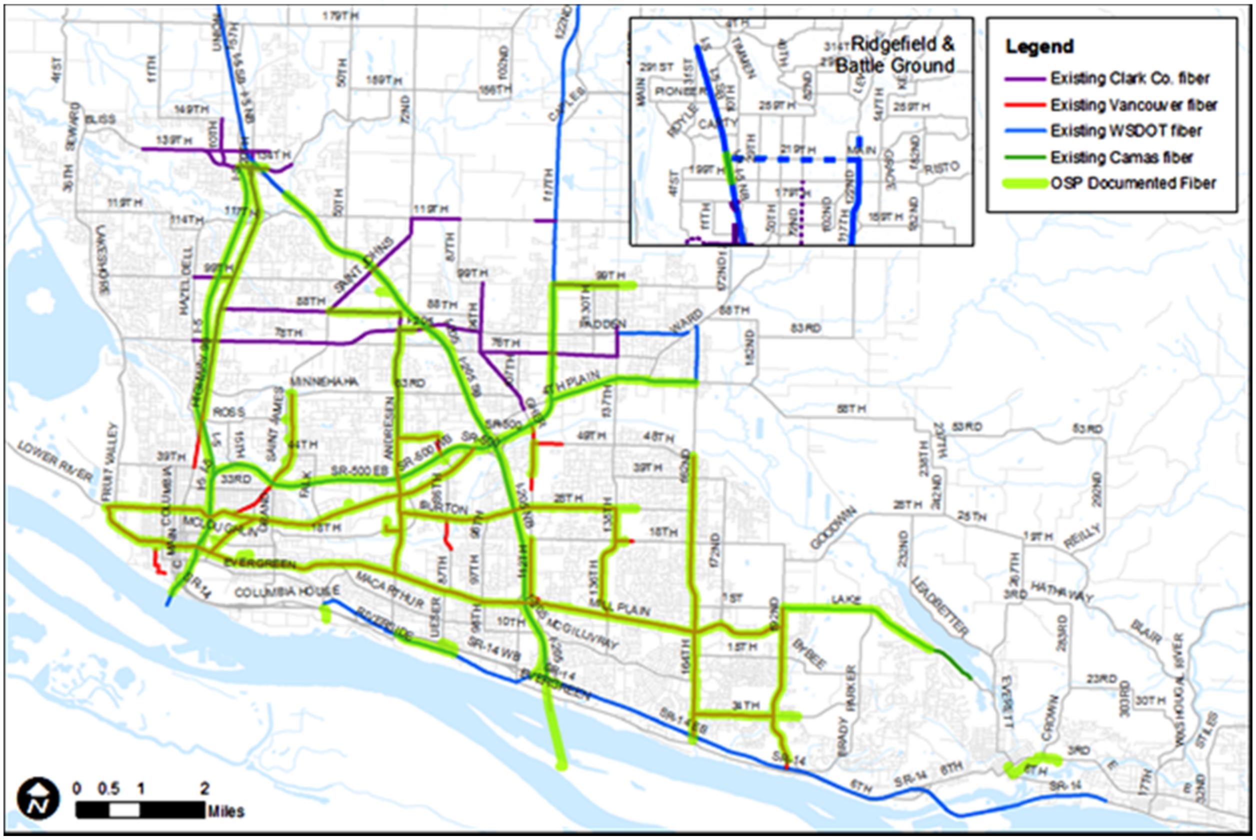

Figure 5-5 OSP Insight Documented Fiber

Partner agencies have noticed that recording recent fiber network changes in OSP is an unfamiliar process with no clear rules on what data should be collected and maintained in OSP. There is a need for standards to be created for what data should be maintained in OSP, and best practices identified to streamline the process.

Additionally, accurate information in OSP can drive decisions on where to prioritize fiber upgrades. While upgrading fiber media and bandwidth is an important long term goal for the region, it is important to find segments with capacity constraints and plan capacity increases or identify alternate routes. Agencies need to collect documentation in the form of plans, as-builts, and contractor changes need to be captured and entered in OSP going forward.

Agencies should agree on an approach for a single point of entry to update and maintain the database as well as a funding strategy for ongoing support of OSP.

5.3 SERVICES

5.3.1 PORTAL DATA ARCHIVE

Portal is the transportation data archive for the greater Portland, OR and Vancouver, WA area. Portal exists to assist regional transportation partners in archiving data and to create tools to analyze system performance and inform decision makers.

Currently, VAST partners, C-TRAN, WSDOT, and Clark County are working to provide data to Portal. C-TRAN is developing a process to export Computer Aided Dispatch and Automatic Vehicle Locations (CAD/AVL) into Portal. C-TRAN will use Portal to analyze transit performance by leveraging existing CAD/AVL data visualizations developed with TriMet.

VAST agency partners are working with Portal to allow arterial Bluetooth travel time data to be consumed by the archive. Clark County will use Portal to develop visualizations for travel times and origin and destination reports.

VAST should continue to work towards delivering regional data to Portal through the ITS data network. VAST should then continue to find opportunities for new data sources to be pushed into the data archive. Specifically, VAST should work with Portal to develop Congestion Management Plan reporting capabilities. The ability to feed the detection system data, especially Bluetooth, License Plate Readers, and Wavetronix, to the PORTAL Regional Data Archive for further analysis.

5.3.2 THIRD PARTY DATA SHARING

3rd parties such as Google and Waze are currently working to provide travelers with journey planning information such as trip routes, estimated travel times, and congestion or incident warnings. These companies gather data from cell phone data providers, GPS receivers, and public agencies, and combine these data to provide accurate information to travelers.

Agencies should consider partnerships with these and other 3rd party data providers to release transportation data such as traffic flows, travel times, traffic signal phasing. Further, agencies should use these partnerships to acquire flow and incident data from the 3rd parties in return.

5.3.3 JOINT SYSTEMS

Jointly operated systems offer partner agencies benefits in cost sharing, shared operation opportunities, and reduce the communications requirements. While the region is currently exploring video sharing systems, opportunities for other shared systems should be identified and the advantages and disadvantages determined.

Possible systems that should be considered for joint administration include:

- **ATMS.now** – Both Clark County and the City of Vancouver use ATMS.now for managing traffic signals in the region, however, they are currently separate management systems. WSDOT is migrating to a shared ATMS with Clark County and several of the small cities have agreed to also be a part of the same system. Clark County has been working to expand the functionality of ATMS.now by working with the vendor, Trafficware, to develop Arrival on Green (AOG) reporting. These agencies in the region can benefit from new ATMS.now functionality by managing their traffic signals under Clark County's central system, but agencies may need to upgrade to ATMS.now 2.0 (and generally stay consistent with all other partner agencies), to be able to take advantage of this advanced functionality.

- **Rugged Com Network Management Server** – The Rugged Com NMS provides Clark County extensive visibility into the operations of the communications network. NMS allows agencies to monitor routers and switches for performance, and identify overloaded network infrastructure. Clark County would be able to let other agencies share the NMS for monitoring their networks, but partner agencies would need to acquire their own licenses to support this. There may be an opportunity to pool these licenses regionally.

- **VDG Sense video sharing** – While the pilot project to share video between Clark County, WSDOT, and the City of Vancouver, is moving forward, agencies should plan to continue to add traffic surveillance cameras to maximize the potential. Further, traffic agencies can work with other agencies, i.e. public safety, fire, and police, to share video in the event of traffic and other incidents requiring responses from multiple agencies.

  Approximately 200 PTZ cameras may be added to the system in the near future. Any amount of new cameras added to the surveillance system will require a significantly higher bandwidth. Agencies must ensure the communications system can handle the new bandwidth, and fiber communications are highly recommended.

- **GTT Opticom CMS Server** – Currently all agencies in the region are using GTT Opticom systems for emergency vehicle pre-emption. C-TRAN, having completed a Transit Signal Priority Pilot project in 2012, is planning on using TSP on three additional corridors in the near future. TSP systems require significant set up using a central management server (CMS), especially during initial configuration. Agencies could benefit from managing all TSP operations from a single CMS. Regional Preemption and TSP policies are needed to ensure compatibility between existing and future systems.

As jointly operated systems provide benefits to partners, and agencies depend more on the systems it becomes increasingly important to make efforts to support, maintain, and keep these systems online. Shared systems use should include agreements between partners on management and incident response.

5.4 ADDITIONAL COMMUNICATIONS INFRASTRUCTURE COMMITTEE TOPICS

The VAST partner agencies have a long history of successfully working together to improve the regional transportation network. Throughout the development of this plan a number of topics were identified that, while outside the scope of this plan, are important to the future collaboration of agencies in the region. To facilitate such collaboration and plan for future changes in transportation, upcoming CIC discussion should include:

- **Standards** – Agencies are currently defining their own standards for fiber installations. The region would benefit from a set of minimum standards for fiber installations including:
    - Conduit sizes and numbers
    - Fiber counts
    - Installation
    - Equipment

- **Fiber Tube Assignment Policies** – The VAST Partner agencies may want to revisit the Fiber Tube Assignment Policies. Agencies may want to standardize on fiber tube assignments for sharing purposes, or simply, document how each agency is assigning tubes.

- **Asset Management** – VAST's continued success in regional collaboration has made progress in increasing the regional transportation system infrastructure. However, as some of these systems are nearing end of life and others need repairs, agencies are finding problems locating funding sources for management of transportation communications assets. Currently Clark County is the only agency that is required to set aside funds for Early Retirement and Replacement (ER&R) when purchasing new equipment. The VAST CIC should make a priority to identify strategies for funding the ongoing maintenance and replacement of communications infrastructure.

- **Fiber Sharing Policies** – The current fiber sharing permit process has been largely successful in facilitating the sharing of fiber network resources between partner agencies. New permits have been proposed that fall outside of the intent of the original permit process. The current permit process should be documented and new rules should be developed for new permit types with an emphasis on flexibility. Additional policies need to be developed between the lessor and lessee when the borrowing agency needs fiber repair in an accelerated time frame. VAST CIC may also want to review the "first come, first serve" basis of the fiber sharing policy, particularly when it comes to non-VAST member agencies or departments borrowing fiber on constrained corridors.

- **Connected and Autonomous Vehicles** – Connected and Autonomous Vehicles (CAV's) represent some of the emerging technologies that traffic agencies must prepare for. CAV'S include both connected vehicles that include communications technologies to communicate with roadway devices and other vehicles, and autonomous vehicles that utilize a number of on-board sensors to assist a driver or take complete control of driving responsibilities. Currently standards for these emerging vehicles types are still being developed. The CIC should continue to follow these standards discussion and begin developing policies and projects that will future proof current systems (e.g. upgrading signal controller CPU's). Finally, any future discussions of Connected and Autonomous Vehicles should identify private partnerships with automobile manufacturers or software service providers.