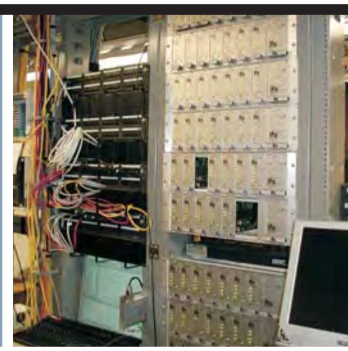
Spokane Valley
ITS Strategic Plan

May 2011



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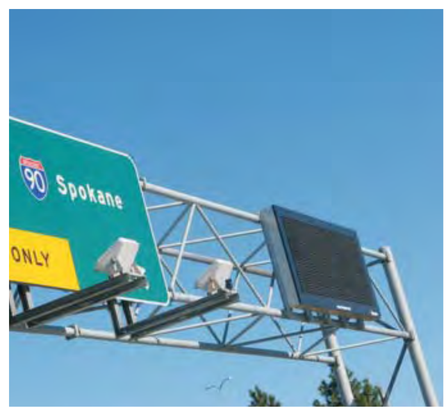

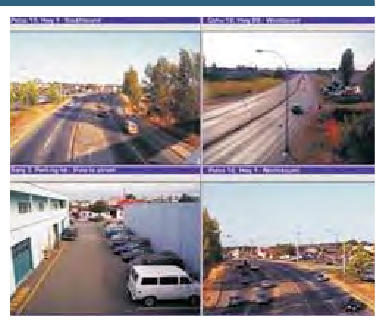

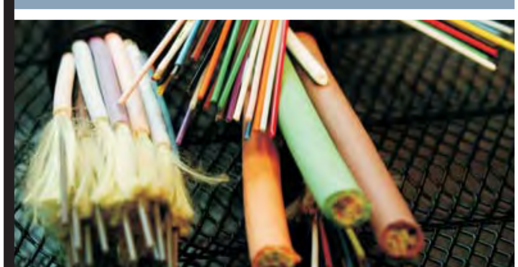

CITY OF Spokane Valley

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ITS STRATEGIC PLAN

Prepared for:
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EXECUTIVE SUMMARY

This Intelligent Transportation Systems (ITS) Strategic Plan has been prepared for the City of Spokane Valley and will serve as the City's road map for future ITS projects, improvements and policies. This ITS Strategic Plan will be the first ITS plan that the City will adopt. The plan's purpose is to establish the need for ITS investments in the region, to identify relative priorities to direct ITS investment, define the framework and specific technology, and to identify specific projects to be deployed to address identified needs.

The City of Spokane Valley established a vision that was used as a basis for developing the ITS goals for the ITS Strategic Plan, which includes five key points: improve the safety and security of the transportation system, improve the efficiency of the transportation system, provide improved traveler information, deploy functional and cost effective infrastructure, and integrate ITS projects with local and regional partners.

Existing Conditions. The City of Spokane Valley has made modest investments in ITS components. Of the 99 traffic signals within the City limits, 28 use an IP-based protocol connected to the City of Spokane Valley through a combination of fiber optic and wireless Ethernet and 14 are currently operated and maintained by WSDOT. The City currently has three CCTV cameras maintained and operated by WSDOT in addition to the nine CCTV cameras on I-90 owned by WSDOT. The City is a partner in the Spokane Regional Traffic Management Center (SRTMC).

Assessment of Needs. Needs and priorities were identified through evaluation of existing conditions and meetings with the City's traffic engineers. The top needs included upgrading the communication system and providing a traffic surveillance and real-time data gathering system that would allow for remote monitoring by SRTMC staff and the City's operations and engineering departments with the capability for providing real-time information.

Recommendations. It is recommended that the City of Spokane Valley leverage the existing signal cabinets by using hardware that is both flexible for future development and established in the region. The plan assumes a ten year phased implementation with the following prioritized project objectives:

- Upgrade/Install Fiber Optic Network
- Information Dissemination
- Installation of ITS Devices

The projects may be implemented by corridor or as part of a system implementation process as funding allows.

INTRODUCTION

An Intelligent Transportation Systems (ITS) strategic plan incorporates advanced technology into traffic management and operation facilities by installing or upgrading signal control, vehicle detection, traffic monitoring, and computer equipment. Traffic departments utilize ITS technology to increase efficiency and safety on the travelled roadways. The technology allows for improved traffic mobility and quicker response to the varied traffic conditions that occur within the roadway network. An ITS system also facilitates coordination between adjacent and regional agencies for seamless roadway management.

ITS technologies provide additional information and services while increasing performance of the existing functions. All of this will help improve the mobility of people and goods using the existing infrastructure and has the potential for future savings. Therefore, the deployment of ITS in a strategic manner will allow advanced technologies and management techniques to improve safety and efficiency. This document presents a strategic plan for the deployment of ITS equipment and infrastructure in the years to come.

This plan can be used in conjunction with new roadway construction, developer mitigation, and grant funding opportunities. With the installation of ITS technology, it is necessary to invest in the operations and maintenance of the new system to keep the traveling public safe and the roadway operating efficiently.

The City of Spokane Valley is located in Spokane County, Washington. It is the seventh largest city in the state. Spokane Valley’s population is 90,210. Nearby cities include Spokane to the west and Millwood to the north; and Liberty Lake to the east. The I-90 and Pines Road (SR 27) interchange is a critical junction of major regional roadways within the City’s boundaries. These routes are major arterials and are used as alternate routes during congestion or emergencies. Currently City signal maintenance and operation is provided primarily by Spokane County. Signals along Pines Road (SR 27), Trent Avenue (SR 290), and ramps for I-90 are maintained by WSDOT. The majority of traffic signals within the city operate on a standalone basis. Select signal controllers within the City tie into the Appleway Boulevard or I-90 WSDOT fiber trunk line where data, video feeds, and operational monitoring can be managed at the SRTMC and Spokane County signal shop.

1 INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

ITS technology provides an alternative to capacity construction and complements existing infrastructure. ITS has proven to be a cost effective method of improving the safety and efficiency of traffic flow in cities across Washington State. ITS consists of a combination of technical tools, concepts, software, hardware and advanced communication technologies. ITS must be planned and implemented in an integrated fashion in order to achieve the desired safety and efficiency improvements to both existing and future transportation facilities. Examples of ITS applications include traffic signal management, transit signal priority (TSP), incident management, traffic management centers (TMC), traveler information systems and traffic data collection. Regionally, ITS has been implemented through completion of TMCs, installation of video for monitoring and signal operations, upgrading of signal controllers, and upgrading communications systems that can be tied to other agencies to share information and data.

1.1 BENEFITS OF ITS

A comprehensive ITS deployment will allow traffic engineers to monitor arterials and traffic signals for congestion issues and implement modifications in response. Data can be collected to better understand traffic patterns specific to the City and develop notification triggers and response patterns for more efficient operations, improving utilization of the existing roadway infrastructure. With the ability to monitor and respond, travel delays are reduced, emergency response times to incidents are improved, vehicle emissions are reduced, and safety and efficiency are improved. This will allow the City to continue to offer residents easy access to services and will encourage continued growth. The cost for ITS is relatively low compared to widening a roadway or intersection, yet can increase capacity of an existing roadway. Even with a widening project, ITS provides the ability to monitor and respond to congestion that overloads the roadway. A strategic ITS plan is critical in laying out a variety of ITS solutions that meet various concerns and to integrate future improvements on the existing roadway. This plan will assist in coordination with surrounding agencies to provide an integrated regional transportation improvement plan.

1.1.1 SPOKANE VALLEY'S ITS VISION

As part of the ITS Master Plan process, an ITS Vision was developed to document the desired outcome of ITS implementation for the City of Spokane Valley. The City's current mission is shown below.

"Our mission is to develop and maintain a safe and appropriate transportation system within our community …."

The City's ITS Vision was based on the desire to continue to strive toward the ideals described in the mission statement. Five fundamental components to the ITS Vision were identified and are listed below.

The City of Spokane Valley's vision for ITS technology applications is to:

1) Improve the safety and security of our transportation system

Objectives:

- Reduce frequency, duration, and effects of incidents
- Reduce emergency response times
- Reduce recurrent congestion
- Coordinate incident/security response with other local and regional agencies
- Provide redundancy for operations

2) Improve the efficiency of the transportation system

Objectives:

- Improve travel time for vehicles
- Reduce travel time variability
- Reduce fuel consumption and environmental impacts
- Provide database for systems evaluation and future improvements

3) Provide improved traveler information

Objectives:

- Provide information about construction activities
- Provide incident information
- Provide real-time road condition information including closures, speed and/or delay, and weather information

- Provide one location where customers can access all regional and local traveler information

4***) Optimize Use of Transportation Infrastructure***

Objectives:

- Deploy systems that fit in with future improvements
- Deploy systems that maximize the use of existing infrastructure
- Deploy systems that minimize need for maintenance and operational support
- Integrate deployments with other local and regional projects

5***) Integrate ITS projects with local and regional partners***

Objectives:

- Share resources between local and regional agencies
- Continue to coordinate and integrate projects with other agencies

1.2 ITS STRATEGIC PLAN

An ITS strategic plan incorporates advanced technology into traffic management and operation facilities by identifying new installations or upgrades required to signal control, vehicle detection, traffic monitoring, and computer equipment to meet the goals of the agency. Traffic departments utilize ITS technology to increase efficiency and safety by improving traffic mobility and enabling quicker response to the varied traffic conditions that occur within the roadway network. An ITS system also facilitates coordination between adjacent and regional agencies for seamless roadway management. Because of the range of volumes and complexity of both city and highway traffic, the Federal Highway Administration (FHWA) has outlined potential solutions that are available and potential benefits that can be gained from incorporating ITS technology.

The purpose of the Spokane Valley ITS Strategic Plan is to define the transportation framework and specific technology to implement on the roadways and in the Traffic Management Center (TMC). The plan leverages the City’s existing investments in the areas of transportation and telecommunication. This ITS Strategic Plan takes the available ITS technologies and applies them to Spokane Valley’s vision to produce a recommended program.

1.3 SPOKANE VALLEY'S CONNECTION WITH OTHER AGENCIES

Spokane Valley currently contracts with Spokane County to maintain and operate the City's traffic signals. The future plan is to reduce the City's dependence on the County for these services.

The Spokane Regional Transportation Management Center (SRTMC) is Spokane County's interagency traffic management center that is funded by the Cities of Spokane and Spokane Valley, Spokane Transit Authority, Spokane County, Washington State Department of Transportation (WSDOT), and the Spokane Regional Transportation Council. The SRTMC actively controls devices that are used to monitor and control traffic including closed-circuit television (CCTV) cameras, dynamic message signs (DMS), traffic data stations, and traffic signals. At the present, the SRTMC only has the capability to control devices that are connected to Spokane Valley's existing fiber optic network.

As identified in the Spokane Regional Transportation Council's (SRTC) *2007 Spokane ITS Implementation Plan Update*, the region will be coordinating with Idaho Transportation Department to implement a Center-To-Center (C2C) plan, connecting the SRTMC facility to neighboring ITD TMCs.

WSDOT currently has the capability to operate their signals at the I-90 interchanges within the City using the i2TMS central system software at the SRTMC facility. These signals communicate over an Internet Protocol (IP) using WSDOT's fiber network on I-90 to facilitate the sharing of traffic conditions through live video and connected traffic management software. The future expansion of this network is planned to allow TMCs throughout the region to be directly connected, improving mobility and emergency response.

1.4 PROJECT APPROACH

The approach for the ITS Strategic Plan is to assume that there is a ten year implementation timeline for the installation of a fiber optic communication network. This is a phased approach, separating the City into 11 ITS corridors for balancing the ITS device locations with the communication network.

The plan was developed to identify the types and locations of ITS applications the City should implement. The plan was developed with the following in mind:

- The plan allows for a systematic approach to identify the needs of the City and a plan for implementing the desired infrastructure.
- The plan assures that Spokane Valley plays an integral role in the various ITS initiatives in the region.
- The plan is developed based on the ITS deployment plan and objectives as outlined in both the National and Regional ITS Architecture. The SRTMC Operations Board has developed a regional plan for ITS implementation. This Strategic Plan builds off what has already been built or is planned to be built by surrounding agencies.
- The vision and plan for how to implement ITS in Spokane Valley will position the City more competitively with other jurisdictions for state and federal funding. Federal and state monies are available through grant funds that improve safety, reduce emissions and improve travel time for various modes of transportation. A commitment to an ITS Strategic Plan will demonstrate that Spokane Valley is a good candidate to receive grant money to implement well thought-out ITS solutions.

1.5 RECOMMENDATIONS

Based on the review of existing conditions, identified system needs, and City staff input, the following highlights the elements recommended for the City of Spokane Valley ITS Plan:

- Install fiber optic communication and field Ethernet switches that would enable communication between controllers, ITS devices, and traffic management centers in the region over an IP network
- Increase resources for traveler information dissemination
- Install additional ITS equipment for enhanced traffic management in the region
- Install system detection to provide traveler information and collect traffic data in the region for future planning and transportation improvement needs
- Maintain a current central system workstation to promote interagency cooperation and provide City staff with the ability to access field devices
- Perform a phased implementation of equipment upgrades to work with existing ITS deployment within the city and equipment deployed by other agencies

1.6 NEXT STEPS

A detailed evaluation of existing equipment is outside the scope of this plan. In order to provide detailed project recommendations, the current condition of the corridors and equipment would need to be evaluated separately to assess the City's need for traffic management and operations. A more detailed analysis of the existing infrastructure is required to determine current conditions, replacement timelines, and usable conduits at each signal location for additional equipment installation.

A full analysis of controller software and central system software should be performed with City staff being allowed to test a complete system for no less than a month. It is also important to schedule regular updates to the plan to take advantage of new technologies and deployment.

2 ASSESSMENT OF EXISTING CONDITIONS

Major transportation routes within Spokane Valley include I-90, Pines Road (SR 27) and Trent Avenue (SR 290) , making Spokane Valley accessible to the region. I-90, which carries more than 93,000 vehicles per day through this region, bisects the City providing east-west access to other destinations along the I-90 corridor and beyond. Pines Road (SR 27) serves as a major north-south connector through the City, providing access to surrounding neighborhoods such as Trentwood and Opportunity. Trent Avenue (SR 290), near the south boundary of the City, runs east-west parallel to I-90 and provides access to Spokane City to the west and Idaho to the east. Other major transportation routes include Sprague Avenue, Appleway Boulevard, Argonne Road/Mullan Road, Dichman Mica Road and Sullivan Road. The study area included as part of the review includes state highways, urban principal arterials and urban minor arterials within the City's limits as shown in Figure 1. This map also illustrates the City's roadway classifications and shows the City's location to its surrounding neighbors.

The transportation system serves citizens traveling to their jobs, schools, social activities, and recreational activities. It connects families with neighbors and neighborhood services. The transportation system is the backbone of an economy and a key component to economic competitiveness. It includes highways, local roads, sidewalks, bike paths, transit, and rail. As Spokane Valley is driven primarily by retail and industrial manufacturing, one key theme of this element is recognizing the importance of freight movement to the economy of Spokane Valley as well as being the economic engine for the Spokane County region. Improving the mobility of trucks and rail will support the efficient flow of goods and services, helping to strengthen Spokane Valley's economy.

The following Highways of Statewide Significance (HSS) are located within or adjacent to the City of Spokane Valley:

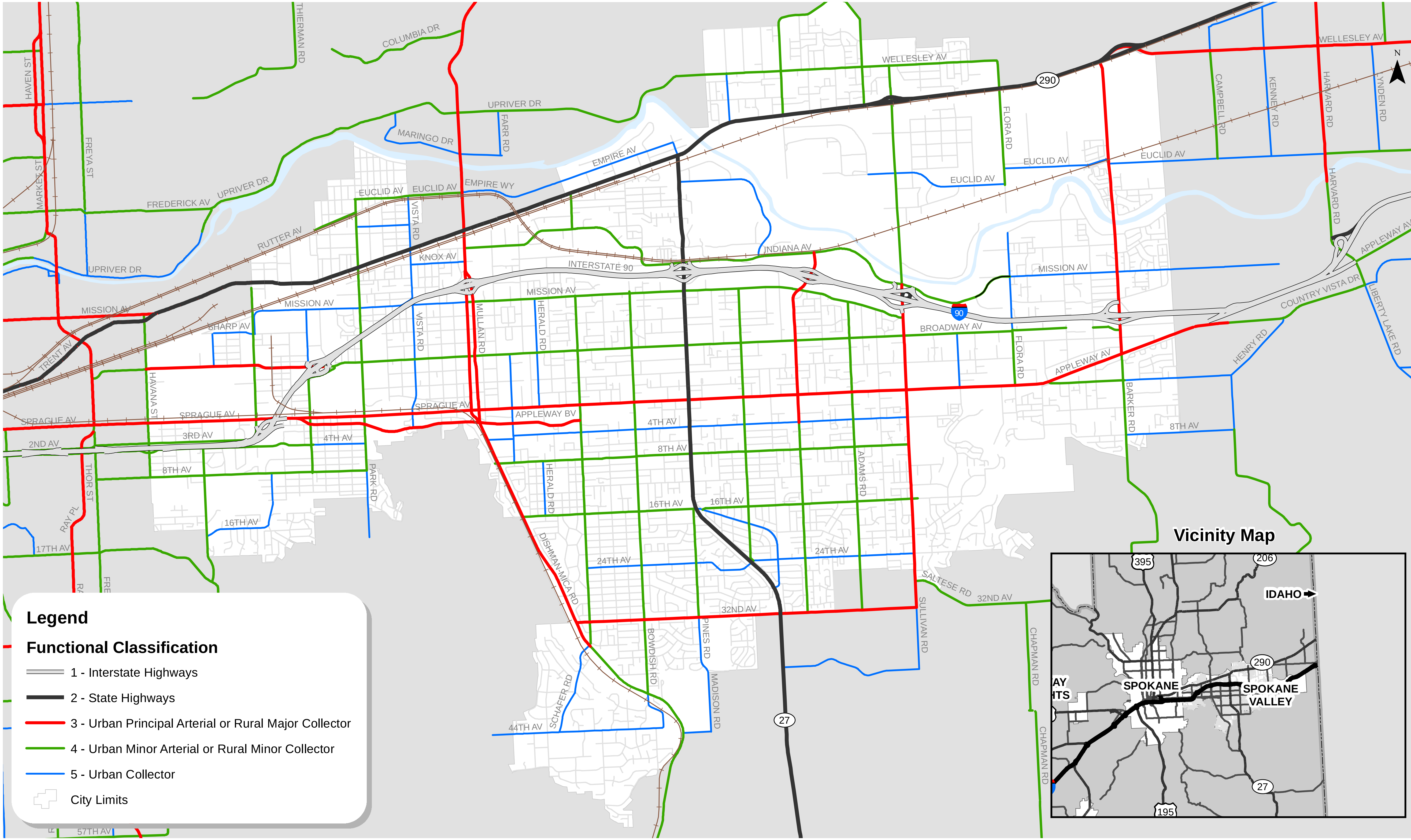
Interstate 90: The principal east-west freeway in the region, I-90 contains six (6) general purpose lanes in the Spokane Valley area. The City of Spokane Valley is directly served by seven major interchanges along I-90 located at Sprague Avenue, Broadway Avenue, Argonne Road/Mullan Road, Pines Road (SR 27), Evergreen Road, Sullivan Road, and Barker Road.

Pines Road (State Route 27): Pines Road (SR 27) contains four (4) general purpose lanes in Spokane Valley. One major Pines Road interchange is located at I-90. Pines Road provides connections between communities within Spokane Valley.

Trent Avenue (State Route 290): Trent Avenue (SR 290) contains four (4) general purpose lanes and one two-way left turn lane in Spokane Valley. Trent Avenue provides connections between communities within Spokane Valley.

The City's roadway system consists of a hierarchy of streets that provide access to residential and business areas, as well as through movement of vehicle trips originating and ending outside the City's boundaries.

When roads and rails intersect, the trains have priority. Spokane Valley is moderately impacted by at-grade railroad crossings on arterial roadways. Within the city, Fancher Road, Park Road, Appleway Boulevard, Montgomery Avenue, Pines Road (SR 27), Flora Road, Bowdish Road, University Road, and Barker Road cross the tracks at-grade and create significant conflicts between the railroad and the movement of people, either in vehicles or on foot, as well as the movement of freight via trucks. These conflicts are anticipated to increase in the future as both systems forecast growth.



Study Area

Spokane Valley ITS Strategic Plan

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FIGURE 1

2.1 Existing ITS NETWORK

Existing transportation and communications infrastructure were reviewed and documented in order to develop the ITS Strategic Plan that will serve the City now and in the future. Figure 2 shows the location of the existing ITS devices. The City's existing communication infrastructure is shown in Figure 3. The existing ITS infrastructure that is currently owned by the City of Spokane Valley includes:

- Traffic Signal System
- Communication Infrastructure
- Closed-Circuit Television (CCTV) Cameras
- Traffic Detection

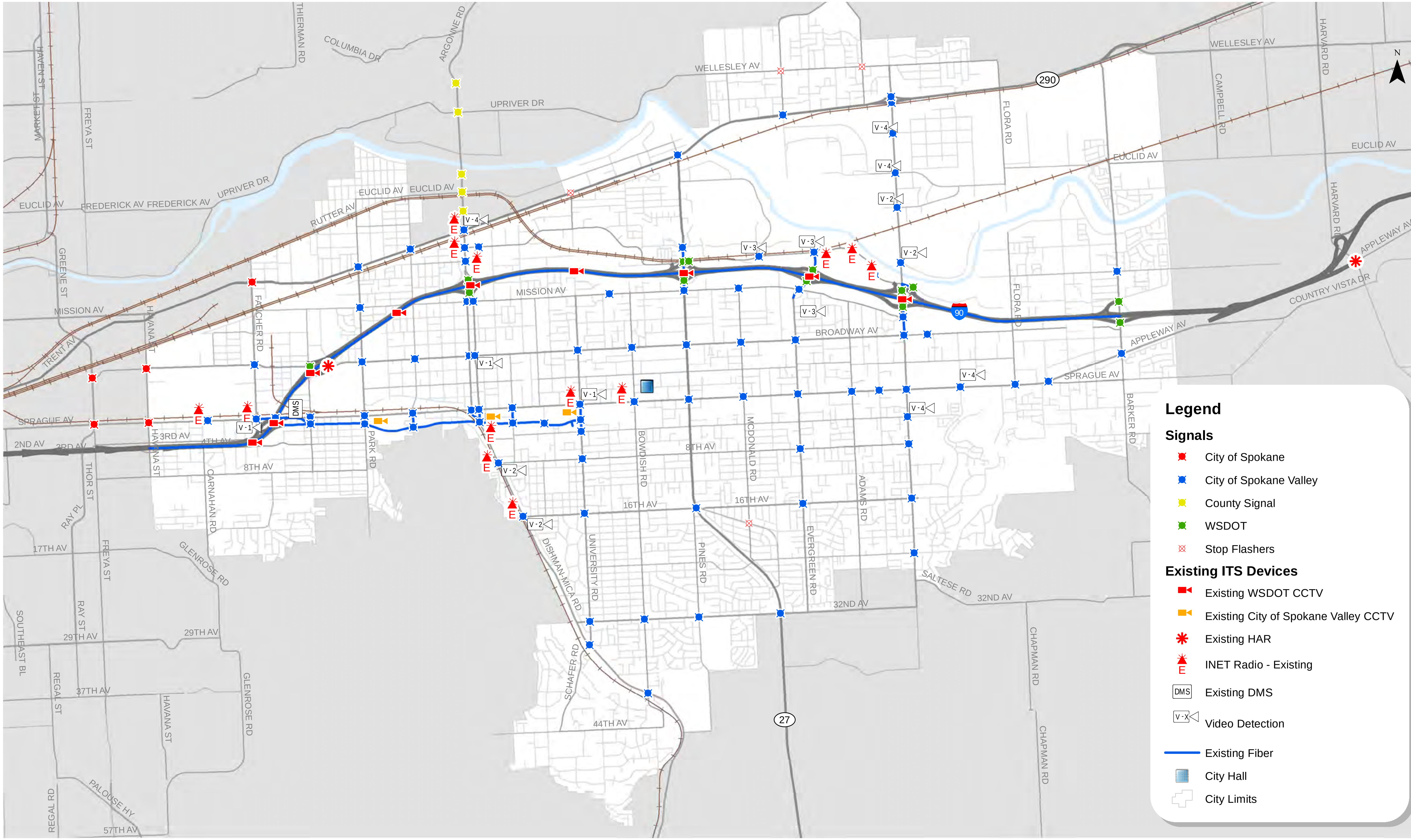
In general, the City has made very modest investments in ITS systems. The following sections provide an overview of the existing ITS infrastructure within the city limits.

2.1.1 TRAFFIC SIGNALS

There are 99 signalized intersections within the City. A large majority of these signals at the major roads operate on a standalone basis. Although not interconnected, time-based coordination is provided for signals along some of the busier corridors within the City. WSDOT owns and operates 14 of the signalized I-90 ramp intersections within the City limits. Additionally WSDOT currently maintains 11 City-owned signals along the Pines Road (SR 27) and Trent Avenue (SR 290) corridors. All WSDOT signals in the area are also synchronized using time-based coordination. The remaining signal controllers are maintained and operated by Spokane County. The location and ownership of all traffic signals within the City of Spokane Valley are shown in Figure 2.

TRAFFIC SIGNAL OPERATIONS

There are three components needed for a coordinated corridor: signal controller, communication between signalized intersections, and signal management software. First, the signal controller collects traffic inputs to make traffic decisions as to the safe movements of various traffic modes through the signalized intersection. There are a variety of manufacturers and models of signal controllers. Older model traffic controllers provide very simple operational capabilities for traffic signals. Newer models provide much more flexibility for traffic signal programming, timing,



Existing ITS Devices

Spokane Valley ITS Strategic Plan

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FIGURE
2

interconnect and transit signal priority. The City's current signal system consists of a combination of Eagle M52 and Peek 3000E signal controllers housed in NEMA TS2 cabinets. Along state routes within the Spokane Valley, the City's signal system consists of 2070 controllers housed in 332 cabinets. The current signal system that WSDOT owns and maintains at the I-90 interchange locations within the Spokane Valley city limits consist of 2070 controllers housed in 332 cabinets.

The second component is the communication between coordinated traffic signals and allows a central signal system to communicate and coordinate timing with traffic signals. This allows data collection and timing modifications to be done at a centralized location using signal system software. Currently Spokane Valley communicates with 28 select signals using an IP-based protocol for signals that have a combination of fiber optic and wireless Ethernet radio connections.

The third component is the signal management software, which is used to manage the signal controllers. Spokane Valley uses the i2TMS signal management software and manages coordinated corridors by communicating to the traffic signals using a combination of the city-owned fiber optic communication network, WSDOT I-90 fiber optic trunk line, and wireless Ethernet radios.   The i2TMS signal management software is available in the SRTMC, WSDOT traffic office, Spokane Valley traffic office, and Spokane County signal shop facilities where operators have some capability to remotely adjust signal timing.

TABLE 1: EXISTING TRAFFIC SIGNAL SYSTEM COMPONENTS

Component	Purpose	System Type/ Application
Signal Controller	Operates intersection signal timing.	Peek 3000E, Eagle M52, Eagle 2070 and Econolite 2070
Interconnect	Provides communication between signalized intersections for signal timing synchronization.	Limited Fiber Optic and Wireless Ethernet Radio deployment
Signal Management Software	Manages signal controllers.	i2TMS

Table 2 provides a summary of the functionality of the i2TMS central signal system software currently adopted by many of the public agencies in the Spokane region.

TABLE 2: SIGNAL MANAGEMENT SOFTWARE FUNCTIONALITY SUMMARY

Functionality	Siemens i2TMS
GIS Base Map	No
Alarming/Paging	Yes
Event Triggers	No
TSP Operations	Yes
Hyperlinking	No
Adaptive Support	No
Video Detection	No
Temperature Probes	No
Synchro Connection	No
Time Space Diagram	Yes
Opticom Connection	Yes
Built in Asset tracking	No
Traffic Data Collection/Storage	No
Flow Map	Yes

2.1.2 COMMUNICATIONS INFRASTRUCTURE

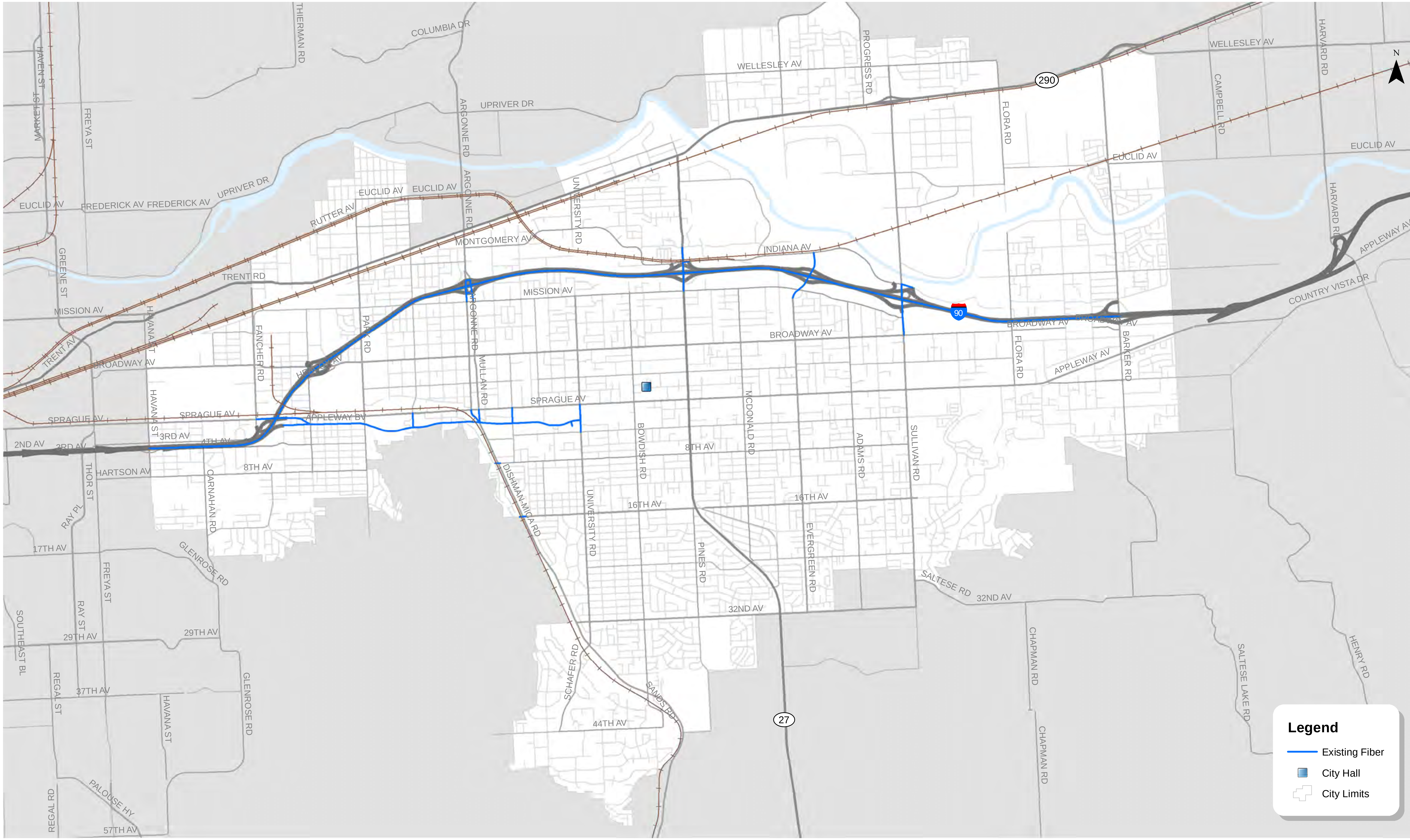
The communications system is one of the most critical components in the deployment of ITS infrastructure since local agencies must be able to monitor, control, and operate traffic management devices from remote locations to effectively manage the movement of passengers and goods. The existing transportation-related communications network in the Spokane Valley area consists of a variety of media such as fiber optic cable and wireless Ethernet network.

An inventory of the existing communication network and conduit was collected from the field and shown in Figures 2 and 3. As shown in the figures, the majority of the traffic signals in the City of Spokane Valley are standalone and do not communicate with other signals. Additionally, 28 traffic signals within the City communicate through a combination of fiber optic and wireless Ethernet radios where one end of the wireless system is connected to the I-90 fiber optic backbone. Traffic signals and CCTV cameras along Sprague Avenue and Appleway Boulevard between I-90 and University Road are interconnected with fiber optic cable. Intersections which are interconnected via wireless Ethernet radios branch off of the main Appleway Boulevard fiber optic trunk line. This fiber optic trunk line was installed as part of the Appleway ITS Phase 2 project. There are currently no direct connections between any of the City's traffic signals and the Spokane Valley City Hall.

The City of Spokane Valley has installed empty conduits in sections of the City along Sprague Avenue, Broadway Avenue, N Argonne Road, Sullivan Road, and Barker Road suitable for future deployment of fiber optic cable. In summary, the City has currently deployed a limited fiber optic network.

OTHER FIBER OPTIC INFRASTRUCTURE

WSDOT has fiber optic cable installed within the City of Spokane Valley that runs along the I-90 corridor and provides connections to freeway ramp signals. The fiber communication equipment at these locations, including fiber switches and patch panels, are consistent with the fiber communication equipment deployed at the majority of signals maintained and operated by Spokane County on behalf of the City. Several locations within the City also include wireless Ethernet radios which tie into the WSDOT fiber optic system to provide additional wireless Ethernet interconnection to some of the City-owned signals.



Existing ITS Infrastructure

Spokane Valley ITS Strategic Plan

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FIGURE
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2.1.3 CLOSED-CIRCUIT TELEVISION (CCTV) CAMERAS

Closed-Circuit Television (CCTV) cameras with pan tilt and zoom (PTZ) capabilities are used to monitor traffic conditions. CCTV cameras transmit real-time video streams using fiber optic transceivers in the field. The video stream is then connected to a fiber optic receiver at the SRTMC where it is encoded for control and viewing. The City currently has three Pelco analog CCTV cameras that are installed on WSDOT standard camera poles at Appleway Avenue & Park Road, Appleway Avenue & Dishman-Mica Road, and Appleway Avenue & University Road. WSDOT maintains and operates the CCTV cameras for the City.

In addition to the City's CCTV cameras, WSDOT also uses nine closed-circuit television (CCTV) cameras to monitor traffic on Interstate 90. WSDOT's CCTV cameras are all connected to the fiber trunk line along I-90. These CCTV cameras are also connected at SRTMC for viewing only.

2.1.4 TRAFFIC DETECTION

There are multiple ways to detect traffic on the roadway but the most common is loop detection. Traffic detection is used for stop bar presence and advanced pulse detection for signal operations as well as system data collection. The City of Spokane Valley mainly has loops with video detection used at a select few intersections for stop bar detection purposes. The City also uses video detection as a temporary method of stop bar detection on approaches where loops require maintenance. Sensys Network Wireless Vehicle Detection technology is also used on Sprague Avenue at I-90 for detection purposes.

2.1.5 DYNAMIC MESSAGE SIGNS

The City owns a Dynamic Message Sign (DMS) that was installed as part of the Appleway ITS Phase 2 project. The DMS is located on Sprague Avenue east of the I-90 interchange. This DMS provides westbound travelers on Sprague Avenue with advance warning regarding traffic conditions and freeway incidents prior to their commute between the Sprague Avenue/I-90 interchange and downtown Spokane. The DMS is a 13.5' x 6' front access Daktronics VF-2320 DMS that communicates over an IP network to the SRTMC where it is operated. Currently WSDOT provides the maintenance for the DMS device and it is controlled at the SRTMC.

Front Access Dynamic Message Sign

SPECIAL VEHICLE DETECTION

Emergency Vehicle Pre-emption: The majority of the traffic signals in the City of Spokane Valley have full emergency vehicle preemption using infrared detectors on all intersection approaches. Police and fire vehicles are equipped with infrared emitters that allow emergency vehicle detection and prioritized signal operations.

Railroad Pre-emption: The railroad network throughout the city is used for freight mobility. There is detection at the grade crossings to provide safe operations of the rail system tied into the adjacent traffic signals but this has a distinct impact on the general public.

2.1.6 TRAFFIC MANAGEMENT CENTER

The Spokane Regional Traffic Management Center (SRTMC) is a shared facility that is jointly managed by the WSDOT Eastern Region, City of Spokane, City of Spokane Valley, Spokane County, Spokane Transit Authority, and Spokane Regional Transportation Council. The SRTMC facility is located at 221 W. 1st Avenue in the City of Spokane. The facility is utilized to manage and coordinate response to incidents and to dispatch WSDOT and/or County personnel throughout the Spokane County area. Currently, the SRTMC utilizes the i2TMS software which enables the communication to signal controllers, CCTV cameras, and DMS signs. This central system software facilitates traffic operators in monitoring congestion, adjusting signal parameters and displaying traveler information to strategically manage traffic in the region. Proactive traffic management from operations personnel helps to alleviate recurring congestion and minimize the effects of traffic incidents.

Where interconnection exists, City of Spokane Valley signal and ITS devices are accessible to the Spokane County signal shop, WSDOT operations facility, and City of Spokane Valley i2TMS workstation through the SRTMC hub where information and data is distributed. Dispatchers in the traffic management center are responsible for posting messages on the dynamic message signs and updating the traveler information web page. The center has access to video streams and images from cameras deployed throughout the region.

2.2 TRAVELER INFORMATION

Within the Spokane Valley area, the SRTMC provides most of the traveler information. SRTMC's website provides camera images and video feed, traffic conditions, incident maps, and construction activities for the I-90 corridor through Spokane Valley and for other ITS devices on the City's fiber network. The SRTMC is working towards providing similar information for arterial roadways within Spokane Valley. The figure below indicates the map interface shown on SRTMC's website.

SRTMC Website Traveler Information System

The Washington State Department of Transportation (WSDOT) also provides traveler information along I-90 in the area through their website, 511, and highway advisory radio. WSDOT's website includes camera images, road conditions, weather information, incident maps, and construction activity. The 511 system is accessible to travelers over the phone through touch-tone dialing or voice activation.

Both WSDOT and SRTMC continually add information to their respective websites as new equipment and more traffic-related information becomes available in the region.

2.3 KEY FINDINGS

The following provides a summary of key findings based on the ITS existing conditions assessment:

- The City's current ITS system consists mainly of traffic signals, limited video detection, CCTV cameras, and one DMS.
- The traffic signal system consists of Peek 3000E, Eagle M52, and 2070 controllers. The Eagle M52 and 2070 controllers have capabilities to be interconnected. The Peek 3000E controllers are not capable of being interconnected with the citywide network.
- For the traffic signals that are currently connected on a fiber IP network, the SRTMC, Spokane County signal maintenance department, and Spokane Valley City Hall central system workstation all currently have the ability to remotely control signals via the i2TMS signal management software. However, the County has indicated limited usage of the software to adjust and monitor signal timing. Additional training may help operators become more familiar with the software's capabilities such that remote monitoring of intersections can be performed when necessary.
- The City has limited traffic surveillance with three CCTV cameras in total. All three are located on the Appleway Boulevard corridor and were installed as part of the Appleway Trunk line – ITS Phase 2 project. Currently SRTMC operates and maintains these devices. The City has a maintenance contract with WSDOT to maintain the CCTV cameras along the Appleway Boulevard corridor. The City can also control the I-90 CCTV cameras within the City limits.
- The City's communication infrastructure is comprised of limited fiber and wireless Ethernet connections.
- All communication goes to the SRTMC as a point-to-point topology. The existing system does not provide redundancy.

3 ASSESSMENT OF NEEDS

While the existing conditions review provides a good understanding of the current infrastructure and locations of ITS applications, it is critical to understand the needs and concerns of the stakeholders who rely daily on the City's transportation system. Location and type of ITS equipment and the communication network to be addressed in the ITS Strategic Plan were developed based on the input from the Public Works and signal maintenance groups in the City of Spokane Valley as well as the consultant's ITS experience in other jurisdictions.

This chapter provides a summary of transportation system user needs to meet the vision identified for the City of Spokane Valley. The assessment of current and future transportation user needs in the City of Spokane Valley provides a backbone for the development and evaluation of potential ITS projects.

3.1 SPOKANE VALLEY ITS NEEDS

The project team met with public works and signal maintenance representatives to discuss the City's ITS needs. Additional needs were developed in conjunction with the City's input. The following is a summary of the needs assessments that were developed.

3.1.1 TRAFFIC OPERATIONS AND MANAGEMENT

Traffic operations and management user needs were identified as follows:

- Upgrade the City-wide traffic signal system
- Expand Traffic Monitoring
- Expand System Detection
- Upgrade the Spokane Valley central system workstation to provide active control of systems.
- Integrate systems between local transportation and emergency agencies
- Coordinate traffic signals to alleviate congested freeway off-ramps
- Develop an incident response program
- Monitor high accident locations for incidents
- Develop an emergency/incident response plan including all response agencies

3.1.2 TRAVELER INFORMATION

Traveler information user needs were identified as follows:

- Expand SRTMC map to include Spokane Valley arterial roadways
- Provide congestion information to travelers (prior to congested areas)
- Provide travelers with information about incidents, congestion, construction, or any other event that will increase travel times
- Provide congestion information along major roadways
- Provide real-time traveler information at freeway on-ramps
- Keep "real-time" information current (i.e. DMS, 511, HAR)
- Interface and share resources with the National Weather Service
- Provide more camera images for visual verification of conditions
- Post information in locations that will not be obstructed by truck traffic
- Standardize message sets for DMS
- Disseminate emergency information (ie. amber alert)
- Disseminate evacuation route information

3.1.3 INTERAGENCY USERS

Interagency user needs were identified as follows:

- Develop a citywide fiber optic communications infrastructure
- Implement a ring-type fiber network topology to create failure redundancy
- Link to surrounding agencies
- Install citywide CCTV cameras
- Install additional DMSs
- Install data stations

3.1.4 GENERAL NEEDS

It has been identified that the City would benefit from a fiber network that would effectively connect all the city's traffic signals using an Internet Protocol. By interconnecting the City's signals, the City will gain flexibility in controlling their own signals, be able to assign priority rules for other agencies to monitor and manage signals and ITS devices, and establish communication between signals to improve coordination. The City would also benefit from deploying additional CCTV cameras in the city as a means to monitor traffic operations at intersections and observe the real-time effects of remote signal timing changes. Additionally, citywide deployment of DMS signs and data stations in strategic locations would have a positive effect to improve travel time and information dissemination within the City. Roadway users will be better informed regarding the roadway network and will be able to modify their travel paths as needed.

Other general needs were identified as follows:

- Use common standards throughout the region to enhance integration
- Integrate the communications system between transportation agencies and emergency management agencies to improve response times.
- Identify funding sources for safety improvements on state highways and major arterials
- Identify funding sources for interagency coordination projects
- Research and test communications systems prior to implementation to ensure ease of use and regional functionality
- Deploy ITS projects that improve a traveler's available choices and make travel more efficient
- Facilitate coordination between agencies

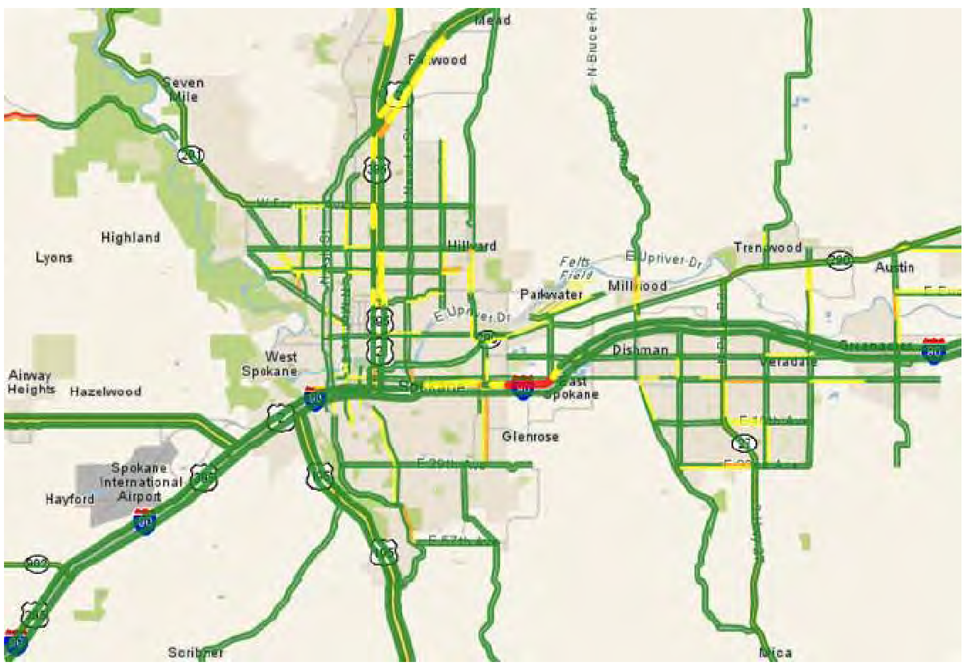
3.2 DESCRIPTION OF NEEDS

Based on the conversations with representatives of the City, a range of ITS applications were identified. As a result, the ITS Strategic Plan will focus on the following core ITS components and devices:

Communication System: To allow remote monitoring of the traffic signals and ITS devices, there needs to be infrastructure to allow interconnection between field devices. Interconnection also provides the City with the necessary communication infrastructure for any future considerations for adaptive signal upgrades. With the amount of ITS equipment that will use the communication system, the infrastructure will need to have enough size and speed (bandwidth) to allow for sufficient monitoring and data collection.

Traffic Monitoring: CCTV cameras provide monitoring of the roadway by allowing City staff to move the camera as needed to observe traffic flow, incidents, and conflicts. This monitoring will allow real time observation and adjustments.

Real Time Data / Traveler Information: With upgraded equipment and software, traffic data will be collected continually for analysis and for traveler information on real time congestion. This data can then be presented to the public through common means such as the internet, cell phones and Dynamic Messaging Signs (DMS) on the roadway to allow for route modification. Traffic flow maps are commonly used to disseminate congestion levels on the roadway network and are distributed to the public through the internet. Strategic placement of DMS locations will allow vehicles already in route to make changes if there is an event that requires immediate response by the traffic operations personnel. Any future ITS devices which facilitate information dissemination should also be accessible at the SRTMC or the regional i2TMS system, allowing key operators to post pertinent information about the roadway network conditions.



Traffic Flow Map Example

Data Sharing: With an expanded communication network and a connection with WSDOT's fiber network complemented with future ITS deployment to collect data, the City will be able to share data and receive traffic data from surrounding agencies. Volume, occupancy, speed, and flow data can be shared between agencies to develop a network traffic map in the region to inform travelers with regards to traffic conditions. This will allow better traffic flow within the city and in the region. Additionally, weather data can be shared within the regions to assist in maintaining clear roads under adverse weather conditions. Data sharing should also involve local emergency responders and road maintenance crews to improve incident response times and help to effectively communicate roadway disruptions.

Central System Workstation: With the current i2TMS workstation at City Hall, City staff are currently able to manage select signal controllers, perform traffic surveillance via CCTV cameras, and provide oversight to the County on the quality of operational changes. The City's central system workstation also enables City staff to actively review of traffic conditions and adjust traffic signal and ITS systems to better manage traffic flow when needed. Regular communication with the surrounding agencies is necessary to ensure that the central system stays current with the upgrades in hardware and software implemented at the SRTMC.

3.3 KEY FINDINGS

The following is a list of the major transportation needs identified:

- Interconnect and synchronize traffic signals;
- Install CCTV Cameras (Pan/Tilt/Zoom) along key corridors (Real time video access);
- Install proper equipment for driver information dissemination via dynamic message signs, highway advisory radios (HARs), and web site;
- Install proper equipment for collection of traffic data along key corridors in "real time" via system loops and travel time devices;
- Use of "real time" and archived traffic data in planning and operations studies;
- Share traffic data and video with other local jurisdictions; and
- Provide regular maintenance and upgrade to City's central system workstation to enable City staff to better manage the City's traffic and ITS systems when needed.

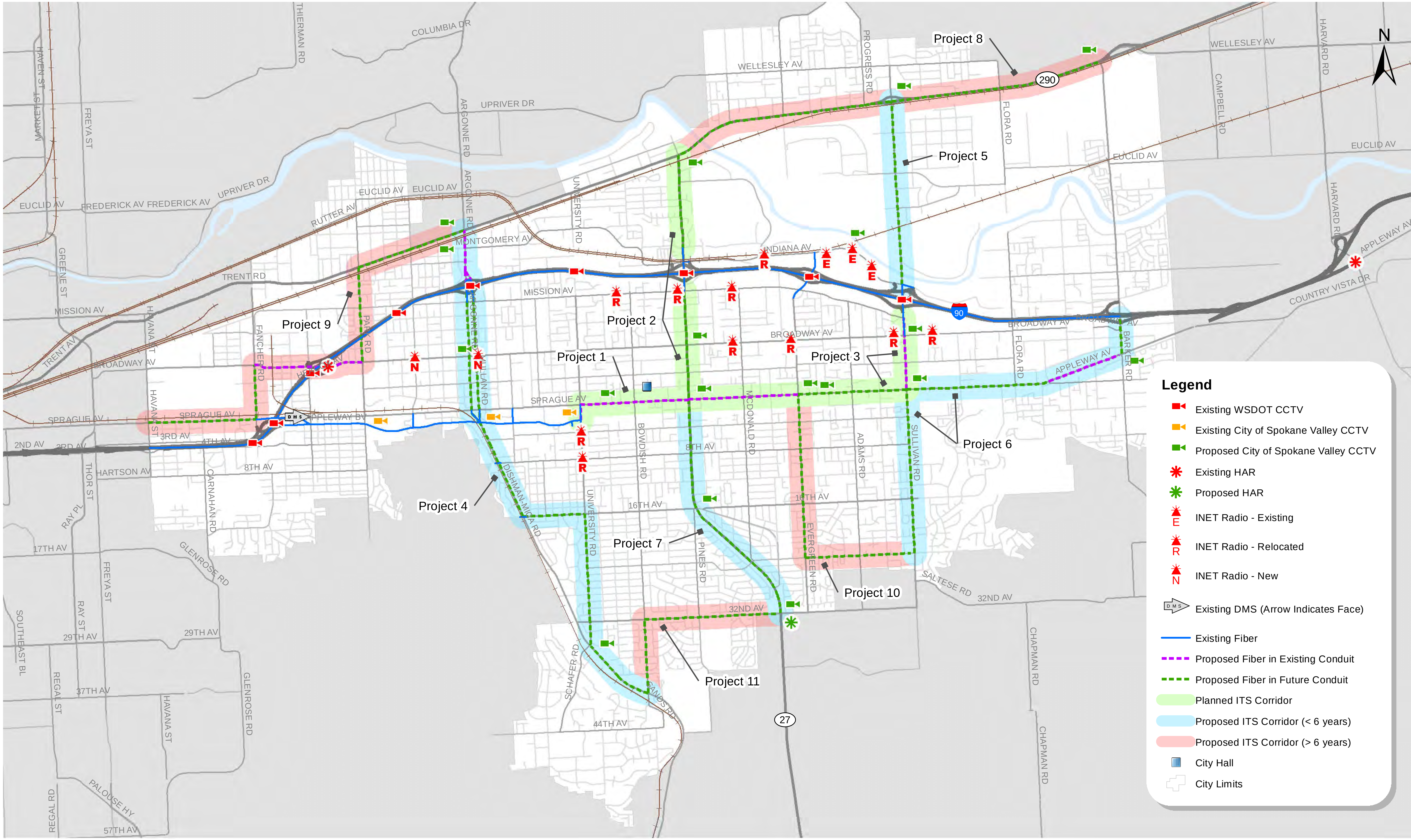
4 RECOMMENDED ITS SYSTEM

The existing conditions and needs assessment, along with the ITS architecture and selection of market packages (Appendix A), have resulted in developing a recommended communication system and specific ITS applications for the City. The recommendations focus on the primary corridors that will be targeted for ITS applications, a description of the overall communication system and the specific ITS devices that will be deployed.

In general, it is recommend that the City of Spokane Valley leverage the existing signal cabinets by using hardware that is both flexible for future development and established in the region with a variety of ITS equipment. These recommendations include:

- Maintain a central system that is compatible with the system at SRTMC
- Install a citywide fiber network to interconnect traffic controllers and ITS devices
- Utilize Internet Protocol for communication to ITS devices
- Collect traffic data on the roadway for analysis, review and providing traveler information
- Expand traffic monitoring system (CCTV and data stations)
- Increase traveler information dissemination
- Bring all the ITS data to a central TMC location at SRTMC
- Upgrade equipment to work with existing ITS deployment by other agencies

Once the City implements its Strategic ITS plan, it will be able to implement a series of ITS devices along the primary ITS corridors as communication infrastructure is expanded. The Strategic Plan will allow specific devices to be installed in a logical manner and come online quickly when specific segments of the communication system have been implemented. The recommended ITS devices include different types of equipment and technology as listed in this section. Figure 4 illustrates the proposed locations of the future ITS devices.



Proposed ITS Devices

Spokane Valley ITS Strategic Plan

M:\09\09130 Spokane Valley ITS Strategic Plan\GIS\Spokane County\MXD\FIG_Proposed_ITS_Devices.mxd

FIGURE
4

transpoGROUP

4.1 TRAFFIC SIGNAL SYSTEM

4.1.1 CENTRAL SIGNAL SYSTEM SOFTWARE

The City of Spokane Valley's signals are currently managed using the i2TMS central signal system software. Spokane County, which maintains a majority of the City's signals, has the capability to monitor signals and adjust timing using the i2TMS software from their signal maintenance facilities. Within the region, WSDOT and SRTMC also have the capability to use the i2TMS software to adjust signal timing and access CCTV video footage. When necessary, the City also has a workstation that has the capability to access the City's field traffic equipment via the i2TMS software.

The i2TMS software is designed for ease of use to accommodate the multi-device, multi-jurisdiction expansion necessary for today's ITS applications. Expandable and customizable as an agency grows and changes, i2TMS provides a full featured, object oriented graphical user interface to support centralized management and control. Components are implemented in a single integrated platform for information management, graphical data display, and system control. Graphical icons provide easy and intuitive access to traffic control data, real-time data, parameter database, and graphical image files. Additional modules can be added to the system to incorporate CCTV, DMS, adaptive traffic control, and transit priority control. i2TMS is compatible with NEMA, Model 170, Model 2070 variants, and advanced transportation controllers including NextPhase controller software, which is used throughout Spokane Valley. When used in conjunction with the NextPhase controller software, i2TMS has the capability to handle many special and complex operations such as Transit Signal Priority (TSP) applications. As the City currently uses this combination of central system and controller software, they would be able to consider integrating transit operations into the system to improve travel efficiency in the future.

It is recommended that the City maintain a version of i2TMS that is consistent with operations at SRTMC to maintain full compatibility. This will ensure that there is a seamless communication between all the local agencies in the area. Additionally, the NextPhase signal controller software should be periodically updated through the city to ensure that additional features are available, thereby maximizing the use of the existing controllers.

4.1.2 SIGNAL CONTROLLERS

The city currently uses Eagle M52 controllers for the majority of their signal controllers while a few intersections operate on older Peek 3000E controllers. Most of the City's signals are currently maintained by Spokane County. Signals currently operated and maintained by WSDOT within the City are the 2070 type housed in 332 cabinets. Six of Spokane Valley's signals in the south-side of the city use Peek 3000E controllers which will require upgrading in order to be interconnected with the other signals in the City. It is recommended that the City upgrades these signals to the Eagle M52 controllers with the adopted NextPhase controller software to enable compatibility with future plans for city-wide interconnection of signal controllers. The Eagle M52 controllers would also be suitable for these locations as they will provide consistency with the majority of signal controllers deployed within the City and allow for remote access to the controllers. With future fiber infrastructure expansion that will interconnect more devices in the City, SRTMC operators may require additional training with respect to the i2TMS software operations to effectively control a larger network of signal controllers and ITS devices.

4.2 ITS DEVICES

Closed-Circuit Television (CCTV): The City currently uses analog Pelco Esprit top-of-pole mount pan-tilt-zoom (PTZ) cameras. Video from the Pelco cameras are transmitted from each location using Optelecom single-channel video transmitters. Currently, this is an analog system and should be converted to IP utilizing video encoders. IP video cameras broadcast their video as a digital stream over an IP network. Like an analog system, video is recorded on hard drives; but since the video communicated over an IP stream straight from the camera, there is more flexibility as to how and where that video is recorded. Testing must be conducted to ensure the CCTV commands are transmitted properly through the Ethernet switches for control at central locations. The City should also consider the use of the High-Definition (HD) PTZ CCTV cameras for future deployment. One of the benefits in using newer technology HD CCTV cameras is that they provide higher resolution video streams. Higher resolution video streams provide more range and field of view, minimizing the number of cameras that need to be deployed to gain substantial roadway coverage. Additionally, the majority of HD CCTV video cameras also utilize H.264 video compression which enables higher resolution video to be transmitted using less bandwidth. Using less bandwidth frees up fiber optic capacity and enables strands to be utilized for other types of data. As the IP CCTV camera technology develops further, built-in analytic features of an IP camera could potentially enable the City to gather data and issue alerts. When these features become more applicable to traffic operations, the City may evaluate the use of such analytics to more effectively manage the traffic network in the City.

Additional deployment of IP CCTV cameras enables traffic operations personnel to gain more coverage and remotely monitor roadway conditions in the city. By providing remote monitoring capabilities, traffic abnormalities can be detected sooner. Earlier detection improves emergency response since first responders become notified about the incident sooner and can react more promptly. Earlier detection also improves roadway congestion as signal timing can be preemptively adjusted by the operator to free up congested roadways. CCTV video streams can also be shared between multiple agencies to improve interagency data sharing capabilities in the region. This allows maintenance personnel, operators, and engineering staff to all have remote access to the same CCTV video resources for real-time information.

Dynamic Message Signs (DMS): Traveler information applications such as Dynamic Message Signs (DMS) provide information to the general public including information to assist them during their trip. The main purpose of this equipment is to provide information and communicate roadway and congestion conditions to the driving public. Tactical deployment of DMS informs drivers about roadway conditions where the incident has occurred while strategic deployment informs drivers about the incident on other roads on the same network. Tactical deployment attempts to reduce secondary incidents while strategic deployment attempts to minimize the effects of incidents by re-routing traffic. The City currently owns one Daktronics DMS that is maintained and operated under contract with the WSDOT. DMSs are designed to work on key arterials, such as Sprague Avenue, Pines Road (SR 27), Trent Avenue (SR 290), etc. The current trend is to have a graphically enabled DMS to allow both text and pictures to inform the public. Future testing on size related to speed and the type of information to display should be completed before full deployment is initiated. Most central systems have a DMS module and support the NTCIP communication protocol which is adopted by many DMS sign manufacturers. This should also be fully tested before implementation. The City currently does not have any plans for additional DMS deployment in the City. However, the future fiber infrastructure identified in this plan will accommodate the installation of DMS on key ITS corridors should the City decide to consider additional deployment.

System Detection: This ITS component provides the City with the ability to collect real-time traffic data and performance measures and store this data for future use. Performance measures could include, but are not limited to, corridor and/or intersection travel times, delay, speeds, volumes, occupancy data, etc. The real-time and performance measures are critical to the efficient operation of the transportation network. Information gathered from detection systems is often disseminated to the public through traveler information websites and DMS to help improve network efficiencies. In addition to real-time information, data can also be archived for planning purposes and implementation of transportation system improvement.

Currently the City has a combination of both intrusive and non-intrusive detection systems. Intrusive detection systems, such as loops and in-pavement magnetic sensors, impact the roadway pavement in which vehicle detection is installed. Non-intrusive detection systems, such as video detection and microwave radar sensors, are generally mounted on roadside structures and do not impact roadway pavement. The selection of a detection system is dependent on factors including: detection accuracy, cost, local weather conditions, availability of surrounding communication infrastructure, installation complexity, and operations and maintenance complexities. It is recommended that the City install microwave radar sensors for future data and count station deployments. Microwave radar sensors are recommended because they are easy to install, require minimal maintenance, and are generally unaffected by winter weather conditions. It is also recommended that the city continue to deploy inductive loops for stop bar detection at signalized intersection to help optimize signal timing parameters. Inductive loops are recommended for stop bar detection because loops have high detection accuracy and are widely deployed in the region. As such, local expertise in installing and maintaining this type of system is available.

With recent developments, system detection can also be achieved using software-based applications that gather data from GPS-equipped vehicles and cellular phone signals. Using this type of system, real-time data points are extrapolated from select roadway network users to determine performance measures including speed, travel time, delay, and congestion levels. INRIX is a developer that currently provides a product that is capable of analyzing traffic data through software means within the City of Spokane Valley. At the present, information through the INRIX application is only available for principal arterials in Spokane Valley during peak hours due to the limited number of detectable devices in the region. This is expected to expand to more time periods and more roadways as more GPS-equipped vehicles and cellular phone subscribers become detectable on the roadway network in Spokane Valley.

It is recommended that the City of Spokane conduct a trial on a software-based application such as INRIX as a short-term means for traffic data acquisition. It is suggested that this near-term solution be complemented or replaced with longer-term deployment of permanent count stations. Although the City currently does not have any future plans for ITS data station deployment, infrastructure for other planned ITS initiatives such as CCTV cameras, DMS, and weather stations should consider future compatibility with ITS data station installations. This may be accomplished by constructing multipurpose ITS cabinets which are capable of accommodating various ITS applications. The application of system detection as identified will help to improve traveler information dissemination and improve network operational efficiencies. Roadway users will be able to adjust their travel patterns to help strategically manage the flow of traffic within the city.

Highway Advisory Radio Stations: Highway Advisory Radio Stations (HAR) are another form of traveler information dissemination. These devices utilize a low-power AM radio station to broadcast pertinent traffic information on major thoroughfares in the region. Within the City of Spokane Valley, the WSDOT currently maintains and operates two HAR systems to disseminate traveler information along I-90. Travelers within the City of Spokane Valley would benefit from another HAR transmitter on the south side of the City. Prior to installation of a HAR an FCC license will be required for transmission on the AM band. This HAR system would forewarn drivers about roadway hazards, allowing travelers entering the City from the south to be notified about I-90 conditions prior to selecting a route to enter the freeway system. Information would provide drivers with the opportunity to avoid routes where roadway hazards occur.

4.3 COMMUNICATION NETWORK INFRASTRUCTURE

The City of Spokane Valley has provided an inventory of the citywide conduit system and fiber optic infrastructure. As a base assumption, all identified existing conduit could be used for the installation of the fiber system. Fiber optic communication is important because data transmission capacity is greatly increase and the flexibility to provide communication system redundancy is available.

It is recommended that the City utilize existing conduit to interconnect all the existing traffic signal controllers onto a fiber optic network to allow maintenance and operations personnel to adjust signal timing remotely. Managed Ethernet switches should be deployed at each signal controller cabinet to enable communication over the fiber optic Internet Protocol (IP) network.

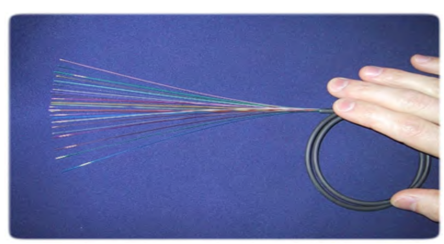
4.3.1 FIBER OPTIC BACKBONE

To have the most flexibility, the City should deploy a multi-fiber multi-drop fiber optic backbone system that will be ultimately developed into a ring network topology for Ethernet-based devices. The ring network topology would build off of the existing communication infrastructure to SRTMC and utilize two dedicated strands of fiber optic cable to service the city's traffic signal and ITS network. The two dedicated strands provide communication redundancy within the City limits by transmitting and receiving data in two opposing directions such that if a particular link in the network was disrupted, communication would still be available in the other direction. At certain points in the network, point-to-point connections may be needed to interconnect other signal controllers or CCTV cameras. A point-to-point method of interconnection is only suggested for devices where redundancy is not paramount. This is because point-to-point connections only transmit and receive data in one direction where communication is entirely lost when a link is disrupted. Appendix D provides additional information for communication system design guidelines for establishing Spokane Valley's fiber optic topology.

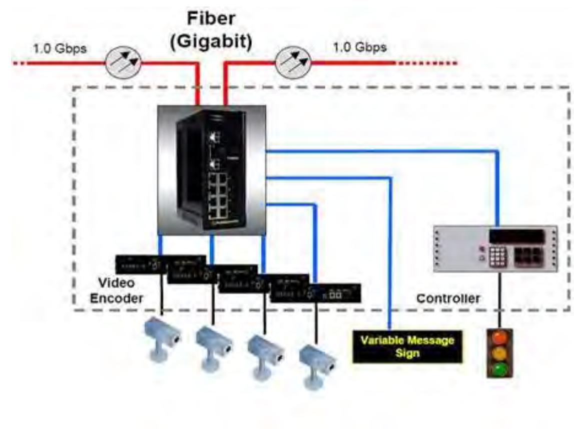
With this in mind, a few routes of a 48 strand fiber should be installed to several fiber termination/patch cabinets around the city. These cabinets become hub locations for expansion of fiber in various directions and for completion of fiber redundancy. The remaining routes should be a minimum of a 24 strand fiber trunk line. By using a minimum of 24 strands, the City's fiber optic backbone will have sufficient bandwidth for future expansion in the ITS system utilizing a Gigabit network. In addition, where new fiber connections are replacing the existing wireless Ethernet radio devices, the radios could be temporarily relocated to other locations to establish communication to other ITS devices until additional fiber optic connections are available citywide.

Deployment of a fiber optic backbone will allow the city to operate and manage City signal controllers and ITS devices remotely from a central location, promoting increased operations and management efficiency for personnel. The capability of traffic operations staff to remotely access ITS devices is critical to the implementation of coordinated timing plans and to the overall operations and maintenance of these devices. A fiber optic backbone interconnecting all signal controllers and ITS devices also enables operators to proactively detect congestion and incidents remotely. This form of traffic management also helps to strategically manage traffic flows and reduce delays in the city's transportation network. Providing fiber interconnection also maximizes the use of the City's existing signal controllers as most are already equipped with an Ethernet communication port that is ready to communicate over an IP network. Future ITS projects should include consideration to connect police and fire with the ITS network. Providing access for emergency responders to observe and control CCTV cameras will help to improve emergency response times.

Currently, the city does not have any plans for adaptive signal systems. However, implementation of a citywide fiber optic network in Spokane Valley would also provide the necessary communication infrastructure for any future considerations to improve efficiency through real-time synchronization and optimization of adjacent traffic signals.



4.3.2 ETHERNET SWITCHES



Signal controllers and other ITS devices will be connected to the fiber optic interconnect through Ethernet switches. Ethernet Switches will be deployed at each signal controller or ITS cabinet to enable communication between field equipment and a central system workstation. For future communication expansion, the use of Gigabit Ethernet Switches is recommended for all field devices. Gigabit Ethernet Switches are designed to transmit signals over long distances, up to 60 miles, and provide increased bandwidth capacity, maximizing the use of the deployed fiber and providing ample bandwidth for future needs. Table B in Appendix D outlines typical bandwidth requirements for various signal and ITS Equipment.

The benefits of Ethernet Switch deployment are similar to benefits identified for the installation of a fiber optic backbone. Ethernet switches enable signal controllers and ITS devices to be interconnected over an IP network to improve operations and maintenance efficiencies for personnel from a central location. Other benefits include improved quality of data transmission and enhanced security.

4.3.3 WIRELESS ETHERNET RADIO

For short and mid range communication goals, the use of wireless communication can be deployed temporarily before conduit and fiber is installed or as a permanent bridge where other types of installation may be too costly. The City currently operates wireless Ethernet radios at 12 intersections which tie into the WSDOT or Appleway Boulevard fiber optic trunk lines. Phased replacement of fiber optics at these intersections will allow the City to relocate wireless Ethernet radios based on prioritized locations within the city as a temporary means of connection to the City's IP network.

The benefit of a wireless Ethernet radio solution is that they provide a cost effective means for interconnecting signal controllers and ITS devices since conduit infrastructure is not needed, minimizing materials and construction costs. However, the limitations of wireless Ethernet radios include lower bandwidth support and clear line of sight requirements. Typically, wireless Ethernet radios are able to cost-effectively provide up to 300 mbps under ideal conditions. At higher transmission rates, costs increase significantly. Additionally, wireless Ethernet radios are limited to adjacent locations with a clear line of sight between the wireless Ethernet base station and client antenna. If clear line of sight is unavailable, communication may not exist or may be frequently disrupted. These two limitations eliminate the possibility of using wireless Ethernet radios in many cases. Should the city implement additional wireless Ethernet radios in the city, a comprehensive wireless coverage analysis would be necessary.

4.3.4 CONDUIT SYSTEM

As the City initiates construction projects, the installation of either a 4 inch conduit with innerduct or 2 – 3 inch conduits should be included along all arterials. This would accommodate the typical 48 count fiber strand with additional room for future installation of fiber or other communication media. It is important to have additional conduit capacity if there is a break or damage in the primary conduit or when additional fiber is needed.

In addition, the City should investigate the use of Micro-trench fiber installation which can save between 50 to 70 percent in costs compared to the traditional trenching with conduits. The micro-trench technology becomes a viable option for locations where the city has not identified installing conduit within the next six years due to cost savings. The micro-trench technology allows the city to remove overhead fiber installation, connect to currently unconnected signals, or to complete a link in a redundant fiber ring topology.

Example of Micro Trench Conduit

4.3.5 PULL BOXES AND CABLE VAULTS

Pull boxes serve several functions for below ground fiber optic installations. As the name suggests, fiber optic conduit pull boxes are used primarily to facilitate cable pulling through conduits and raceways. Pull boxes, installed at strategic points in the cable run, significantly reduce stress on cable as it is pulled through long cable run. It is recommended that pull boxes be spaced at 1000 feet maximum. It is also recommended that at least one pull boxes be installed at each intersection within close proximity to the signal cabinet or ITS cabinet where the fiber is being terminated. It is also a common practice to coil additional fiber optic cable in pull boxes to help in further reducing cable stress and provide extra cable to facilitate in future communication system upgrades. Cable vaults are used to gain access to cable for splicing and testing and to store slack cable for future expansion.

4.4 CENTRAL SYSTEM WORKSTATION

The i2TMS traffic management software installed on the Spokane Valley City Hall's central system workstation currently provides the City staff with the capability to remotely change signals in response to incidents, gather and evaluate data, and edit DMS messages. At the present, these functions are primarily performed by operators at the SRTMC. By providing the City with access to their own traffic signal and ITS devices, changes can be implemented under unforeseen circumstances and emergency situations when needed. Additionally, the City can use the workstation to simply monitor traffic conditions and alert appropriate authorities when required.

As more ITS devices are deployed within the City, the need for more system upgrades would likely be necessary at the regional SRTMC. In order for the City to maintain their level of accessibility to the various field devices, it is pertinent that their central system workstation remain compatible with the SRTMC's system. The City should maintain regular communications with SRTMC staff to discuss hardware and software upgrades within the region to ensure that their Central System Workstation is current. A current Central System Workstation will help to establish a two-way link between SRTMC and the Spokane Valley City Hall, promoting interagency cooperation within the region through increased data sharing initiatives.

In addition, future plans for a secure and fast connection to the SRTMC and Spokane County Signal Maintenance Shop should be deployed to enable a reliable connection to all traffic management agencies. The connection to the video images from the installed CCTV cameras and data from signal controllers should be split in the field and brought into the City Hall through a dedicated communication network. By providing a dedicated connection into the City Hall, if future plans necessitate the needs for the City to maintain and operation their own traffic system, the necessary infrastructure will already exist. If the city desires to take over the maintenance and operations of the traffic system then a comprehensive plan must be developed to train the needed staff to perform the ITS functions.

4.5 SUMMARY OF ITS COMPONENTS

The following ITS system components presented in Table 3 are recommended to provide the City with an ITS system that is scalable and does not lock the City to proprietary hardware or software systems.

TABLE 3: ITS SYSTEM RECOMMENDATIONS

ITS Equipment and Materials	ITS Function	Minimum Recommendation	Potential Benefits
Signal Controller	Traffic Management (flow and control)	Phased replacement of all Peek 3000E controller to Eagle M52 with Ethernet communications	- Improve signal management and operation efficiency - Improve interagency integration
Closed Circuit Television (CCTV) Camera	Video Surveillance and Monitoring	IP-based camera High-definition video Industry standard video compression MPEG-4 and H.264	- Reduce data transfer rate (bandwidth) - Reduce video storage size. - Improve safety and security in the transportation network - Improve interagency video sharing
Dynamic Message Sign	Traveler Information	NTCIP Communication Support (National standard protocol)	- Improve City ITS system integration - Improve interagency integration - Improve traveler information dissemination - Enables strategic traffic management in the region
Vehicle Detection	Intersection detection, system detection, collection, and incident management	Induction loops for intersection detection Initiate software-based traffic data acquisition pilot project	- Allows traffic data archiving for future planning and signal timing adjustment - Improves intersection operations. -Improve traveler information dissemination
Highway Advisory Radio	Traveler Information	Hardened AM band transmission devices and digital recorder modules	-Improve traveler information dissemination -Improve roadway safety in the region
Fiber Optic Backbone	Communication Infrastructure	24-72 strand SMFO in existing 2" conduits, new 4" conduit, or two 3" conduits.	- Ease of future communication expansion. - Provide City-owned communication system for improved manageability
Ethernet Switches	Communication between field equipment and traffic management centers	Managed and industrial switches with Gigabit speeds for all field installed devices At least 6 RJ-45 ports (ITS device connections to switches) and 2 fiber ports	- Ease of future communication expansion. - Improve manageability and operation for maintenance personnel. - Improve data transmission rates
Central System Workstation	Traffic Management	Maintain current versions of all software on the Central System Workstation to ensure consistency with SRTMC	- Improve City ITS system integration - Improve interagency cooperation and data sharing

5 DEPLOYMENT PLAN

This section summarizes the recommended ITS projects, project prioritization process, and how the cost estimates were prepared. Each project proposes future ITS upgrades that are consistent with the Spokane Regional ITS Architecture Plan to fulfill the following objectives:

- Provide access to transportation information
- Provide capability to access and control ITS devices
- Provide ability to implement coordinated incident management strategies
- Provide information dissemination to the general public

5.1 PRIMARY ITS CORRIDORS

The key arterials within the City that provide for the majority of regional and local mobility for City residents, visitors, and customers will also serve as the primary ITS corridors. ITS solutions will have the greatest opportunity along these corridors to better manage the facilities and provide for the most efficient use of City resources. ITS devices will be deployed by first completing a fiber communication backbone to link the devices together and then back to the SRTMC. The ITS devices and applications will then monitor and manage these corridors in real-time. The following corridors have been identified as the primary ITS corridors and are also shown on Figure 4.

- Sprague Avenue
- N Pines Road (SR 27) Corridor
- Sprague Avenue/Sullivan Road Corridor
- Argonne Road / Mullan Road/Dishman-Mica Road Corridor
- Sullivan Road Corridor
- Sprague Avenue/Appleway Avenue/Sullivan Road Corridor
- S Pines Road (SR 27) Corridor
- Trent Avenue (SR 290) Corridor
- Trent Avenue (SR 290)/Park Road/Broadway Avenue/Fancher Road/Sprague Avenue Corridor
- Evergreen Road/24th Avenue Corridor
- 32nd Avenue/Bowdish Road Corridor

Appendix A lists the proposed ITS projects on the corridors identified and provides a detailed description of each. The project sheets in Appendix A include the following information.

- Project Description and Need: Summarize the technologies that form the particular project and the benefit.
- Project Location Map: Schematically represents the project location. Specific project limits and inclusions would be detailed in a preliminary design process.
- Project Dependencies: Indicates the core dependencies in which the identified project relies on for effective implementation of ITS.
- Project Components: Indicates the main ITS components that are required in the identified project corridors.

Implementation of the ITS projects should follow the system and design guidelines presented in Appendix D. The guidelines are tailored to system needs for the City of Spokane Valley.

5.2 PHASED PROJECT PRIORITIZATION

Project priorities as presented in order of precedence in Appendix A were established based on a range of transportation-centered criteria and future growth. The key criteria identified in the prioritization process of corridor projects include:

- Anticipated increase in delay per vehicle at each intersection within the corridor,
- Annual average daily traffic along the corridor,
- Degree the corridor serves regional traffic, and
- Availability of existing conduits, copper, or fiber.

Based on the criteria identified above, Projects 1-3 in Appendix A are ranked with higher priority and are identified as planned projects in the City of Spokane Valley where funding has already been allocated for design or construction.

Projects 4-7 in Appendix A are projects identified as proposed ITS corridors within a 6-year period. Within this category of planned projects, prioritization is determined based on traffic volumes and consideration for cost-to-benefit ratio with respect to the criteria identified above. Project 4 is unique in that partial ITS upgrades will be deployed as part of a current roadway project along Argonne Road where fiber optic communication will be installed north of I-90.

Projects 8-11 in Appendix A are projects identified as longer-term ITS corridors where implementation will occur beyond a 6-year period. Completion of projects identified in this category of ITS corridors will enable the City to install the remaining links to establish a citywide fiber optic ring topology, thereby providing citywide communication redundancy.

As fiber optic communication is installed as part of the projects identified in Appendix A, it is recommended that the City also prioritize relocation of existing Wireless Ethernet radios. Relocation of the radios will provide a means for temporary communication system expansion for additional signal controllers and ITS devices within the City. As more projects are completed over time, a gradual phase-out of the wireless Ethernet radios will exist where the entire system will be dependent on the fully-established redundant fiber optic infrastructure.

5.3 PROJECT COST ESTIMATES

Preliminary cost estimates were prepared for each project in order to evaluate the costs required to implement an ITS system for the City of Spokane Valley. All cost estimates are prepared in 2011 dollars and represent a best estimate based on current equipment costs and construction rates. Project costs will fluctuate over time and will require a more detailed cost estimate when project design begins. The cost estimates are presented to provide the City with planning-level information to use for budgeting and grant application purposes. The specific components of each cost estimate are detailed in Appendix B. Estimated costs are also shown in the individual project sheets in Appendix A.

5.4 FUNDING

The funding of ITS traffic projects is very fluid in nature. The approved budget for maintenance and operations can be increased to allow replacement of older equipment. Knowing that electronic components in the ITS field will have a shorter life cycle than the signal poles and heads should allow the budget to separate out the electronics. It is recommended to have budget set aside for potential grant matching. There are consistently new grants that come through the federal or state government, and to be positioned with an established plan and grant matching budget will allow for a greater chance of success for obtaining grant dollars. With the applications for each grant, there will be a need to identify the fuel savings, change in emission quality, and increase in safety. Funding is more readily allocated to projects that encourage alternative modes of transportation, especially transit. This ITS Strategic plan will make the City more competitive for future grant funding.

5.5 IMPLEMENTATION

The ITS projects may be implemented in two ways: either on a corridor by corridor basis or as part of a system implementation process as funding allows. This implementation plan presents projects planned along 11 corridors which are the City's main arterials that include the necessary infrastructure for ITS applications.

The City may choose to move ahead in a comprehensive manner by completely funding all projects identified or, depending upon funding and timing, the City may choose to separate out pieces of these projects at any time. This project has been detailed and prioritized as part of this plan, which includes a cost estimate assuming completion of the project at one time.

Appendix A: ITS PROJECT SHEETS

Project 1:

Sprague Avenue Corridor
(between University Road and Progress Road)

Project Description and Need:

The Sprague Avenue corridor is a principal east-west arterial. It provides for inter-city connectivity and access to a large number of businesses within the city. Sprague Avenue is also a major transit corridor in the area providing connections to downtown Spokane via bus route #90. This project will allow for improved signal operations and maintenance efficiencies.

The proposed upgrades will improve access to Pines Road (SR 27) and I-90 by reducing travel times along the corridor and improving signal operations. This project is found to be of a high priority based on the relative traffic volumes to other roadways in the city, connectivity to other principal arterials and freeways, and access to businesses in the city.

This project will include the design and installation of two CCTV cameras and extension of the fiber optic trunk line terminated at Appleway Boulevard/University Road. The proposed fiber communication along the corridor will provide interconnection between all signalized intersections along the proposed ITS corridor. Installation of fiber communication along this corridor will enable the relocation of two wireless Ethernet devices. This connection will also allow for communication to the SRTMC, Spokane Valley City Hall, and the new City maintenance facility on the south side of Sprague Avenue.

Project Location Map:

Project Dependencies:

- Coordination with the WSDOT to utilize available strands on the I-90 fiber optic trunk line to establish communication to SRTMC.

Project Components:

- 2.2 Miles Fiber Communication System
- 2 CCTV Camera
- 7 Ethernet Switches
- 1 Hub Cabinet

Estimated Project Cost (2011 $)

$334,000

Project 2:

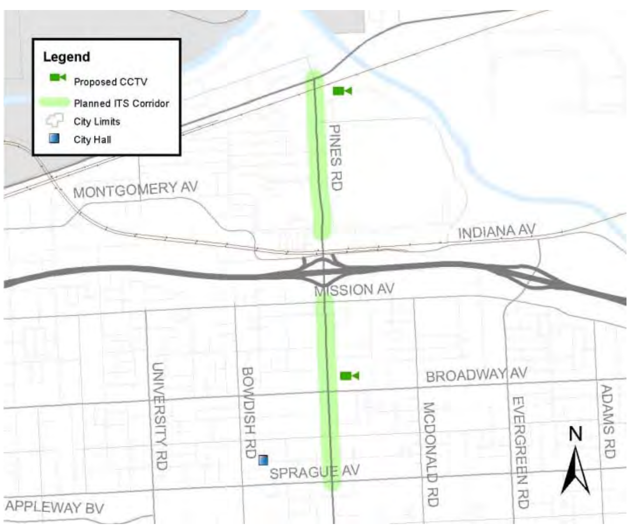
N Pines Road (SR 27) Corridor
(Between Trent Avenue (SR 290) and Sprague Avenue)

Project Description and Need:

The N Pines Road (SR 27) corridor is a north-south principal arterial connecting Spokane Valley to other major east-west arterials and features a full interchange with I-90. Traffic along this corridor exceeds 25,000 vehicles per day at various locations. This ITS project will help improve signal and traffic operations and maintenance efficiencies along portions of N Pines Road (SR 27). Improvements along this corridor will also help to improve travel times for the large volume of traffic this roadway experiences.

This project will include two CCTV cameras, approximately 2.3 miles of fiber optic communications and new conduit between Trent Avenue (SR 290) and Sprague Avenue. The proposed fiber optic communication along this corridor will be connected to the Sprague Avenue fiber optic trunk line. Complemented with the completion of Project 1, this project will enable the city to establish a fiber ring topology bounded by fiber links on Sprague Avenue, Appleway Boulevard, I-90 and Pines Road (SR 27). The fiber ring topology will benefit the city by adding failure redundancy to the city's communication infrastructure. This connection will provide communication back to the SRTMC. This project will require collaboration with WSDOT for installations on N Pines Rd and utilizing the WSDOT I-90 fiber trunk line as part of the city's fiber optic ring topology.

Project Location Map:



Estimated Project Cost (2011 $)

$1,193,000

Project Dependencies:

- Coordination with WSDOT to interconnect city signals with I-90 ramp signals and utilize I-90 fiber optic trunk line to establish communication to SRTMC.
- Establishes a fiber optic ring topology with the completion of Project 1.

Project Components:

- 2.3 Miles Fiber Communication System
- 2 CCTV Cameras
- 6 Ethernet Switches
- 1 Hub Cabinet

Project 3:

Sprague Avenue/Sullivan Road Corridor
(between Evergreen Road on Sprague Avenue and I-90 on Sullivan Road)

Project Description and Need:

The Sprague Avenue and Sullivan Road corridors are principal arterial roadways in the City. The identified section of roadways provides for inter-city connectivity and access to many of the City's businesses along Sprague Avenue. Additionally, the I-90 / Sullivan Road interchange is one of the most utilized access points to I-90 within the City.

The proposed upgrades will improve access to I-90 by reducing travel times along the arterials identified and improving signal operations. This project is found to be of a high priority based on the relative traffic volumes to other roadways in the city, connectivity to other principal arterials and freeways, and access to businesses in the city.

This project will include the design and installation of three CCTV cameras, extension of the fiber optic trunk line on Sprague Avenue to Sullivan Road, and a new fiber optic connection on Sullivan Rd between Missions Avenue and Sprague Avenue. The proposed fiber communication along the corridor will provide interconnection between all signalized intersections along the proposed ITS corridor, allowing remote access to field devices from a central system workstation. Additionally, this project will enable the relocation of two wireless Ethernet devices to provide wireless interconnection elsewhere in the city. This project will require collaboration with the WSDOT to interconnect City signals with the I-90 ramp signals.

Project Location Map:

Estimated Project Cost (2011 $)

$702,000

Project Dependencies:

- Coordination with the WSDOT to interconnect city signals with I-90 ramp signals and utilize I-90 fiber optic trunk line to establish communication to SRTMC.
- Establishes a fiber ring topology with the completion of Project 1.

Project Components:

- 1.8 Miles Fiber Communication System
- 1.0 Miles of Conduit
- 3 CCTV Cameras
- 8 Ethernet Switches
- 1 Hub Cabinet

Project 4:

Argonne Road/Mullan Road/Dishman-Mica Road ITS Corridor
(between Trent Avenue (SR 290) and Bowdish Road)

Project Description and Need:

Argonne Road and Mullan Road form a north-south one way couplet roadway system and serve as major principal arterial connections between I-90 and the Spokane Valley city center. Argonne Road and Mullan Road connect with Dishman-Mica Rd, another highly utilized principal arterial, towards the south. Together, the three principal arterials provide north-south connectivity for western communities in Spokane Valley. This project will allow for improved signal operations and maintenance efficiencies.

This project will include the design and installation of four CCTV cameras as well as 5 miles of new conduit and fiber optic interconnect between Trent Avenue (SR 290) and Bowdish Road. The proposed fiber communication along the corridor will enable communication with all signalized intersections and ITS devices from the SRTMC. The City currently has immediate plans to install fiber optic interconnect and CCTV cameras between I-90 and Trent Ave on this corridor as part of a roadway construction project. The full build-out of this project is expected to be completed over a longer timeframe. This project will require collaboration with the WSDOT to interconnect City signals with the I-90 ramp signals.

Project Location Map:

Project Dependencies:

- Coordination with the WSDOT to coordinate signals at the I-90 interchange to improve travel time through the proposed ITS corridor.

Project Components:

- 5.0 Miles Fiber Communication System
- 5.0 Miles of Conduit
- 4 CCTV Cameras
- 19 Ethernet Switches
- 1 Hub Cabinet

Estimated Project Cost (2011 $)

$2,618,000

Project 5:

Sullivan Road ITS Corridor
(between I-90 and Trent Avenue (SR 290))

Project Description and Need:

The Sullivan Road corridor is major north-south arterial which serves as a major access point into the Spokane Valley city limits from the east. Additionally, the Sullivan Road corridor between I-90 and Trent Ave is a highly utilized principal arterial that provides north-south connectivity for many industrial establishments. ITS upgrades along Sullivan Road will provide improved signal operations and maintenance efficiencies for the eastern communities of Spokane Valley.

This project will include the design and installation of one CCTV camera as well as new conduit and fiber optic interconnect along the identified corridor. This project will enable all ITS and signal devices along the corridor to communicate with the SRTMC. Additionally, interconnection will allow for remote access to signal and ITS devices to improve maintenance efficiencies. This project will require collaboration with the WSDOT to interconnect City signals with the I-90 ramp signals.

Project Location Map:

Project Dependencies:

- Coordination with the WSDOT to interconnect city signals with I-90 ramp signals and utilize I-90 fiber optic trunk line to establish communication to SRTMC.

Project Components:

- 1.8 Miles Fiber Communication System
- 1.8 Miles of Conduit
- 1 CCTV Camera
- 7 Ethernet Switches

Estimated Project Cost (2011 $)

$877,000

Project 6:

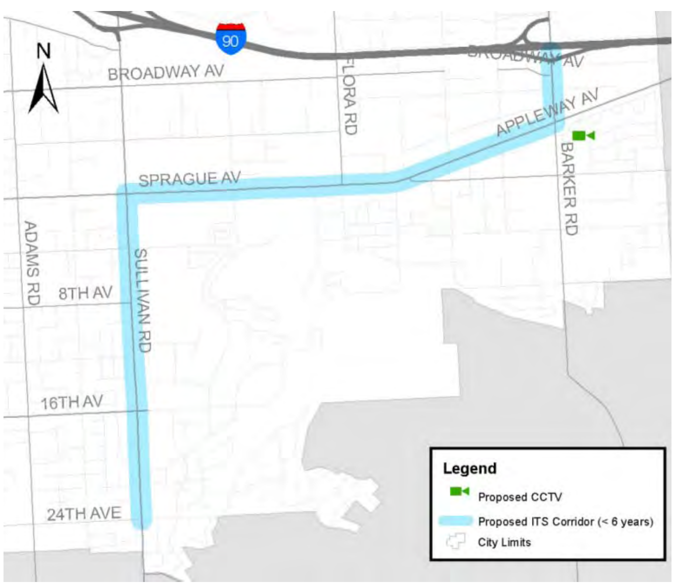
Sprague Avenue/Appleway Avenue/Sullivan Road ITS Corridor
(Sprague & Appleway between Sullivan Road and Barker Road; on Sullivan Road between Sprague and 24th Ave)

Project Description and Need:

The Sprague Ave/Appleway Ave corridor is an east-west principal arterial which serves as a major access point into the Spokane Valley city limits from the east. Additionally, the Sullivan Rd corridor is a highly utilized principal arterial that provides north-south connectivity within the City. Together, the two corridors provide connectivity and access for the eastern communities of Spokane Valley. ITS upgrades along the identified roadways in this project will provide improved traveler information, signal operations, and maintenance efficiencies for the eastern communities of Spokane Valley.

This project will include the design and installation of one CCTV camera as well as new conduit and fiber optic interconnect along the identified corridor. This project will enable all ITS and signal devices along the corridor to communicate with the SRTMC. Additionally, interconnection allows for remote access to the devices to improve maintenance efficiencies. This project will require collaboration with the WSDOT to interconnect City signals with the I-90 ramp signals in order to establish a fiber optic ring topology within the City.

Project Location Map:



Estimated Project Cost (2011 $)

$1,634,000

Project Dependencies:

- Coordination with the WSDOT to interconnect city signals with I-90 ramp signals and utilize I-90 fiber optic trunk line to establish communication to SRTMC.
- Establishes a fiber ring topology with the completion of Project 3.

Project Components:

- 4.2 Miles Fiber Communication System
- 3.4 Miles of Conduit
- 1 CCTV Cameras
- 9 Ethernet Switches

Project 7:

S Pines Road (SR 27) ITS Corridor
(between Sprague Avenue and 32nd Avenue)

Project Description and Need:

S Pines Road (SR 27) is a major north-south state route which serves as a major access point into the Spokane Valley city limits from the south. This ITS project will allow for improved traveler information, signal operations, and maintenance efficiencies.

This project will include the design and installation of two CCTV cameras, new conduit and fiber optic interconnect along the identified corridor, one signal upgrade, and one highway advisory radio transmitter. The proposed fiber communication along the corridor will enable traffic operations staff to communicate with all signalized intersections along this proposed ITS corridor using the existing i2TMS system. This project also includes the upgrade of one Peek 3000E legacy controller at S Pines Road/32nd Avenue to a 2070 controller. This controller upgrade will also enable traffic operations staff to communicate directly with the controller using i2TMS. This project will require collaboration with the WSDOT to coordinate ITS and signal upgrades on the state route as signal equipment along this corridor is currently maintained by the WSDOT.

Project Location Map:

Project Dependencies:

- Coordination with the WSDOT to upgrade signal and communication infrastructure as well as install ITS equipments along the state route.
- Fiber connection at Sprague Avenue installed by Project 1 or Project 2.

Project Components:

- 2.3 Miles Fiber Communication System
- 2.3 Miles of Conduit
- 2 CCTV Cameras
- 4 Ethernet Switches
- 1 Highway Advisory Radio
- 1 Signal Controller Upgrade

Estimated Project Cost (2011 $)

$1,219,000

Project 8:

Trent Avenue (SR 290) Corridor
(between Pines Road (SR 27) and Barker Road)

Project Description and Need:

The Trent Avenue (SR 290) corridor lies on the northern border limits of the City of Spokane Valley. It is an important state highway providing east-west connectivity between the neighborhoods of Trentwood and Millwood. Trent Avenue (SR 290) serves as an important connector between Spokane Valley and Spokane. ITS upgrades along this corridor will provide improved signal operations and maintenance efficiencies as well as provide the missing link to deploy a fiber ring topology within the city.

This project will include the design and installation of one CCTV camera and 4.1 miles of new conduit and fiber optic interconnect along the identified corridor. This project will enable all ITS and signal devices along the corridor to communicate with the SRTMC. Complemented with the completion of Projects 2 and 5, this project will also provide the city with a fiber optic ring topology for the roadways bounded by SR 290, Sprague Avenue, Sullivan Road, and Pines Road. A fiber ring topology is advantageous because it creates a system redundancy in which the direction of data transmission can reverse in the situation that a particular link in the fiber connection malfunctions or is severed.

Project Location Map:

Estimated Project Cost (2011 $)

$1,952,000

Project Dependencies:

- Collaboration with WSDOT to install ITS upgrades along Trent Avenue (SR 290)
- Fiber connection along Pines Road installed by Project 2.
- Fiber connection along Sullivan Road installed by Project 5.

Project Components:

- 4.1 Miles Fiber Communication System
- 4.1 Miles of Conduit
- 1 CCTV Cameras
- 2 Ethernet Switches

Project 9:

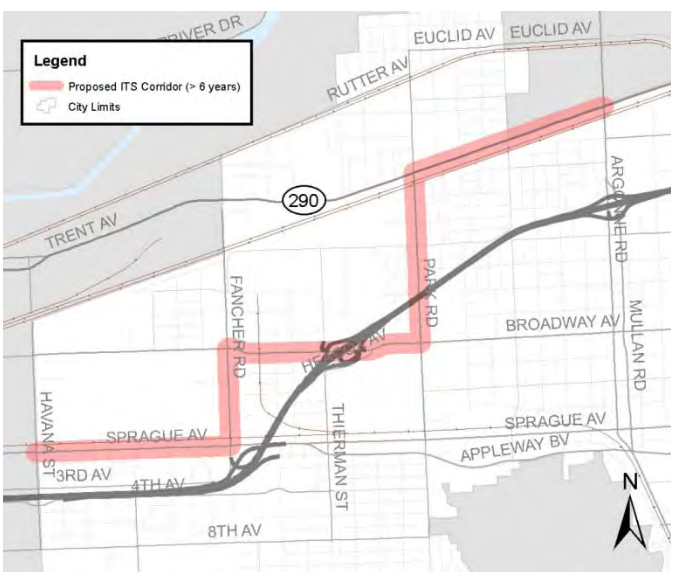
Trent Avenue (SR 290)/Park Road/Broadway Avenue/Fancher Road/Sprague Avenue ITS Corridor
(roadway segments as identified on project location map below)

Project Description and Need:

This project will include the design and installation of 4.4 miles of new fiber optic interconnect and 3.4 miles of new conduit on a combination of roadway segments along Trent Avenue (SR 290), Park Road, Broadway Avenue, Fancher Road, and Sprague Avenue as identified on the project location map below. This project will enable all ITS and signal devices along the identified corridor to communicate with the SRTMC. This project will require collaboration with the WSDOT to install ITS upgrades along Trent Avenue (SR 290) and to interconnect City signals with the WSDOT ramp signals at the I-90/Broadway interchange.

Complemented with the completion of Project 4, installation of fiber optic communication infrastructure on the identified roadways would establish a fiber optic ring topology. A fiber ring topology is advantageous because it creates a system redundancy in which the direction of data transmission can reverse in the situation that a fiber link between two adjacent signals malfunctions or is severed.

Project Location Map:



Project Dependencies:

- Collaboration with WSDOT to install ITS upgrades along SR 290.
- Coordination with the WSDOT to interconnect city signals with I-90 ramp signals and utilize I-90 fiber optic trunk line to establish connection to SRTMC.
- Establishes a fiber ring topology with the completion of Project 4.

Project Components:

- 4.4 Miles Fiber Communication System
- 3.4 Miles of Conduit
- 7 Ethernet Switches
- 1 Hub Cabinet

Estimated Project Cost (2011 $)

$1,641,000

Project 10:

Evergreen Road/24th Avenue ITS Corridor
(roadway segments as identified on project location map below)

Project Description and Need:

This project will include the design and installation of 2.6 miles of new conduit and fiber optic interconnect on the combination of roadway segments along Evergreen Road and 24th Road as identified on the project location map below. This project will enable all ITS and signal devices along the identified corridor to communicate with the SRTMC.

By installing fiber optic communication infrastructure on the identified roadways (complemented with the completion of Projects 1 and 6), it is possible for the city to create a fiber optic ring topology. A fiber ring topology is advantageous because it creates a system redundancy in which the direction of data transmission can reverse in the situation that a fiber link between two adjacent signals malfunctions or is severed.

Project Location Map:

Project Dependencies:

- Fiber connection at Sprague Avenue installed by Project 1.
- Fiber connection at Sullivan Road installed by Project 6.

Project Components:

- 2.6 Miles Fiber Communication System
- 2.6 Miles of Conduit
- 2 Ethernet Switches

Estimated Project Cost (2011 $)

$1,122,000

Project 11:

32nd Avenue/Bowdish Road ITS Corridor
(roadway segments as identified on project location map below)

Project Description and Need:

This project will include the design and installation of 2.0 miles of new conduit and fiber optic interconnect on the combination of roadway segments along 32nd Avenue and Bowdish Road as identified on the project location map below. This project will enable all ITS and signal devices along the identified corridors to communicate with the SRTMC.

By installing fiber optic communication infrastructure on the identified roadways (complemented with the completion of Projects 4 and 7), it is possible for the city to create a fiber optic closed ring topology. A fiber ring topology is advantageous because it creates a system redundancy in which the direction of data transmission can reverse in the situation that a fiber link between two adjacent signals malfunctions or is severed. In addition to communication infrastructure upgrades, this project will include the upgrade of two City-owned Peek 3000E legacy controllers to Eagle M52 Ethernet equipped controllers in the south side of the city. This upgrade will enable traffic operations staff to control and monitor intersections remotely.

Project Location Map:

Project Dependencies:

- Fiber connection at Dishman-Mica Road installed by Project 4.
- Fiber connection at S Pines Road (SR 27) installed by Project 7.

Project Components:

- 2.0 Miles Fiber Communication System
- 2.0 Miles of Conduit
- 2 Ethernet Switches

Estimated Project Cost (2011 $)

$900,000

APPENDIX B: PROJECT COST ESTIMATES

Planning Level Project Estimates

	Equipment and Installation Costs														Design and Construction Management Costs				TOTAL
	Signal Controller Upgrades	CCTV Camera Systems	Highway Advisory Radio Station	Comm. Cabinet	Single Mode Fiber Optic Cable - SMFO (lf)	Conduit (lf)	Ethernet Switches	Gigabit Ethernet Hub Switch	Junction Boxes	Pull Box	***Equipment Subtotal***	***Sales Tax***	**Construction[3]**	**Equipment & Installation Subtotal**	Design (% of Equipment & Installation)	Contingency	Construction Management (% of Equipment & Installation)	**Design/CM Subtotal**	**Total Project Cost**
Unit Costs (in 2011 Dollars)	$3,000	$15,000	$15,000	$5,700	$3	$8	$1,700	$7,000	$400	$1,500		**9%**	**80%**		35%	10%	10%		
***Corridor Projects*:**																			
1 - Sprague Avenue Corridor	0	2	0	1	13,500	700	6	1	5	2	**$104,000**	**$9,400**	**$105,600**	**$219,000**	$73,400	$21,000	$21,000	**$115,400**	**$334,000**
2 - N Pines Road (SR 27) Corridor	0	2	0	1	11,900	11,900	5	1	5	24	**$220,100**	**$19,800**	**$556,900**	**$777,000**	$265,000	$75,700	$75,700	**$416,400**	**$1,193,000**
3 - Sprague Avenue/Sullivan Road Corridor	0	3	0	1	9,400	5400	7	1	2	11	**$158,300**	**$14,200**	**$299,400**	**$457,700**	$155,200	$44,400	$44,400	**$244,000**	**$702,000**
4 - Argonne Road/Mullan Road/Dishman-Mica Road Corridor	0	4	0	1	26,400	26,400	18	1	11	53	**$477,600**	**$43,000**	**$1,226,900**	**$1,704,500**	$581,500	$166,200	$166,200	**$913,900**	**$2,618,000**
5 - Sullivan Road Corridor	0	1	0	0	9,600	9,600	7	0	19	4	**$146,100**	**$13,100**	**$424,100**	**$570,200**	$195,000	$55,700	$55,700	**$306,400**	**$877,000**
6 - Sprague Avenue/Appleway Avenue/Sullivan Road Corridor	0	1	0	0	22,000	17,700	9	0	20	20	**$275,900**	**$24,800**	**$787,100**	**$1,063,000**	$363,400	$103,800	$103,800	**$571,000**	**$1,634,000**
7 - S Pines Road (SR 27) Corridor	1	2	1	0	12,100	12,100	4	0	5	24	**$225,900**	**$20,300**	**$567,900**	**$793,800**	$270,700	$77,400	$77,400	**$425,500**	**$1,219,000**
8 - Trent Avenue (SR 290) Corridor	0	1	0	0	21,500	21,500	2	0	9	43	**$323,000**	**$29,100**	**$946,400**	**$1,269,400**	$434,100	$124,000	$124,000	**$682,100**	**$1,952,000**
9 - Trent Avenue (SR 290)/Park Road/Broadway Avenue/Fancher Road/Sprague Avenue Corridor	0	0	0	1	23,200	17,800	6	1	22	22	**$276,700**	**$24,900**	**$791,000**	**$1,067,700**	$365,000	$104,300	$104,300	**$573,600**	**$1,641,000**
10 - Evergreen Road/24th Avenue Corridor	0	0	0	0	13,500	13,500	2	0	25	2	**$164,900**	**$14,800**	**$563,900**	**$728,800**	$249,900	$71,400	$71,400	**$392,700**	**$1,122,000**
11 - 32nd Avenue/Bowdish Road Corridor	2	0	0	0	10,600	10,600	2	0	19	2	**$136,600**	**$12,300**	**$448,500**	**$585,100**	$200,500	$57,300	$57,300	**$315,100**	**$900,000**
Total for Corridor Projects	3	16	1	5	173,700	147,200	68	5	142	207	**$2,509,000**	**$226,000**	**$6,718,000**	**$9,236,000**	$3,153,700	$901,200	$901,200	$4,956,100	**$14,192,000**
																	Total for All Projects		**$14,192,000**

***Notes*:**

1. All future signalized intersection ITS equipment are not included.
2. Sales tax applies to materials only.
3. 80% of Equipment + $32/lf for trenching conduit

Transpo Group
May 2011

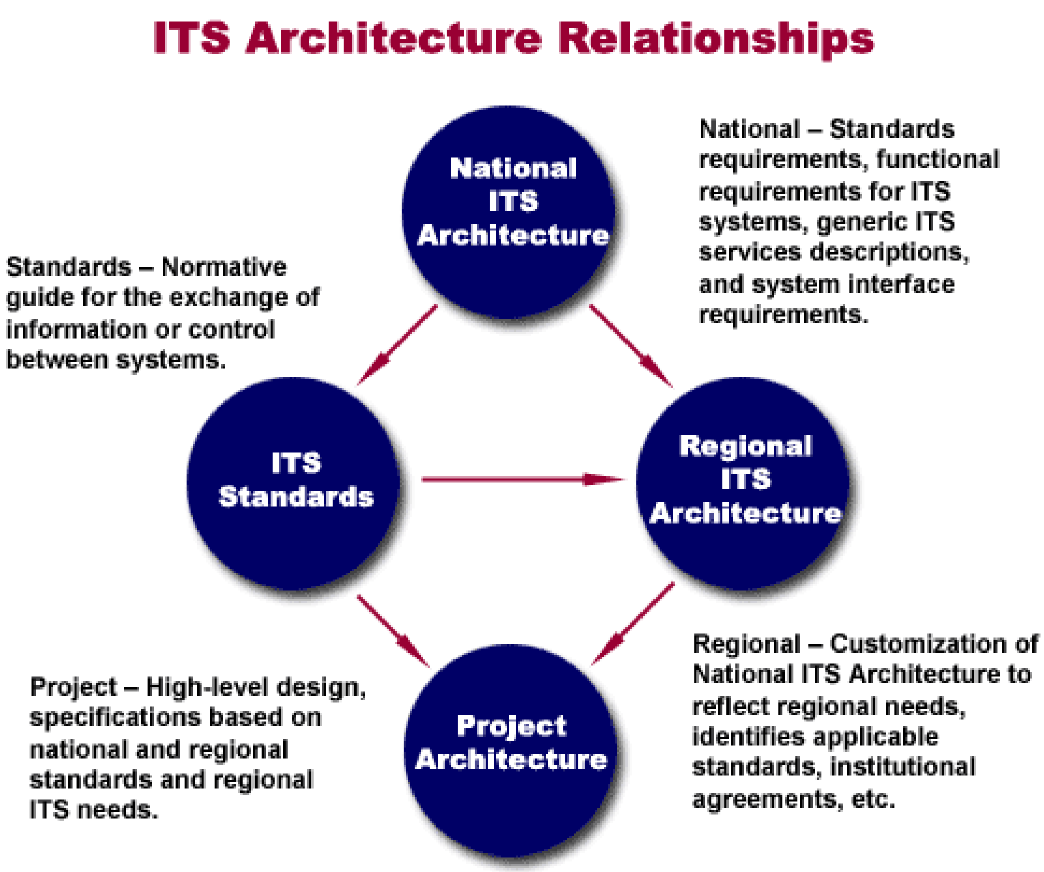
APPENDIX C: ITS SYSTEM ARCHITECTURE

An ITS system architecture, established by the United States Department of Transportation (USDOT), explains what various devices do to help safety and efficiency on roadways and how to connect devices and software together. The USDOT developed standards and definitions of the various devices and how they interact with users of the system. This section discusses the national and regional ITS architecture and will help identify which technology the City may want to install and what the City will need to implement to connect the system together. Every ITS project must comply with national and regional architectural structure and standards.

This section is more technical due to the definitions of the different components of the entire ITS network. The National ITS Architecture provides a common framework for planning, defining, and integrating ITS. It defines the functions that must be performed by subsystems, where these functions reside (e.g., field, traffic management center, in vehicle), the interfaces and architecture flows to/from the subsystems, and the communications requirements for the architecture flows. It is a mature product that reflects the contributions of a broad cross-section of the ITS community (e.g., transportation practitioners, systems engineers, system developers, technology specialists). The ITS Standards Program has teamed with standards development organizations and public agencies to accelerate the development of open, non-proprietary communications interface standards. These standards define how ITS systems and components interconnect and exchange information to deliver ITS services within a multi-modal transportation network. The consistent and widespread use of ITS standards will permit data and information sharing among public agencies and private organizations, fostering an environment of information sharing and interoperability.

Within the region, the SRTC has also issued a Regional ITS Architecture Plan and Implementation Plan in 2000. This plan was written based on the National ITS Architecture and helps to identify existing ITS systems in the region and helps to address the needs of the region's stakeholders through future deployment of ITS. Key stakeholders in this plan include: Spokane County, Spokane Regional Transportation Council (STRC), City of Spokane, WSDOT, and Spokane Transit Authority (STA). The Spokane Regional ITS Architecture plan identifies the needs for Traffic Control/Information Coordination between local agencies and SRTMC to take place where the SRTMC is where Traffic Management Subsystems, Archived Data Management, Information Service Provider Subsystem, and Transit Management Subsystem take place. As another stakeholder in the region, Spokane Valley's ITS systems/subsystems and information flow would also adhere to the plans and visions for ITS deployment established in the region and meet the three primary objectives of the regional architecture. The three primary objectives of the Spokane regional architecture include:

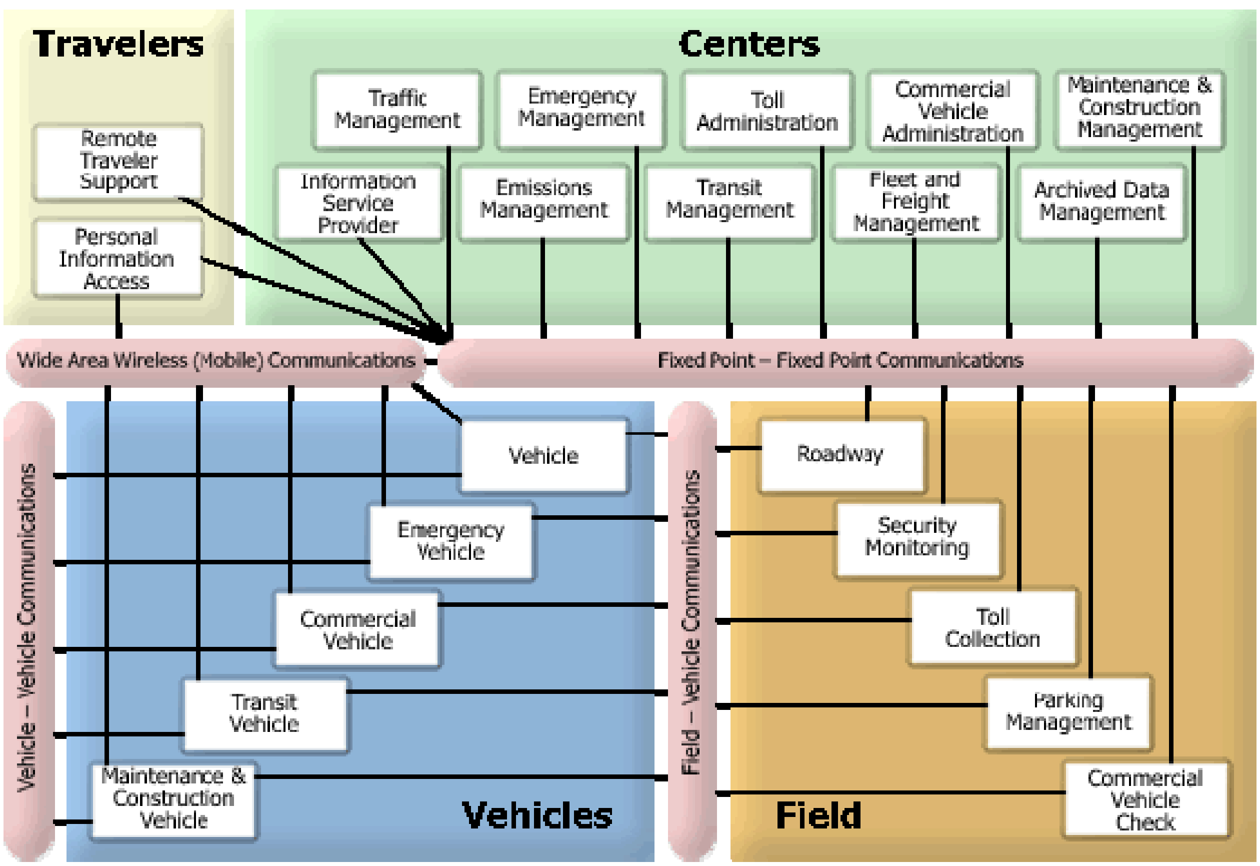
- Interoperability, integration and connectivity between systems and modes
- Efficient system management and operation
- An emphasis on preserving the existing and future transportation system



ITS architecture is a technical and institutional framework for the deployment of ITS. Institutional integration involves coordination between various agencies and jurisdictions to achieve seamless operations and/or interoperability. The technical framework guides and moderates the evolution of the various interconnected ITS elements. It provides standards in order to ensure the ease of integration of hardware, software, data, and communications. The overall architecture also identifies the applications and ITS packages important to the City and the likely benefits the components will provide.

NATIONAL AND REGIONAL ITS ARCHITECTURE

The National ITS Architecture provides a common framework for planning, defining, and integrating ITS. The National ITS Architecture was developed by the United States Department of Transportation (USDOT). The National ITS Architecture also provides guidelines for the development of Regional ITS Architecture. The Figure provides an overview of the National ITS Architecture.



NATIONAL ITS ARCHITECTURE OVERVIEW

The ITS Architecture defines the following types of components:

- The functions (e.g., gather traffic information or request a route) that are required for ITS.
- The physical entities or subsystems where these functions reside (e.g., in the field or the vehicle).
- The information flows and data flows that connect these functions and physical subsystems together into a complete integrated system.

The ITS Architecture is developed from the following processes:

Assessment of user needs and services requirements: The determination of user needs and service requirements is the first step to the development of an ITS Architecture. User services represent what the system will do from the perspective of the user. A number of functions are required to accomplish each user service. To reflect this, each of the user services is broken down into successively more detailed functional statements, called user service requirements (USRs). The logical architecture defines the processes or functions that are required to satisfy the user services.

Identification of Market Packages: The second step in developing an architecture is to identify the transportation services, or "Market Packages," that are important to the City. Market packages identify pieces of the physical architecture required to implement specific ITS services. A market package combines different subsystems, equipment packages, terminators, and architecture flows that provide the desired service.

SPOKANE VALLEY ITS MARKET PACKAGES

By mapping the needs identified by the stakeholders as part of the needs assessment to the Market Packages listed in the National ITS Architecture (Appendix B), several market packages were selected to meet the City's needs. There are five ITS Market Packages selected for the City of Spokane Valley:

- ITS Data Mart Market Package
- Network Surveillance Market Package
- Surface Street Control Market Package
- Traffic Information Dissemination Market Package

The selected market packages are consistent with the market packages identified in *the Spokane Regional ITS Architecture Plan* for other public agencies in the Spokane region. The descriptions below explain each of the market packages in more detail.

ITS DATA MART MARKET PACKAGE

ITS Data Mart (AD1) Market Package is a defined way to store data collected by the ITS systems and provides a focused archive that houses data collected and owned by the City. It provides the basic data quality, data privacy, and data management common to all ITS archives and provides general query and report access to archive data users.

NETWORK SURVEILLANCE MARKET PACKAGE

Network Surveillance (ATMS01) Market Package includes traffic detectors, other surveillance equipment, the supporting field equipment, and fixed-point to fixed-point communications to transmit the collected data back to the Traffic Management Subsystem. The derived data can be used locally such as when traffic detectors are connected directly to a signal-controlled system or remotely (e.g., when a CCTV system sends data back to the Traffic Management Subsystem). The data generated by this Market Package enables traffic managers to manage 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 other users.

SURFACE STREET CONTROL MARKET PACKAGE

Surface Street Control (ATMS03) Market Package provides the central control and monitoring equipment, communication links, and the signal control equipment that support local surface street control and/or arterial traffic management. A range of traffic signal control systems are represented by this Market Package ranging from fixed-schedule control systems to fully traffic responsive systems that dynamically adjust control plans and strategies based on current traffic conditions and priority requests. Additionally, general advisory and traffic control information can be provided to the driver while en route. This Market Package is generally an intra-jurisdictional package that does not rely on real-time communications between separate control systems to achieve area-wide traffic signal coordination. Systems that achieve coordination across jurisdictions by using a common time base or other strategies that do not require real time coordination would be represented by this package.

TRAFFIC INFORMATION DISSEMINATION MARKET PACKAGE

Traffic Information Dissemination (ATMS06) Market 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, 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. A link to the Maintenance and Construction Management subsystem allows real time information on road closures due to maintenance and construction activities to be disseminated.

Matrix table of market packages vs. service provided

ITS Market Packages	ITS Services Bundle
ITS Data Mart	Archived Data Management
Network Surveillance	Travel and Traffic Management
Surface Street Control	Travel and Traffic Management
Traffic Information Dissemination	Travel and Traffic Management

LOCAL (SPOKANE VALLEY) ITS ARCHITECTURE

Identification of the specific ITS market packages, the logical and physical architecture were defined for the city. Spokane Valley's ITS architecture systems (Logical and Physical) identify the ITS requirements to meet the assessed needs of the city.

LOGICAL ARCHITECTURE

Logical architecture represents the functions that are required for ITS and the information that moves between these functions. The City's objectives supported by the "logical" functions are transmission of traffic flow and incident information, and device status and control. These functions support two primary "logical" functions described below.

TRAFFIC SURVEILLANCE / DATA COLLECTION

This process provides traffic surveillance, data storage, and communication with traffic management centers. Traffic surveillance provides vehicle information on surface streets by using traffic field devices. Long term data are stored and used by signal operations and maintenance, and city planners. The data are also available for dissemination to other ITS functions and to other stakeholders, travelers and transit users.

The City's intent to collect and share traffic data could be met by the development of a data management system. The primary dissemination technology for the general public will likely be via a traveler information system using technology such as the internet or dynamic message signs. The City will also be able to share and to leverage information from other stakeholder agencies such as WSDOT, SRTC, Spokane County, and City of Spokane.

ITS DEVICE CONTROL

This process enables traffic control through devices that output information to motorized travelers on the surface streets and freeway network served by the City, County and WSDOT. Different hardware is used to implement this function such as signal controllers, dynamic message signs, etc. Moreover, access and control of ITS devices is beneficial to support the City's current and future traffic management functions. Device Control supports various types of traffic management strategies (information dissemination, active diversions, and road closures).

The traffic monitoring process, previously discussed, provides the traffic flow data required by these management strategies. This process would also facilitate the detection of equipment faults. This process includes the ability to select, view and control CCTV cameras, DMS, and signals. This process allows the selection of appropriate traffic control strategies to be implemented, for normal and special situations and during the different times of day, days of week and/or year.

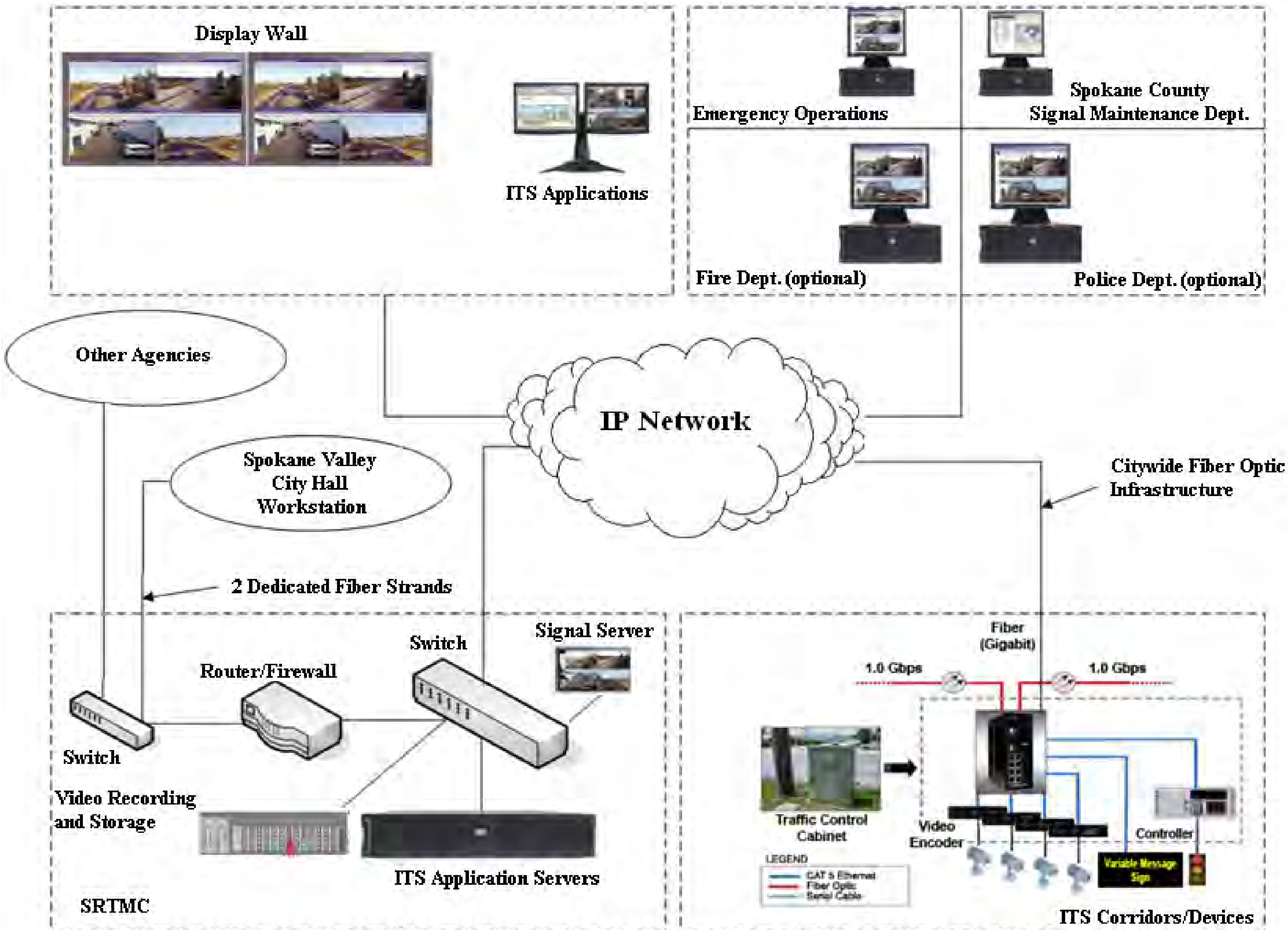
PHYSICAL ARCHITECTURE

The physical architecture addresses the physical structures, also named subsystems by the National ITS Architecture surrounding the "logical" functions described in the previous section and the equipment packages as described by the National ITS Architecture.

The overall physical architecture for the City is depicted in the Figure below and assumes the sharing of information and control capabilities will reflect pre-defined operational and procedural agreements between the agencies. The principal concept of Spokane Valley's physical architecture is connecting ITS devices, Spokane Valley's traffic management center, operators, public safety departments (Police, Fire, and Emergency management), and other agencies to the City's Wide Area Network (WAN) which allows communication between each of these components. The police, fire, and emergency management will be greatly enhanced by the sharing of real time data and live video associated to the roadway system that are vital to their service to the public.

The City's physical architecture subsystems, and related equipment packages, are described in details in the Figure below.

Spokane Valley ITS Physical Architecture



ARCHIVED DATA MANAGEMENT SUBSYSTEM

This is the first of three subsystems used in the ITS architecture. The three subsystems are data management, traffic management, and roadway management.

ITS DATA REPOSITORY

This equipment package collects data and data catalogs from one or more data sources and stores them in a dedicated repository that is suited to a particular set of ITS data users. This equipment package provides capabilities for performing quality checks on the incoming data, error notification, and archive coordination. This equipment package 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.

TRAFFIC MANAGEMENT SUBSYSTEM

This subsystem communicates with the other regional stakeholder Traffic Management Subsystems (TMS) to facilitate the provision of coordinated traffic information and control strategies in the agencies' jurisdictions. Traffic information is currently already coordinated through SRTMC. Additionally SRTMC also monitors and operates signal and monitors roadway conditions. However, Spokane Valley's TMS would include numerous equipment packages applied to their own Central System Workstation to meet the City's needs. These equipment packages are not necessarily separate "systems" - rather they represent separate (but related) technical "applications" that will be operated at the City's TMC.

TRAFFIC DATA COLLECTION

This equipment package collects and stores traffic information that is collected in the course of traffic operations performed by the Traffic Management Subsystem. This data can be used directly by operations personnel or it can be made available to other data users and archives in the region. This equipment package supports the collection of both real-time data (which would be used by agencies to provide traffic management services) and historical data (which could be used for planning purposes and also to analyze the effectiveness of certain traffic response strategies).

TRAFFIC AND ROADSIDE DATA ARCHIVAL

This equipment package collects and archives traffic and roadway information for use in off-line planning, research, and analysis. The equipment package 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.

TRAFFIC MONITORING

This equipment package collects, stores, and provides electronic access to the traffic monitoring data. This equipment package pertains primarily to CCTV camera images and traffic sensor data.

TMC TRAFFIC INFO DISSEMINATION

This equipment package provides the capability to disseminate real-traffic conditions and incident related information to travelers. In addition to these links, dissemination of information between agencies through a wide area network is also important.

TMC SIGNAL CONTROL

This equipment package 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 subsystem.

TRAFFIC EQUIPMENT MAINTENANCE

This equipment package provides monitoring and remote diagnostics of field equipment to detect field equipment failures, issues problem reports, and tracks the repair or replacement of the failed equipment.

ROADWAY SUBSYSTEM

ROADWAY MONITORING

This equipment package monitors traffic conditions using fixed equipment such as loop detectors, video detection and CCTV cameras.

ROADWAY DATA COLLECTION

This equipment package 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. This equipment package includes the sensors, supporting roadside infrastructure, and communications equipment that collects and transfers information to a center for archival.

ROADWAY TRAFFIC INFORMATION DISSEMINATION

This equipment package provides the roadside elements of traffic information dissemination including DMS, and talking pedestrian signs.

ROADWAY EQUIPMENT COORDINATION

This equipment package coordinates field equipment that is distributed along the roadway by supporting direct communications between field equipment. This includes coordination between remote sensors and field devices (e.g., Dynamic Message Signs) and coordination between the field devices themselves (e.g., coordination between traffic controllers that are controlling adjacent intersections).

BENEFITS OF ITS DEVICES

The following describes the benefits of the primary ITS devices recommended for implementation. System benefits would include such items as:

- improved travel times
- emergency operations
- travel safety
- travel advisory
- data management.

Other benefits would include sharing of data with other agencies, reduced vehicle emissions, staff capability to more quickly respond to incidents, and better transit speed and reliability. The table below summarizes the benefits that could be expected from each of the recommended devices.

Spokane Valley ITS System Benefits Summary

ITS Functions	Surface Street Control		Traffic Monitoring and Detection		Traveler Information		Communication Infrastructure
ITS Devices / Benefits	Signal Control Upgrade	Central System Workstation Upgrade	CCTV Monitoring	Data/Count Stations	Dynamic Message Signs	Highway Advisory Radio	Fiber Optic Backbone
Improve the Safety and Security of the Transportation System			X		X	X	X
Improve the Efficiency of the Transportation System	X	X	X	X	X		X
Provide Improved Traveler Information				X	X	X	X
Optimize Use of Transportation Infrastructure	X	X					X
Integrate ITS projects with local and regional partners	X	X	X	X	X		X

With the installation of ITS devices and a fiber communication network, there are some practical benefits that the City of Spokane Valley will gain.

- Allow traffic signals to be interconnected and managed at several locations as needed: Spokane Valley City Hall, SRTMC, Spokane County Signal Maintenance Department, WSDOT Signal Shop.
- Allows flexibility in implementing signal operations strategies
- Increase capacity by reduction of delay. A coordinated system will reduce delay by 20-25% and fuel consumption will be reduced 7-14%
- Reduces staff time required for investigating signal operation problems
- Monitor signal performance and identify signals that need re-timing
- Reduce time it takes to implement signal timing changes
- A traveler information system using DMS's can reduce travel time by up to 29%
- CCTV monitoring of the roadway has improved incident validation by 50-80% and improved incident response time by 5-12 minutes each incident.

APPENDIX D: COMMUNICATION SYSTEM DESIGN GUIDELINES

A robust communication system is critical in order to enable the deployment and operation of any ITS system. A robust system will allow multiple types of communication protocols to simultaneously be transmitted. It will also include redundant communication paths to allow equipment to find and continue to communicate when a failure or errors occur on the primary connection. The main goal for the Spokane Valley ITS communication system is to support the deployment and operation of the recommended ITS devices.

In order to provide the above functionalities, the communication system must provide a high bandwidth and speed network capable of supporting both video and data transmission. The system should also be scalable to accommodate future ITS applications in addition to other City communication needs.

BACKGROUND

As previously mentioned, the City has a very limited fiber cable. The existing ITS infrastructure on the fiber network is currently connected to the SRTMC's system. The remaining signal controllers within the City operate on a standalone basis. Segments of roadway within the city along Sprague Avenue, Appleway Avenue, Sullivan Road, Broadway Avenue, and Argonne Road have empty conduits constructed to accommodate future fiber optic interconnects. The City should install a high speed network that employs the Gigabit Ethernet (GigE) communication standard for the City ITS network. Gigabit Ethernet is a term describing various technologies for transmitting data at a rate of a gigabit per second.

DESIGN REQUIREMENTS AND CONSIDERATIONS

In this section, design requirements and considerations are defined for the development of a solid and manageable communication system.

RELIABILITY AND REDUNDANCY

The Spokane Valley ITS applications require that the communication system be operational at all times. This can be achieved using a system with the following strategies:

- Fault Tolerant: This is the ability to detect and handle failures and attacks in network nodes (communication connection points). Some example of failures and attacks are power failure, power surge, data loss, ITS device failure, unauthorized access, system overload, and viruses.
- Self Healing: This is a network architecture that can withstand a failure in its transmission paths such as power failure and surge.

- Route Redundant: This provides at least two communication routes from a source node to a destination node to handle data overload and physical communication failure. For example, when one of the communication routes has a failure (fiber optic breakage) point, the communication network will transmit data via the second communication route.

SCALABILITY AND SECURITY

The communication system should be capable of providing an easy and cost effective mechanism to grow and expand to accommodate future systems and applications. The system should be capable of providing a high level of security in order to protect the City's network and data.

NETWORK MAINTENANCE AND MANAGEMENT

The communication network should be easily configurable, upgradable, and recover easily due to fault. The network should be managed via network management software (NMS) tools to ensure optimum operation and performance. The network should be tested yearly.

EQUIPMENT SPECIFICATIONS

It is best if the communication system consists of Commercial Off the Shelf (COTS) equipment, and not custom or proprietary systems. COTS are software or hardware products that are ready-made and available for sale, lease, or license to the general public. Custom or proprietary systems are software or hardware developed specifically for one brand of product or agency. Therefore, it is difficult to integrate custom or proprietary systems, especially at an interagency level.

In addition, the equipment should be environmentally hardened to withstand the harsh outdoors environment of the typical ITS field applications. It is highly recommended that any equipment used in ITS systems meet the NEMA TS2 environmental standards listed in Table A. This insures that the equipment is hardened for outdoor use in the traffic signal cabinets.

Table A: NEMA TS2 Environmental Standards

Parameter	NEMA TS2
Temperature	-29 F to 165 F
Humidity	18% to 90% RH, non-condensing
Voltage	120-135VAC @ 57-63HZ
Vibration	0.5g @(5-30) Hz
Shock	10g's for 11ms

BANDWIDTH REQUIREMENTS

Digital bandwidth is a rate of digital data (1 and 0) transfer, usually measured in bits/second. The communication system for the Spokane Valley ITS should be able to provide enough bandwidth to accommodate various ITS equipment such as CCTV cameras, dynamic message signs (DMS), traffic signal controllers, video detection and data, and communication with other neighboring jurisdictions such as City of Spokane and Spokane County. This system should allow for expandability in the future for other ITS devices. Typically, video transmission will require the most bandwidth and largely influences the design of the communication network. The data bandwidth requirements for the Spokane Valley ITS applications are generally low. Utilizing gigabit Ethernet technology, a typically recommended system is to have a minimum 24 fiber strand count on trunk lines and 12 fiber strand count connected to each signal cabinet.

Video images can be transmitted in either analog or digital format, depending on the communication media and technology used. Typical video bandwidth requirement are listed in Table B. The transmission of video in digital format is more efficient and cost effective. It also has many operational benefits namely in the areas of video collection, distribution, and archiving. There are many digital video formats and each has its own bandwidth requirements.

Table B: Digital Video Encoding Systems

Video Encoding Scheme	Bandwidth
MJPEG	240 kbps
MPEG-2	3 to 15 mbps
MPEG-4	1.5 mbps

The MPEG-4 video encoding scheme has become a very mature and cost effective solution for the transmission of digital video over communication networks. There are many public agencies that are successfully using MPEG-4 video encoding in Washington. The main advantage of using MPEG-4 is the lower bandwidth requirement as compared with other encoding schemes such as MPEG-2. As a minimum, it is recommended that MPEG-4 video encoding be used in Spokane Valley along key arterials to optimize use of bandwidth.

The City should also consider the H.264 video compression standard as more devices become available for the traffic industry under this encoding scheme. The H.264 is a video compression method that allows higher resolution with a lower bandwidth requirement. This standard provides for easier and more flexible integration with web applications and requires less bandwidth than MPEG-4 without compromising video quality.

NETWORK TOPOLOGY

A communications network consists of two primary application types: Local Area Network (LAN) and Wide Area Network (WAN). The LAN covers smaller geographic regions typically confined to a building (i.e., TMC) or a small geographic area whereas the WAN covers a larger area (city, county, region, or state). WANs typically consist of multiple LANs interconnected through a high-speed data network. Both are necessary and would work together to provide the City's communications network. The City's WAN can be viewed as a fiber optic backbone or as a series of communications hubs/nodes that are interconnected using optical fibers as the transmission media. Each hub/node functions to receive and transmit data and video over the fiber optic backbone, providing a means for equipment connected at one hub/node to communicate with equipment connected at another hub/node.

COMMON TOPOLOGIES

"Topology" is a communication network term that refers to the physical interconnections of ITS devices. Common topologies for communications networks include the linear, star, ring and hybrid topologies.

The star topology is basically where one node serves as the primary central node and all other nodes and/or equipment are physically connected via point-to-point circuits. All communications pass through the central node. This configuration is often used in an environment such as a LAN hub or ATM switch/hub. This configuration is generally unreliable and susceptible to an entire network failure when the central node fails.

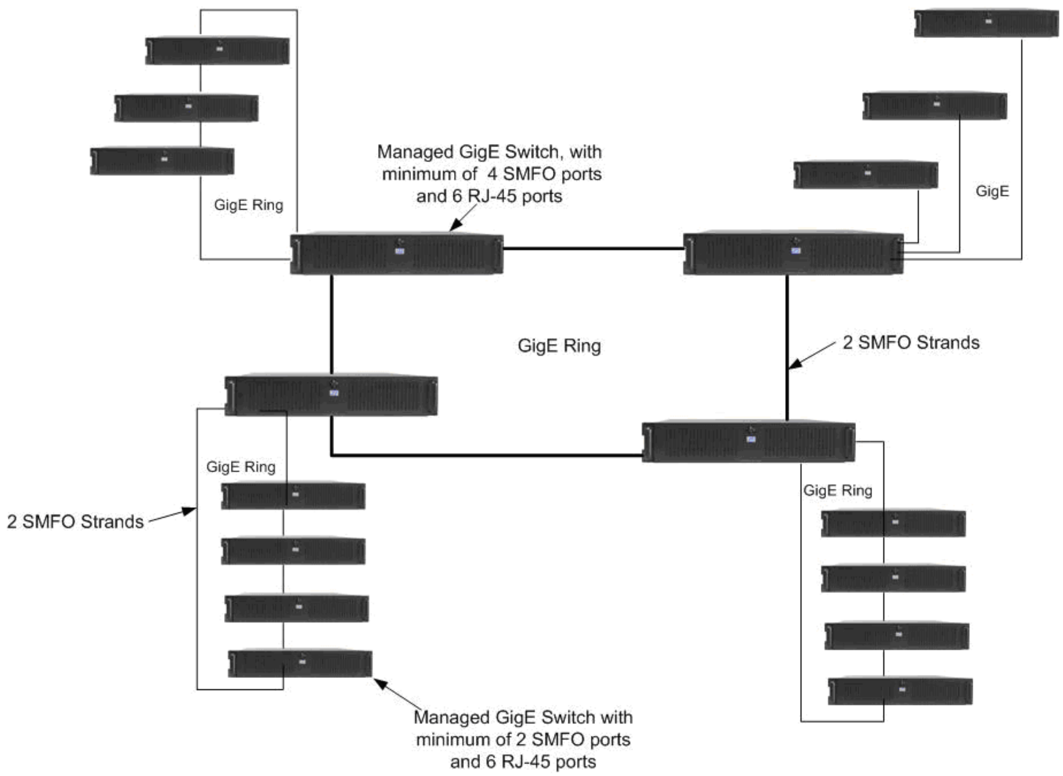
In a ring topology, each communications network node is connected to two other communications network nodes. In most backbone applications, fault tolerance is an essential design consideration that guards against a general network failure in the event of a fiber break or an individual node failure. Examples of these kinds of events are when a backhoe operator accidentally cuts into an underground fiber cable between two nodes or a motorist crashes into a curbside cabinet that contains backbone communications equipment. Fault tolerance can be achieved by employing a dual counter-rotating ring (DCRR) topology with diversity routing. Communications equipment designed for DCRR architectures has the intelligence to sense failures and ‘fold-back’ around the point of failure, thus preserving basic network function. A ring topology is typically configured as a hybrid type with each node functioning as a central node in a local star configuration. The series of local stars are interconnected in a ring configuration.

SPOKANE VALLEY NETWORK TOPOLOGY

For the City of Spokane Valley a hybrid topology is proposed. The backbone (core) of this hybrid network will utilize the ring topology. In some instances where redundancy is not paramount on some of the City’s minor roadways, it would be acceptable to establish point to point connections on these links. The Figure below illustrates the recommended network topology for Spokane Valley.

For the funded projects identified in Appendix A which will undergo design or construction in the near future, the City’s Appleway fiber network will function as the core of the hybrid network and would be used as the City’s communications backbone between the SRTMC and the field communications hubs / nodes. Discrete communication hubs will be provided at the major intersections such as Appleway Boulevard/University Avenue, Sprague Avenue/Pines Road (SR 27), Sprague Avenue/Sullivan Road, etc. where data and video can enter and exit the ring network, and is equipped with a Gigabit Ethernet (GigE) switch. It is recommended that a minimum of a 2 -strand SMFO cable, one strand for data transmission and another for data receiving, be used for communication from the node to field ITS devices.

The City should also consider partnership with WSDOT to utilize any available fiber along the I-90 corridor. This will help the city complete a hybrid topology by utilizing existing communication infrastructure rather than deploying new fiber optic runs, helping to minimize cost. The opportunity to utilize WSDOT fiber also exists since many of the City’s major corridors intersect with major I-90 interchanges.



Recommended Spokane Valley Network Topology