

# Chapter Five

# STRATEGIC PLANS

## INTRODUCTION

This chapter presents an overview of the strategic plans developed by the Technical Advisory Committee. The purpose for these plans is to identify solutions to the transportation issues and needs in Clackamas County that were identified in the User Needs Assessment chapter and to meet the goals and objectives of this project. Strategic plans are provided for the following subject areas:

- Travel and Traffic Management
- Communications
- Public Transportation Management
- Commercial Vehicle Operations
- Emergency Management
- Maintenance and Construction Management

A discussion is also included regarding ongoing or planned projects in the Portland metropolitan region that address regional transportation issues and needs throughout the region as well as within Clackamas County.

## TRAVEL AND TRAFFIC MANAGEMENT PLAN

The primary purpose of this category is to better manage the transportation infrastructure and to provide real-time

traveler information. The industry trend for travel and traffic management in metropolitan areas today is to create a traffic operations/management center allowing transportation professionals to monitor and manage traffic flow on highways and arterials using traffic signals, CCTV cameras, detection stations, weather information stations, variable message signs and other applicable equipment. In addition to managing the roadway system, transportation professionals use the information collected by these field devices to broadcast traveler information through the Internet, radio, television, and variable message signs. The state of the art in travel and traffic management also includes new, more flexible traffic control devices, computer hardware, software systems, surveillance technologies, communications, and analysis methods.



Although ODOT has a Traffic Management Operations Center (TMOC) and applies many of these concepts on their freeways today, limited traffic management strategies are utilized on County-owned, City-owned, or State-owned arterial roadways within Clackamas County. Numerous traffic management strategies should be implemented throughout Clackamas County to provide the tools necessary for transportation operations personnel to better manage and maintain existing transportation infrastructure.

### **Existing Traffic Management**

As described in the Existing Conditions chapter, the traffic management system in Clackamas County today consists of approximately 231 traffic signals, video detection at eight traffic signals, several coordinated traffic signal systems, and limited ODOT applications of CCTV cameras, variable message signs, and ramp meters on I-5 and portions of I-205.



Dial-up phone line connections are used to communicate remotely with a portion of the traffic signals in Clackamas County today. Video detection is used sparingly and some of the video images are transmitted across phone lines to maintenance and operations personnel, but the current configuration does not deliver real-time video. Coordinated signal timing plans are implemented by time-of-day on some major arterials in the County, but no real-time traffic responsive or adaptive signal control has been applied to date.

### **Travel and Traffic Management Solutions**

The two biggest issues identified are congestion/delay and the lack of real-time traveler information.

#### Issue: Congestion and Delay

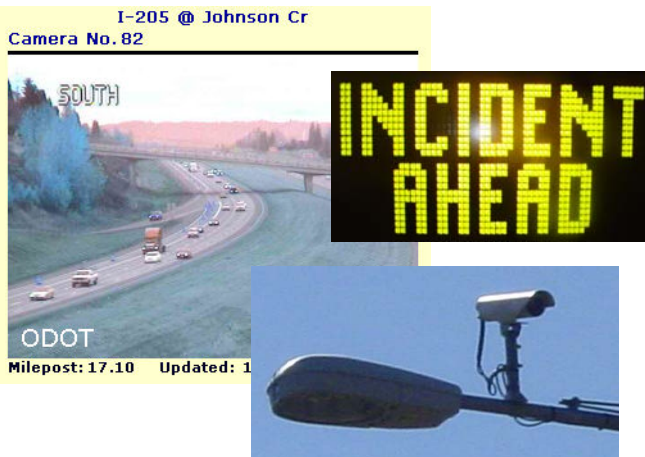
The transportation problems mentioned time and again in Clackamas County are congestion and travel delay, especially on freeways and major arterial roadways. Problems associated with congestion and delay also include the following:

- Recurrent congestion caused by bottlenecks.
- Unnecessary delay at traffic signals due to malfunctioning detection equipment.
- Unbalanced traffic signal control at freeway or highway interchanges that cause on-ramp queues to back up onto arterial roadways or off-ramp queues to extend back onto the freeway.
- Congestion and delay caused by incidents (vehicle collisions, stalled vehicles, etc...).
- Lack of efficient means for transportation personnel to respond to complaints about specific congested or problematic areas. (Without taking the time to go out into the field, there is no way to quickly resolve traffic issues or to view the problem in real-time as soon as the complaint is received.)
- Lack of traffic volume data for analysis purposes.



Advanced technologies and strategies that help reduce congestion and delay include the following:

- A traffic operations center (TOC) to monitor and manage traffic flow in real-time.
- CCTV cameras and/or video detection with remote access at key locations for roadway surveillance.
- Vehicle detection stations on major arterials to collect real-time traffic volumes for roadway surveillance.
- A central signal system to monitor and control all traffic signals in Clackamas County regardless of jurisdiction.
- Traffic responsive or adaptive traffic signal control that reacts in real-time to changing traffic conditions, weather, emergency vehicle priority, and transit priority.
- Traffic signal equipment upgrades to replace malfunctioning detection, support transit priority, and to provide advanced controllers that allow for advanced traffic signal control.
- Incident management plans to coordinate response with other transportation agencies and emergency response agencies and to provide travelers with alternate routes.



Not only do these solutions help to reduce congestion and improve travel times, they also provide the added benefits of improved efficiency, increased safety, reduced fuel consumption, and better air quality.

Issue: Demand for Real-Time Traveler Information



Travelers, transportation professionals, and emergency response agencies are demanding real-time information about roadway conditions to help them make informed decisions. Many travelers are tired of getting caught in congestion when pre-trip or en-route information would have provided them the opportunity to take an alternate route or travel mode to reach their destination more efficiently.

Solutions and strategies for providing real-time information include the following:

- Installation of variable message signs to be used for posting information (incident/ construction locations, alternate routes, travel times).
- Installation of CCTV cameras at key locations on arterial roadways in the urban area.
- Indication of congested locations (travel speeds or congestion levels) based on CCTV camera monitoring and volume/speed data collected by vehicle detectors.
- The deployment of roadway weather stations to supply road temperature and weather conditions.
- Informing travelers of construction locations and schedules in real-time

and in advance of the scheduled start date.

- Measurement of railroad train activity to provide at-grade rail crossing information and crossing durations.
- Advanced parking management strategies that indicate parking availability and alternative options.

Transit traveler information is discussed in the Public Transportation Management Plan section later in this chapter. The key solutions for disseminating real-time information include variable message signs, a traveler information web site, and a 511 telephone system. The 511 system is discussed later in this chapter under the Other Regional Projects section.

### ***Future Travel and Traffic Management***

The following travel and traffic management projects have been developed to provide the solutions outlined in the previous section.

#### **CC-TM-01: Clackamas County Traffic Operations Center (TOC)**

This project will establish a Traffic Operations Center (TOC) housed at the Clackamas County Department of Transportation and Development. The purpose of this project is to set up a center to monitor and control traffic operations through the use of ITS technologies such as a central traffic signal system, closed-circuit (CCTV) cameras, video detection cameras, variable message signs, and communications with other transportation agencies. The “center” will likely start out as one or two workstations with real-time access to field devices and will grow as needed. One option for growth is to set aside a room dedicated to the TOC at a new facility when the

Department of Transportation and Development moves to the Red Soils campus in the future. This would also allow the County the opportunity to combine the TOC with the Emergency Operations Center (EOC) currently located at C-COM on the Red Soils campus.



#### **CC-TM-02: Integrate Clackamas County Traffic Operations Center (TOC) with ODOT Traffic Management Operations Center (TMOC)**

This project will provide access from the Clackamas County Traffic Operations Center (TOC) to the ODOT Traffic Management Operations Center (TMOC) to enable regional sharing and coordination of transportation management information. With this project, Clackamas County will be able to monitor the functions being entered in the TransPort software at the ODOT TMOC, view cameras, and view current messages on variable message signs (VMS) throughout the region.



**CC-TM-03: Upgrade Traffic Signal Equipment**

This project will determine a minimum standard for Clackamas County traffic signal equipment and will update traffic signal equipment throughout the County to bring it to the minimum standard. The base standard will include signal controller type, working detection, Opticom type, communications such as phone drops, and interconnect. The purpose of this project is to bring traffic signal equipment up to date and ensure new signals are built to a base set of standards so that other ITS projects such as adaptive signal control and transit priority can be implemented.



**CC-TM-04: Automated Emergency Vehicle Pre-empt Feedback**

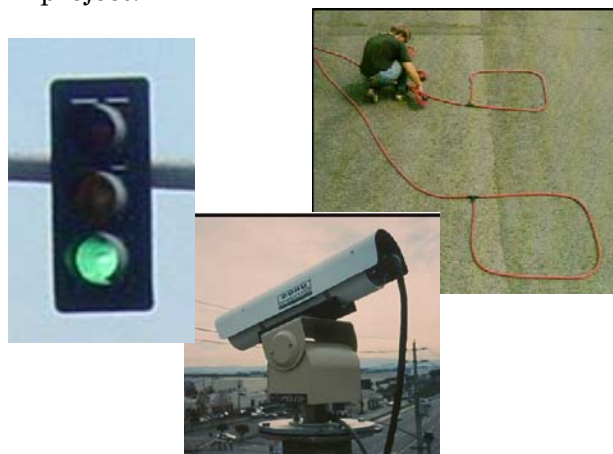
This project will deploy indicators on traffic signals to provide real-time feedback to emergency responders on the status of pre-empt at traffic signals.

**CC-TM-05: Regional Arterial Surveillance and Management**

This project will develop and deploy an integrated multi-jurisdictional regional arterial surveillance and management subsystem that provides for traffic-responsive corridor management of the major arterial corridors and the sharing of roadside subsystems at major decision points within the corridor. It will require the deployment of additional traffic detection and closed-circuit television

(CCTV) systems on regional arterials to provide supporting traffic flow data and incident detection data as well as the deployment of variable message signs (VMS) to provide real-time traveler information along regional arterials.

Several strategies may be implemented to manage regional arterials based on the real-time traffic conditions data collected. These strategies include advanced signal control (traffic responsive signal timing or adaptive signal timing), on-demand “green-wave” routing of emergency response vehicles, and transit signal priority. Traffic responsive signal timing selects alternative pre-programmed signal timing plans based on current traffic volumes and adaptive signal timing automatically adjusts signal timings (cycle lengths, splits, offsets) in real-time based on current traffic conditions. Both methods have been shown to reduce stops, improve travel times, and reduce fuel consumption compared to traditional signal timing methods. This project will deploy additional vehicle detection, update traffic signal controllers and traffic signal communications. The central signal system deployed as part of the Central Signal System project is required prior to implementing this project.



Potential arterial roadways for network surveillance and management include the following:

- Sunnyside Road
- Harmony Road
- Wilsonville Road
- Molalla Avenue
- 82<sup>nd</sup> Avenue (ORE 213)
- McLoughlin Boulevard (ORE 99E)
- Milwaukie Expressway (ORE 224)
- Clackamas Highway (ORE 212/224)
- State Street (ORE 43)

CC-TM-06: Transit Signal Priority



This project will extend the “green time” at traffic signals in Clackamas County for all buses running behind schedule and will build off the existing transit priority project being implemented in the City of Portland. This project will either deploy new Opticom detectors or upgrade existing Opticom detectors at traffic signals and includes the installation of new traffic signal controllers and software to provide transit signal priority functionality.

CC-TM-07: Incident Management

This project will deploy traffic surveillance and control devices in high volume arterial/freeway corridors to manage diverting traffic during a major incident. The objective of this project is to

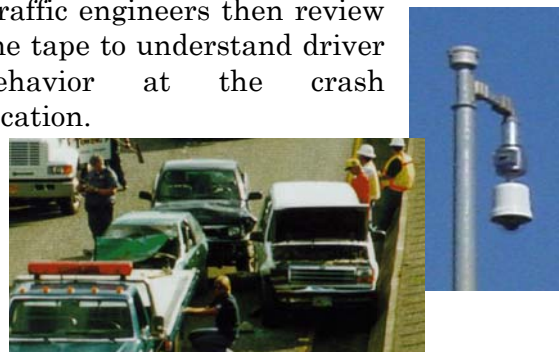
better manage diverting traffic during a freeway incident to minimize resulting delays and secondary crashes caused by the incident and to reduce the number of vehicles diverting onto neighborhood streets. This project will enable and enhance multi-jurisdictional, multi-agency traffic responsive corridor management, and includes emergency and transit priority treatment.

CC-TM-08: Rural Highway Safety Improvements

This project will deploy weather information systems, roadway sensors, and closed-circuit television (CCTV) systems in select locations on rural highways to alert drivers to hazardous conditions and dangers. This project also includes wide-area information dissemination of site-specific safety advisories and warnings.

CC-TM-09: Cameras to Monitor High Crash Locations

The objective of this project is to provide traffic engineers with the tools to investigate the causes of the high number of crashes at some locations. This project will use a combination of cameras, microphones, digital signal processors, and video recording equipment to monitor traffic traveling through an intersection. Recordings are made when the system “hears” the telltale sounds of a crash. Traffic engineers then review the tape to understand driver behavior at the crash location.



### CC-TM-10: Portable Data Analysis



This project will deploy portable data collection equipment for traffic analysis purposes. Equipment could include devices such as portable cameras or traffic count tubes for the purpose of monitoring high incident locations, collecting traffic count data, or investigating traffic issues. The use of portable equipment will allow Clackamas County to move it to desired locations as needed. The first deployment site for portable data analysis should be the intersection of New Era Road/Central Point Road due to the high number of collisions. Other high collision locations that should be considered for analysis are illustrated in Figure 1-8 in Chapter 1.

### CC-TM-11: Dynamic Speed Control

This project will deploy dynamic message signs to display a lower speed limit during certain times of day, and/or to provide real-time feedback to travelers advising them of their current speed. These dynamic message signs will be deployed at select school crossings, in construction zones, or at severe weather locations to dynamically adjust the speed limit based on road conditions.



### CC-TM-12: Advanced Pedestrian Crossings

This project will deploy advanced pedestrian crossing devices to improve safety at select pedestrian crossings. This project is intended to focus on crossings or pedestrian zones that have a history of a high number of crashes and is expected to reduce the number of vehicle-pedestrian crashes. The project will deploy devices such as pedestrian pushbuttons with an active feedback, pedestrian countdown timers, in-road flashers, and passive pedestrian detection.

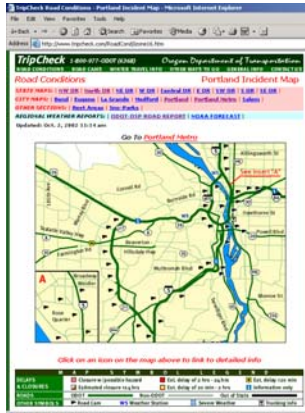


### CC-TM-13: Weather Adaptive Signal Timing

This project will deploy weather information stations on arterial roadways and will implement adaptive signal timing changes based on inclement weather. Signal timing adjustments could include changes such as different offsets, split changes, or increased all red times.

### CC-TM-14: Traveler Information Website

This project will provide a traveler information website for Clackamas County similar to the ODOT TripCheck website and will provide information such as real-time traffic conditions (camera views, travel times), incident locations and durations, construction activity, weather and road conditions, railroad activity, and parking information. Deployment of the web site will occur in



stages as the projects and technologies to collect the various types of information are implemented and data is collected. This project should be linked to the regional transportation

web site (TransPort Project OR0217) that is being planned for the Portland metropolitan area that will include traveler information for the general public as well as a secure mechanism for public agencies and authorized users to access and share operational information.

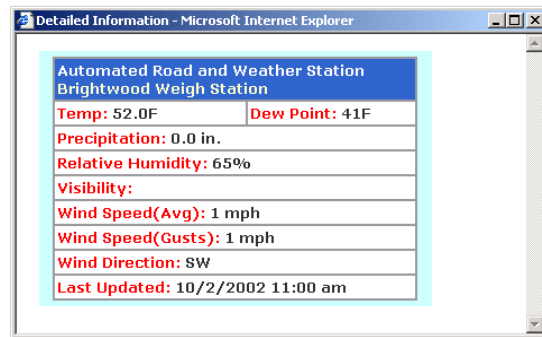
**CC-TM-15: Advanced Parking Management and Information System**

This project will deploy a parking, en-route driver information and demand management system to provide near real-time parking service status and accelerate the effective implementation of regional parking policies. The project will deploy changeable message signs that would provide available parking stall information to travelers in advance of key parking facilities. Potential locations for parking management projects include the Clackamas Town Center and the New Hope Church (potential park and ride site for TriMet bus/light rail).



**CC-TM-16: Road Weather Information System (RWIS)**

This project will deploy road weather information systems on urban arterials and rural highways to provide travelers and maintenance and operations personnel with severe weather information from remote locations.



**CC-TM-17: Flood Warning System**

This project will link the Clackamas County Traffic Operations Center (TOC) with USGS flood data. The USGS currently collects real-time river and stream flow data for approximately 100 locations in Oregon and Washington. This data could be used to monitor potential flood locations and to provide traveler information to motorists regarding flooded roadways. Traveler information dissemination could include online information as well as roadway message signs on roadways in Clackamas County that are within the flood zone.

**CC-TM-18: Advanced Railroad At-Grade Crossings**

This project will deploy a driver warning system at select railroad at-grade crossings to provide travelers and emergency response vehicles advanced train activity information. The project will deploy dynamic message signs and an automatic train location system to provide crossing activity information at key

decision points so emergency response vehicles or travelers may choose alternative routes. Potential at-grade railroad crossing locations to be considered include:

- Harrison Street (Milwaukie)
- Oak Street (Milwaukie)
- 37<sup>th</sup> Street (Milwaukie)
- Downtown (Oregon City)



## COMMUNICATIONS PLAN

The communications network is the backbone that supports the functions provided by intelligent transportation systems that ultimately reduce travel times, reduce vehicle delay and improve safety. The main issues identified for future communications include the following:

- Need a regional transportation communications network.
- Need to interconnect County facilities.
- Need a redundant communications network.
- Need to install communications conduit with new roadway projects.
- Need a secure network.

## Existing Communications Infrastructure

Today, transportation engineers and maintenance personnel have only limited remote access to field devices such as traffic signals and video cameras. Communications to these field devices is primarily provided with copper twisted-pair interconnect cable and telephone drops. However, benefits are already being realized from the existing communications connections to traffic signals and live video feeds because engineers are able to respond in real-time to changing traffic conditions.

## Future Communications Network and Infrastructure

The future communications network in Clackamas County will be able to support the following functions:

- Engineers will be able to quickly respond to an incident by changing signal timing from a traffic operations center (TOC) because the traffic signals will be linked to the TOC over a County communications network.
- Engineers will be able to respond to *trouble calls* by using video images of the location at the TOC to identify the problem and implement an appropriate response such as modifying signal timing or distributing traveler information on a variable message sign. These field cameras will be linked to the TOC over a County communications network.
- Maintenance personnel will be able to view roadway and weather conditions in real-time from a central location and dispatch the appropriate personnel and equipment to maintain the roadway. The sites collecting the

weather information will be linked to the maintenance building over a County communications network.

- Transportation engineers will be able to distribute traffic condition information to the public via the Internet, radio, etc. The field devices collecting the traffic condition information must be connected to the TOC over a County communications network to distribute the information to the public.
- Transportation planners will be able to collect and share historical traffic data because the field devices collecting the traffic information will be connected to a central data warehouse via a County communications network.
- 911 dispatchers will be able to view traffic conditions in real time because the dispatch center will be connected to the County TOC via the County communications network.
- 911 Centers will be able to coordinate responses to regional incidents because the centers will be connected to each other over a communications network.

The future communications network in Clackamas County will need to support connections to the following field devices/network components:

- Traffic Operations Centers (TOC)
- Closed Circuit Television Cameras (CCTV) with full pan/tilt/zoom (PTZ) capabilities.
- Vehicle Detection
- Road Weather Information Systems (RWIS)
- Variable Message Signs (VMS)
- Traffic Signals

- Emergency Centers (Fire, Police and 911)

The design of the communications system for Clackamas County depends on the number and type of field devices/network elements planned for deployment and the desired network connections between agencies. All of the communications network design considerations cannot be covered within the scope of this report, but a description of some of the factors that need to be considered are provided below along with recommendations for the design of the communications system.

The communications system design requirements described below include:

- Bandwidth Requirements
- Network Topologies
- Traffic Signal Communications
- CCTV Communications
- “Fiber Ready” Conduit
- Wireline and Wireless Media
- Singlemode vs. Multimode Fiber

#### *Bandwidth Requirements*

Bandwidth is used to describe (1) how fast data flows on a given transmission path, and (2) the width of the range of frequencies that an electronic signal occupies on a given transmission medium. Any digital or analog signal has a bandwidth.

In a digital network, bandwidth is defined as the amount of data that can be transmitted in a fixed period of time and is measured in bits per second (bps) or mega bits per second (Mbps). In an analog network, bandwidth is described as the frequency available from a carrier to provide signal variations of a waveform from an incoming source. It is expressed

as a frequency such as hertz (Hz) or megahertz (MHz). The bandwidth required by field devices network elements is one of the factors that drives the selection of communication media and end electronics<sup>1</sup>.

Of the devices/network elements planned for deployment in Clackamas County, video transmission requires the greatest bandwidth. For example, a CCTV camera requires a minimum analog bandwidth of approximately 4 to 6 MHz or for transmission of broadcast quality digital video it requires approximately 4 to 6 Mbps. In contrast, a traffic signal, variable message sign, detector station or RWIS requires only 1200 to 9600 bps. Therefore, the data from approximately 417<sup>2</sup> traffic signals communicating at 9600 bps would fit within the same bandwidth as one video camera. This simple comparison illustrates that the transmission of full motion video drives the requirement for the selection of a communication medium and end electronics for the Clackamas County ITS communications network.

In addition to the field devices, the County will need to consider the size of the network required for the information services department. As a general rule of thumb, 12 fibers should be reserved for a Clackamas County wide area network (WAN). The configuration of the information services (IS) network will drive the decision for a network technology (Ethernet, SONET, etc.) for the transportation department because the IS department will likely play a key

role in the maintenance of the network. Also, the functional, operational and performance requirements of the IS WAN will likely take precedence over the transportation department data because traffic signals will continue to operate normally without central communications, but a break in the network connection to emergency services is much more critical.

#### **RECOMMENDATION**

For the communications network in Clackamas County, fiber optic cable should be used as the medium for backbone communications because it has essentially unlimited bandwidth capabilities and will accommodate future network upgrades at minimal cost. With fiber optic cable, the only limiting factor to bandwidth potential is the end electronics used to transmit the video and data.

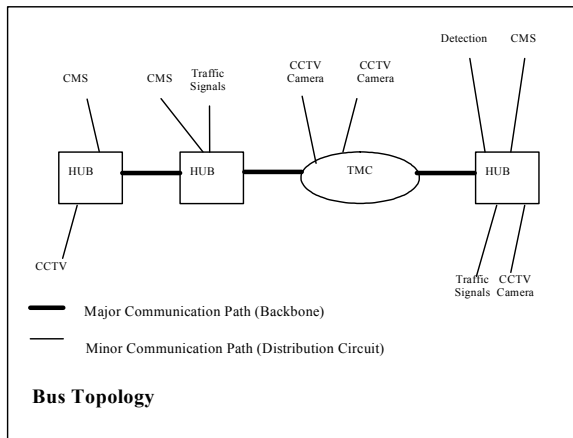
#### *Communications Network Topologies*

A network's topology is a representation of the physical and/or logical layout of the communications between devices and how they are connected together. The common communication topologies are: Bus, Star, Ring and Mesh. More often than not, networks use a combination of these topologies. A bus topology is typically used in computer networks such as Ethernet. A star topology utilizes a point-to-point connection between a central device and the devices that are connected to it. A ring topology utilizes a point-to-point connection between adjacent devices in a closed-loop manner. A mesh topology utilizes multiple-point, multiple-path connections between devices.

<sup>1</sup> End electronics varies based on the network technology used, but could include multiplexers, optical transceivers, switches, etc.

<sup>2</sup>  $4,000,000\text{bps}/9600\text{bps} = 417$

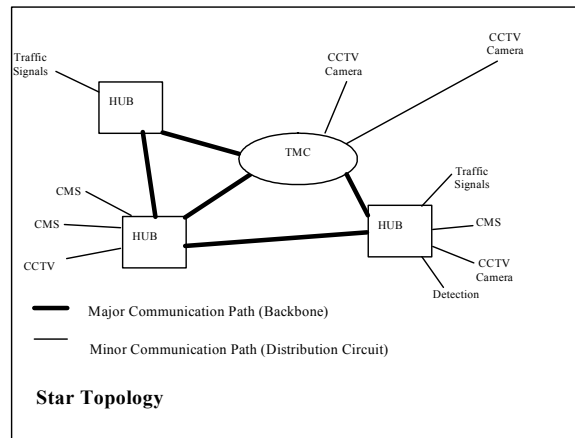
**Bus Topology** – This topology utilizes one medium as the path for all communications with connected devices. Also known as a “shared medium”, this topology was the basis for the design of the original Ethernet. As the name shared medium implies, all of the devices talk and listen over the same medium. Only one device is allowed to speak at a time. When this one device is speaking, all of the other devices are listening. The destination device for the message being transmitted by the device speaking will be the one to accept the message. When the speaking device stops speaking, any other device is free to speak. If two or more devices attempt to speak at the same time, an access control algorithm takes over which then allows only one device to speak. Figure 5-1 illustrates a bus topology.



**Figure 5-1: Bus Topology**

**Star Topology** – This topology utilizes dedicated point-to-point communication paths established between each field element and a central hub, relay point or TMC (Traffic Management Center). A variation of this is known as daisy-chain, and works similar to the star topology except that the communication medium is shared by multiple field elements. Point-

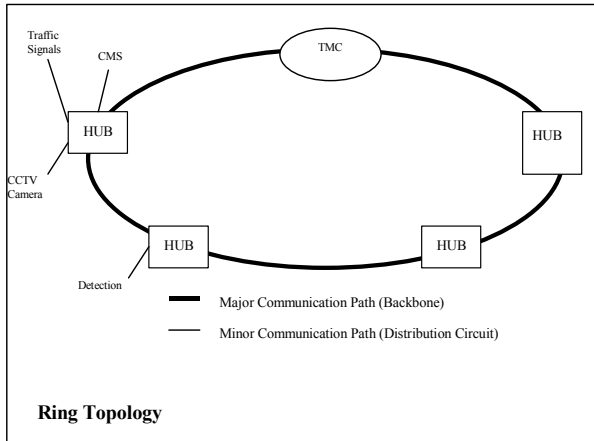
to-point communication provides quick response times because dedicated control channels are utilized for each field element (e.g., it is not shared with other field elements). A field device, such as a traffic signal controller or CCTV camera communicate with the controlling field hub or TMC by means of point-to-point modems. This connection presents a reliability problem, since, if the communication link fails, the field device will be completely isolated from the central facility. Figure 5-2 illustrates a star topology.



**Figure 5-2: Star Topology**

**Ring Topology** – A ring topology connects elements such as communications hubs, and the TMC within a closed-loop. Data travels from one element in the loop to the next in a single direction around the loop. If the medium/connection is broken, the primary data flow direction is blocked but data will flow in the reverse direction around the ring to its destination. Further, if the redundant rings are physically located adjacent to each other, one major failure can break both rings. At multiple strategic points along the ring, communication hubs will typically be installed to provide data concentration

points for communication links to distribution circuits. The distribution circuit may be a single intersection, a central facility, or field device(s). Figure 5-3 illustrates a ring topology.



**Figure 5-3: Ring Topology**

Ring topologies can be setup in a dual-ring, self-healing layout so that the communications system is operated with separate paths to offer fault tolerance. A self-healing ring consists of two data paths, or rings, with each data path running in opposite directions. Under normal operation, only the primary data path is used. When there is a fault (cable or failed device), the data path will be reversed before it reaches the fault or failed unit and use the secondary data path to complete the link. In this manner, the data path to the remainder of the units will remain intact. Counter-rotating, self-healing rings, which are typically found in fiber-based networks, were created to increase reliability of a network.

**RECOMMENDATION**

To provide a redundant network and limit the number of fibers needed for communications a ring configuration for the primary network backbone should be constructed. Communications hubs should be constructed at select points on the ring to collect video and data from nearby field devices and combine them onto the fiber ring.

*Traffic Signal Communications*

Modern traffic signal controllers can be used for more than just traffic signal operation. Most advanced traffic controllers (ATC) can operate variable message signs, detector stations, ramp meters and camera controllers. The standard communication interface for traffic signal controllers is RS-232, which is a digital form of communications that runs off a serial port on a standard controller. As discussed in the bandwidth section, the data messages from traffic signals require minimal bandwidth (9600 bps or less). Therefore, this data can easily be transmitted over any type of media. The intended network design is to connect the traffic signal controllers directly to the fiber optic cable when a controller is on the same corridor as proposed fiber optic cable. If, however, a controller is not on a proposed fiber optic corridor or there is existing copper twisted-pair to the signal, then copper twisted-pair could be installed to the controller from a field communications hub located on the fiber ring. Data from multiple field devices could be collected at the hub and transmitted back to the central computer.

Traffic signal software vendors are beginning to provide the capability to assign Internet Protocol (IP) addresses to traffic signal controllers. The industry trend in traffic signal communications is heading towards a digital network like Ethernet or SONET (Synchronous Optical Network) and IP addressing is well suited for those technologies. If the County installs an Ethernet Wide Area Network (WAN) to traffic signals in the future, then field hardened Ethernet switches could be installed in each traffic signal controller cabinet instead of the fiber optic modems. These switches are normally supplied with multiple ports and could be used to combine data or video from multiple field devices including CCTV for transmission onto the network.

Figure 5-4 illustrates the proposed fiber ring configuration for Clackamas County.

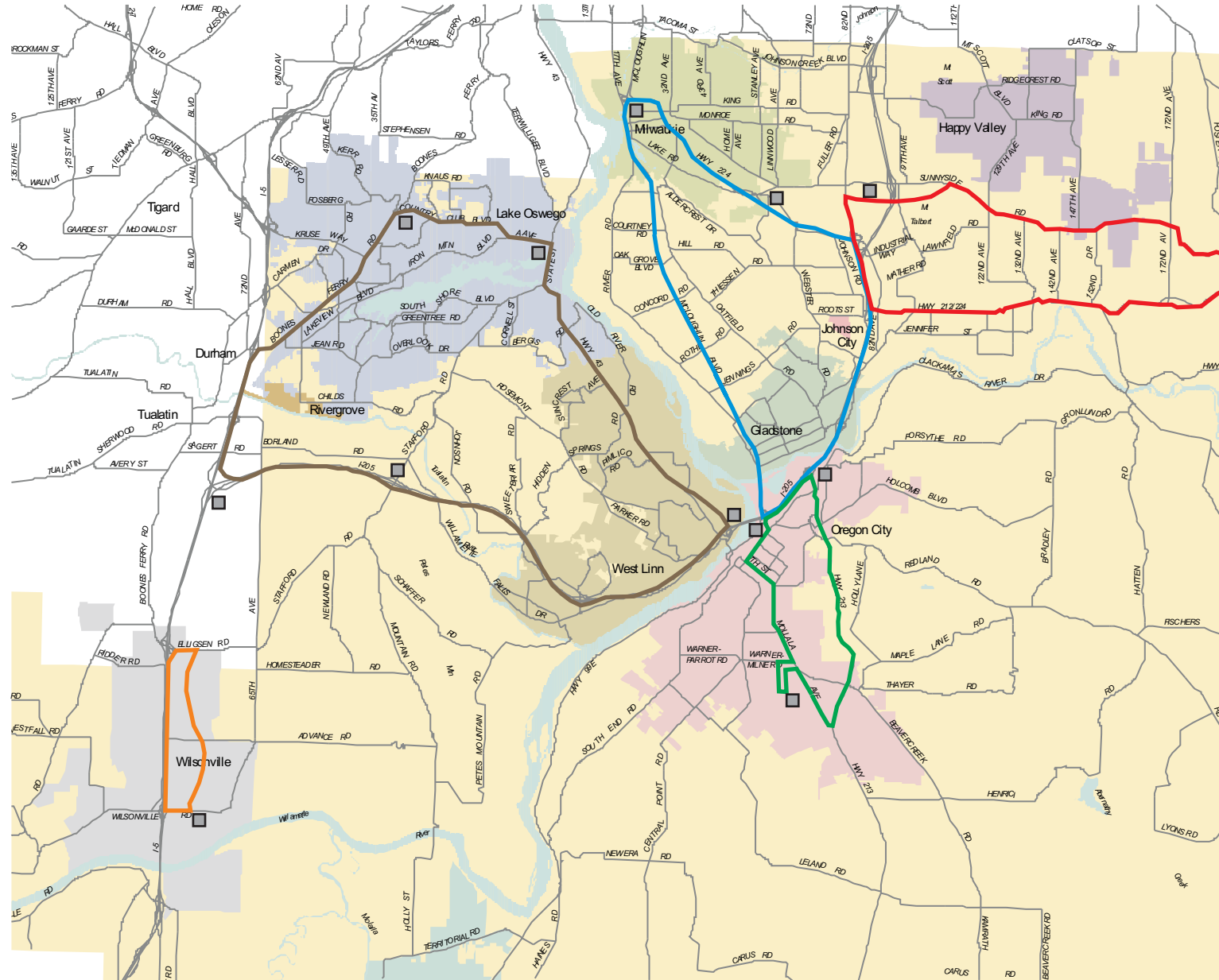
<p><b>RECOMMENDATION</b></p> <ul style="list-style-type: none"> <li>• Utilize existing copper twisted-pair where possible for traffic signal communications.</li> <li>• For new traffic signal installations, along the proposed corridors for fiber optic cable, install fiber directly to the controller.</li> <li>• Combine data onto the fiber rings from remote traffic signals at field communications hubs. Any communication medium could be used between the traffic signal and communication hub.</li> </ul>
--

*CCTV Communications*







As with traffic signal controllers, CCTV cameras will be connected to the main fiber rings via field communications hubs. There are a few options for distributing video on the network:

- **Option 1: IP Video**  
The industry trend is towards transmitting digital video. At this time, the quality of video from digital cameras is not adequate, but video from an analog camera can easily be converted to digital in a field communications hub. With this option, each camera is assigned an IP address and the video is transmitted to a router housed at the hub. The video at the TOC is selected to a monitor based on its IP address.
- **Option 2: Central Switching**  
With this option, each camera would be transmitted on an individual fiber to a field hub where multiple camera images would be combined onto a single fiber using a digital or analog video multiplexer. Current devices on the market can combine and transmit up to 32 cameras on one fiber. Some have built-in redundancy whereas others require an optical splitter to send the video in two directions. The video would all be sent to a central video switch housed at the County TOC. Other local agencies would have access to the video and the switch by installing a keypad at each agency and connecting to the TOC switch using one fiber from each agency.

<p><b>RECOMMENDATION</b></p> <p>Transmit video digitally to the TOC. There are numerous “off-the-shelf” products that can convert the analog video to digital and assign an IP address. In addition, if the County builds a SONET or Ethernet WAN in conjunction with the Information Services department, then the digital video is in the correct form for transmission on the WAN.</p>
---



**LEGEND**

-  Communications Hub
-  Ring # 1
-  Ring # 2
-  Ring # 3
-  Ring # 4
-  Ring # 5

**Figure 5-4**  
**FIBER RING**  
**CONFIGURATION**

*“Fiber Ready” Conduit*

The requirements for installing fiber optic cable are more stringent compared with other wireline mediums. Therefore, all new communications conduit should be installed to accommodate future fiber optic cable. Fiber optic installations are highly sensitive to the quality of installation because the cable has certain minimum bend requirements (20 times outside diameter (OD) during installation and 10 times OD after installation) and maximum pulling tensions.

**RECOMMENDATION**

Future communications conduit installed in the County should be “fiber ready” and meet the following specifications:

- Minimum 3-inch diameter conduit.
- Maximum 45 degree bends.
- Include innerduct or maxcell for long pulls.
- Junction boxes should be larger to accommodate extra fiber optic cable.

*Wireline and Wireless Media*

Communication media may be categorized as either wireline or wireless. “Wireline” communications implies a physical connection between a transmitter and a receiver. This can be done using fiber optic cable, copper twisted-pair, coaxial cable, or leased lines. Wireless communications essentially transmit radio waves through the atmosphere. Wireless communications options include spread spectrum radio, microwave, satellite, cellular radio, cellular digital packet data, and mobile data.

For ITS applications, wireline media are generally preferred for their ease of expandibility, relatively high level of security and dedicated transport characteristics (i.e., line of sight and environmental impacts are not a significant consideration).

The chief advantage of wireless mediums is that no physical connection is required between the transmitter and receiver. This can translate into significant capital cost savings compared to wireline networks and operating cost savings compared to leased facilities. However, repeaters would be required if line-of-sight is not feasible and this would increase the cost. Plus, weather conditions may affect the transmission links.

The two most feasible mediums for Clackamas County are copper twisted-pair and fiber optic cable. Copper twisted-pair is a proven and reliable technology and the County maintenance staff is familiar with maintenance and installation of copper cable. However, due to its limited bandwidth, copper twisted-pair is not an ideal media for long-range video transmission. Fiber optic cable is an established media with plenty of bandwidth available for video transmission. However, the high cost of end electronics for fiber optic cable does not make fiber a cost effective media to use for connections to all field equipment.

**RECOMMENDATION**

Install fiber optic cable as the backbone of the communications network. Copper twisted-pair could be used to connect from field communications hubs to remote devices.

Wireless mediums may be considered for select locations, but at this time are not recommended for the primary network backbone because they are sensitive to line-of-sight and atmospheric conditions and considered less reliable than wireline mediums. Wireless mediums are more suitable for connecting field devices in rural areas where land lines are either not available or too expensive to install.

The County should consider the existing TriMet radio communications network and the planned regional wireless network for remote sites, sites where installing conduit is cost prohibitive or as a redundant communications path in the future. Decisions to use these wireless networks should be made on a case-by-case basis.

#### *Singlemode vs. Multimode Fiber*

There are two distinct types of fiber optic cables: singlemode (SM) and multimode (MM). In singlemode fiber, light travels along one path, and in multimode fiber, light inside the core travels in more than one path. Singlemode fiber has a very thin core and combined with a laser can transmit long distances (up to 110 km with the right transceiver pair) without regenerators or optical amplifiers. Multimode fiber optic cable has a larger core diameter that allows for more refraction, which leads to lower data rates and a shorter range (good for less than 2 km). Multimode fiber optic cables enable less expensive end equipment but the cost of the cable is more expensive.

<p><b>RECOMMENDATION</b></p> <p>Install singlemode fiber optic cables for future County communications installations.</p>
---

There are advantages and disadvantages to both types of fiber optic cable, but the primary reasons for recommending singlemode over multimode include:

- Losses on singlemode fibers are three times less than that of multimode fibers (0.4 dB/km (SM) vs. 1.5 dB/Km (MM) at 1310nm).
- Higher bandwidth on singlemode fiber allows cost-effective increases in data rates.
- Standardization of fiber optic cable type and connectors decreases the maintenance and logistical support requirements for the system.
- Other agencies in the region (ODOT, TriMet, City of Portland, Multnomah County) install only singlemode fibers. The County plans to utilize some ODOT SM fiber for transmitting video back to the TOC. SM fiber should not be spliced directly to MM fiber. Therefore, electronics would be required at every interface point to convert from SM to MM fiber.



#### CC-CO-01: Document Communications Design Standards

This project will document communications network design standards to promote and ensure

compatibility, standardization, connectivity and reliability between different jurisdictions communications systems. These design standards should be developed in coordination with the County IS department, the Cooperative Telecommunications Infrastructure Committee (CTIC) and the ITS Telecommunications Subcommittee. At a minimum, this document should include standards for the following:

- Conduit Construction
- Cable Plant Description
- Minimum Number of Fibers
- Network Technology (e.g. SONET, Ethernet, etc.)
- Junction Boxes
- Fiber Termination Panels
- Fiber Connectors
- Communication Hub Design
- Fiber Optic Testing Specification
- Fiber Optic Installation Specification



**CC-CO-02: Communications Network**

This project will provide a communications network throughout Clackamas County to allow communications between regional agencies and between the Clackamas County Traffic Operations Center (TOC) and ITS devices such as closed-circuit television (CCTV) cameras, video detection, detection stations, traffic signals, and variable message signs (VMS). The network will include links to key agencies and communications

equipment along most urban arterial roadways.

Potential Links to the Communications Network include the following:

- City of Milwaukie
- City of Oregon City
- City of Wilsonville
- Other Cities in the Urban Area (Lake Oswego, Happy Valley, Gladstone, West Linn)
- Clackamas County 911 Center (C-COM)
- Other 911 Centers in Clackamas County (Milwaukie, Gladstone, Lake Oswego)
- Fire Stations
- Police Stations
- Major Arterial Roadways

**PUBLIC TRANSPORTATION MANAGEMENT PLAN**

Public transportation management involves fleet management and operations, passenger and fare management, traveler information, and multi-modal coordination to name a few focus areas. The main issues identified in the area of public transportation in the User Needs Assessment chapter include the following:

- Need for reliable bus schedules.
- Transit priority at traffic signals for buses that are behind schedule.
- Coordination of signal system/roadway improvements with transit service improvements.
- Improved service on major arterial roadways such as McLoughlin Boulevard and Molalla Avenue.
- Real-time transit information.

A transit signal priority project is described under the Travel and Traffic Management Plan as well as a regional arterial surveillance and management project, which will improve transit schedule reliability through improved traffic signal operations

TriMet developed a five-year ITS plan in 2001 that includes 10 TriMet ITS projects and refers to two other regional TransPort ITS projects that involve TriMet and public transportation management strategies<sup>3</sup>. In addition, TriMet is in the process of upgrading their existing 14 frequent bus lines<sup>4</sup>, two of which are located in Clackamas County:

- #33 (McLoughlin)- From downtown Portland to the Oregon City Transit Center
- #72 (Killingsworth-82<sup>nd</sup>)- From Clackamas Town Center to the Multnomah County line



<sup>3</sup> *Tri-Met 5-Year Intelligent Transportation Plan*. Tri-Met, Prepared by Parsons Brinckerhoff and Batelle, Fall 2001.

<sup>4</sup> A TriMet frequent bus line is a bus route that has headways of 15-minute or less at some point during the day. In the future, TriMet plans to set a standard time period for 15-minute headways as well as upgrades to frequent bus lines such as shelters, lighting, real-time information displays, etc...

In the next 10 years, TriMet also plans to upgrade 11 additional routes to frequent bus lines, four of which are located in Clackamas County:

- #33 (McLoughlin)- From the Oregon City Transit Center to Clackamas Community College
- #31 (Estacada)- From the Milwaukie Transit Center to the Clackamas Town Center
- #35 (Macadam)- From downtown Portland to the Oregon City Transit Center
- #79 (Canby)- From the Oregon City Transit Center to Clackamas Town Center



SMART has also included plans for ITS projects in the City of Wilsonville Draft Transportation Systems Plan expected for adoption soon<sup>5</sup>. These projects include transit signal priority, queue bypass, real-time customer information displays, and other improvements.

### **Future Public Transportation Management**

Few County projects related to public transportation management are needed due to the outstanding ITS efforts of TriMet and SMART. The following

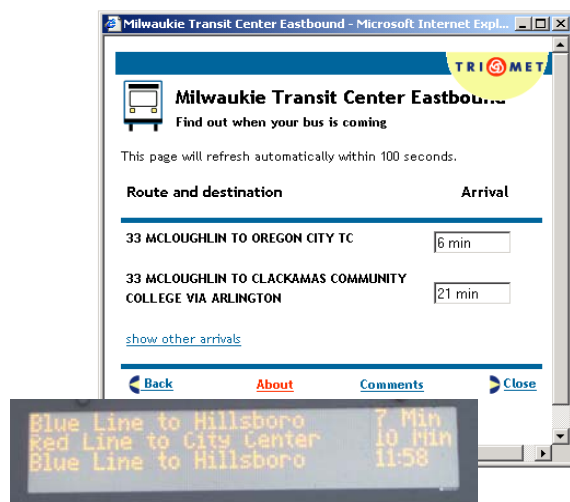
<sup>5</sup> *Draft Transportation Systems Plan*. City of Wilsonville, Prepared by Entranco, June 2002 Public Draft.

project sponsored by TriMet addresses transit information needs for urban Clackamas County.

**CC-PTM-01: Transit Tracker: Real time Customer Information Displays**

This is an existing project (TriMet Project TM001) that will provide real-time transit information online and through electronic displays at TriMet rail stations, transit centers and bus stops throughout the region to inform travelers of transit arrival times. Transit tracker was recently implemented on TriMet’s web site and includes all bus routes, most bus stops, and the number of minutes until the next bus will arrive at a chosen bus stop on a route. Major stops on all bus routes are currently online and a good number of smaller bus stops are also included.

TriMet is currently installing information displays at approximately 50 locations per year. In Clackamas County, TriMet will install information displays at key transit centers, park and rides, and bus stops on priority transit corridors. Input from Clackamas County, its cities, and ODOT would help TriMet determine where information displays should be installed.



**COMMERCIAL VEHICLE OPERATIONS PLAN**

ITS applications for the area of commercial vehicle operations include the use of technologies that enhance safety and simplify fleet and freight management, roadside enforcement, and vehicle operations.

**Existing Commercial Vehicle Operations**

With the exception of a few locations, most designated freight routes in Clackamas County are state highways and fall under ODOT’s jurisdiction. Two state weigh stations (Eastbound Brightwood and Westbound Brightwood) are located on ORE 26 in rural eastern Clackamas County.

Freight traffic originating from Clackamas County is very seasonal and many rural roads are used by commercial vehicles that are not designated as freight routes. The most common freight items include rock hauling in the spring, Christmas tree shipments in November and December, and major nursery shipments approximately three times a year. These variations make it difficult to track freight in Clackamas County, especially on rural routes. The County uses a mobile inspection station twice a

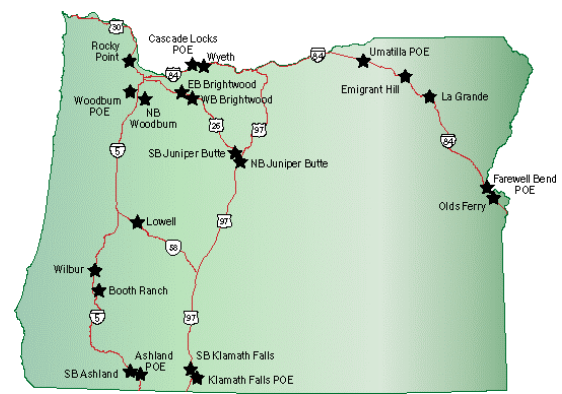
week to spot check commercial vehicles at various locations.

Although not a participant in the federal Commercial Vehicle Information Systems and Networks (CVISN) model deployment program, ODOT has been working on statewide ITS applications in recent years that meet or exceed the goals of CVISN. ODOT has focused its advancements in the following three areas:

- Electronic Screening- use of high-speed weigh-in-motion scales and transponder readers to pre-clear trucks at weigh stations.
- Roadside Safety Assurance- inspection innovations that target critical violations.
- Electronic Credentialing- electronic application and issuance of credentials, participation in national clearinghouses, and information exchange with the national safety data bank.

The most notable ODOT project is the Green Light project<sup>6</sup>, which focuses particularly on electronic screening and credentialing. The Green Light program provides free transponders to any commercial vehicle that wishes to participate in the program. These transponders currently communicate with weigh stations as a commercial vehicle approaches the weigh station. Information such as certifications, taxes paid, weight from high-speed weigh-in-motion scales, and so forth is transmitted between the transponder and the weigh station. If a commercial vehicle meets all of Oregon's trucking regulations, the red light on the

transponder changes to green indicating that the commercial vehicle may bypass the weigh station. If the light on the transponder stays red, then the commercial vehicle must stop at the weigh station for inspection. The Green Light program currently serves approximately 2,000 trucking companies, which includes over 22,000 commercial vehicles.



ODOT Green Light Weigh Station Sites

The key issues for Clackamas County documented in the User Needs Assessment chapter include the following:

- Provide real-time traffic information and construction information to commercial vehicle operators to help them make informed travel decisions.
- Enforce state and federal regulations for commercial vehicles.

### **Future Commercial Vehicle Operations**

The following project involves tracking vehicles in Clackamas County for long-range planning benefits and enforcement purposes. A regional project that addresses real-time information and construction information is discussed in the Other Regional Projects section.

<sup>6</sup> *Oregon Green Light*. Nov. 6, 2002. <http://www.odot.state.or.us/trucking/its/green/light.htm>. Accessed Nov. 14, 2002.



### CC-CVO-01: Advanced Commercial Vehicle Operator Tracking

This project will integrate with the existing ODOT Green Light program by applying the existing technology to Clackamas County roadways to aid in long-range freight planning and commercial vehicle enforcement. This project will deploy permanent and portable transponder detection stations that can communicate with the transponders on trucks to meet several needs. Permanent transponder detection stations will help long-range freight planning within Clackamas County so that planners can more accurately determine where roadway network improvements can be made to benefit trucks along heavily traveled routes.

Portable transponder detection stations will help with enforcement efforts in two ways. First, Clackamas County can use portable detection at their mobile truck inspection station to establish whether or not trucks are traveling on allowable routes. Second, the Sheriff's Office can use portable detection to help them determine when to pull over a truck that is traveling without the proper credentials or on an inappropriate truck route. This would reduce the number of unnecessary truck pullovers and make enforcement a safer and more efficient task. Portable

detection stations can effectively help both long-range planning and enforcement efforts because of the seasonal nature of truck travel in Clackamas County.

One caveat of this project is that not all commercial vehicles that pass through Oregon carry the transponders. It is recommended that Clackamas County and other government agencies in Oregon should push for legislation that would require all commercial vehicles that operate in Oregon to carry a transponder on board.

As technology advances and commercial trucking companies develop fleet management systems, the transponders could be tied to fleet management systems. This would help track freight and hazardous materials as they pass through Clackamas County.

### **EMERGENCY MANAGEMENT PLAN**

Emergency management encompasses areas of interest such as emergency dispatch, emergency response management, and service patrol management to name a few. Coordination between emergency management agencies and traffic management agencies is a major key to managing the roadway network in Clackamas County.



The Clackamas County Communications (C-COM) building houses the County's 911 Center and the Emergency Operations Center.

## **Existing Emergency Management**



The focal areas of emergency management include 911 services (emergency, non-emergency, and dispatch services), police services, fire services, and medical services. The County has its own 911 center (Clackamas County Communications or C-COM), sheriff's office, and fire district that perform services for unincorporated areas of Clackamas County as well as several cities within the County. Other cities within Clackamas County have their own 911 centers, police departments, and/or fire departments. American Medical Response (AMR), a private company, provides medical transportation services for all of Clackamas County by contract as of December 2002. The relationships between the emergency management agencies are outlined in the ITS Plan Concept of Operations chapter.

Each of the emergency management agencies currently operates independently with only limited communications interface or operational compatibility between agencies. Each 911 center uses a computer-aided dispatch (CAD) system, but these systems vary by agency.

The most pressing needs in the area of emergency management that were brought to light in the User Needs Assessment chapter include the following:

- Real-time information at 911 Centers and the Emergency Operations Center.
- Linked dispatch centers and an interface between computer-aided dispatch (CAD) systems.

- Tracking capabilities for emergency response vehicles.
- Reduced emergency response times.
- Better management of incidents.

## **Future Emergency Management**

There are several projects that address the user needs in the field of emergency management. These projects include integration of the 911 centers and CAD systems in Clackamas County, integration of regional emergency operations centers, a traffic adaptive emergency response system, and emergency fleet management. The Travel and Traffic Management System includes a project that addresses incident management and other projects that improve flow on major arterials, which will help to reduce emergency response times.



### **CC-EM-01: Public Safety Integration**

This project will connect and integrate the 911 centers in Clackamas County and the region to allow the effective coordination of regional incidents and the sharing of information. This project will include communications connections between the 911 centers and the integration of computer-aided dispatch (CAD) systems. The four existing 911 Centers in Clackamas County include the following:

- Clackamas County 911 (C-COM)
- Lake Oswego 911 (LOCOM)
- Gladstone 911
- Milwaukie 911

The Milwaukie 911 Center will turn over its operations to the Lake Oswego 911 Center in Spring 2003. ODOT, the Bureau of Emergency Communications (BOEC), Swan Island Networks and Intel are currently working on a “proof-of-concept” to integrate regional 911 centers. This proof-of-concept uses a common central interface so existing CAD systems do not need to be modified. Before embarking on their own effort, the County should evaluate the success or failure of this proof-of-concept.

**CC-EM-02: Regional Emergency Operations Center (EOC) Integration**

This project will deploy traffic information dissemination infrastructure at Emergency Operations Centers to provide real-time information to emergency managers during major incidents. This project will also provide communications connections between the regional emergency operations centers and an integrated system for the dissemination of real-time traffic and incident management information. This project will deploy a central response management system to deliver real-time information securely during a major incident to the people dealing with the incident.

**CC-EM-03: Traffic Adaptive Emergency Response**

This project will deploy an integrated regional emergency response subsystem that provides for pre-trip route planning, en-route guidance (static route plan), and the capability for dynamic route guidance (traffic-adaptive route plan), to most effectively provide the optimal routing for emergency response vehicles. This project will also tie into a similar regional project (TransPort Project OR0203).



**CC-EM-04: Emergency Vehicle Fleet Management System**

This project will deploy automated vehicle location (AVL) on emergency vehicles and disseminate this information in real-time to the 911 center computer aided dispatch (CAD) systems. The objective of the project is to reduce emergency response times by providing dispatchers with real-time location information of emergency vehicles.

**MAINTENANCE AND CONSTRUCTION MANAGEMENT PLAN**

Maintenance and construction management includes fleet tracking and maintenance, winter maintenance, roadway maintenance and construction, work zone management and safety monitoring, and scheduling coordination. Maintenance and construction activities also relate closely to traffic management and emergency management activities.





### **Existing Maintenance and Construction Management**

Typically, government agencies handle routine transportation maintenance in Clackamas County and private contractors are hired to perform construction activities. At times, private contractors are also hired to conduct maintenance jobs. Most government agencies within Clackamas County have a department that is in charge of transportation maintenance responsibilities. Maintenance duties vary by agency and include tasks such as street repaving, pot hole repair, shoulder rehabilitation, street sweeping, traffic control device replacement, removal of illegal signs in public right-of-way, pavement marking repair, traffic signal equipment repairs, and street light re-lamping and repairs. Emergency dispatch services sometimes request help from maintenance personnel during an incident. Construction responsibilities differ by project and by contractor hired to complete the project.

For many maintenance and construction activities, work zones are set up and temporary traffic control is established through the work zone. This varies by project, but temporary traffic control often involves lane closures or detour routes that may significantly impact traffic flow. Maintenance and construction activities are typically prohibited during the

morning and evening peak periods at high volume locations.

The most imperative needs identified in the User Needs Assessment chapter regarding maintenance and construction management include the following:

- Need for real-time traffic information, particularly field device status (signal data, video data, etc...) and weather information.
- Maintenance vehicle tracking, especially for emergency conditions.
- Enhanced traffic management in work zones to improve safety.
- Database of maintenance and construction information (schedules, locations, details, etc...) to help with interagency coordination and to provide traveler information.

### **Future Maintenance and Construction Management**

The following projects address maintenance fleet management, communications with emergency services, and safety enhancement in construction zones.

Several of the travel and traffic management projects and communications projects discussed earlier in this chapter will help provide real-time information to maintenance personnel. Also, a regional project pertaining to a construction planning and scheduling database is discussed in the Other Projects section later this chapter.



CC-MC-01: Maintenance Fleet Management System

This project will deploy automated vehicle location (AVL) equipment on maintenance vehicles including snowplows and disseminate this information in real-time to the 911 center computer aided dispatch (CAD) systems. The objective of the project is to provide dispatchers with real-time location information of maintenance vehicles so they can be managed during an incident.



CC-MC-02: 800 MHz Radio

This project will deploy an 800 MHz radio system for Clackamas County maintenance personnel. The region is standardizing on 800 MHz radio and C-COM is currently upgrading to 800 MHz. The objective of this project is to improve coordination and communication among multiple agencies and jurisdictions during major incidents.



CC-MC-03: Construction Zone Safety Enhancements

This project will deploy innovative traffic control devices in construction work zones to improve the safety for work zone crews. The project will deploy systems to dynamically adjust speed limits, to display in real-time drivers' speed, to estimate travel times through construction work zones and to alert work zone crews of immediate dangers.



Copyright © 2001, MPH Industries, Inc.

**OTHER REGIONAL PROJECTS**

**Transportation Portland** (TransPort) has plans for other regional projects in the Portland metropolitan region that apply to Clackamas County. The TransPort Committee is chaired by ODOT and includes planning input from numerous regional jurisdictions, including Clackamas County, transit agencies, academic sectors, and private sectors. The latest TransPort plan<sup>7</sup> includes 16 ITS projects in the Portland metropolitan region, about half of which are applicable to Clackamas County. This section includes a description of the applicable projects and how they relate to Clackamas County.

<sup>7</sup> *TransPort 2000*. A FY 2000 Federal Transportation Appropriations Bill Project Request, Submitted to ODOT by ODOT Region 1, City of Portland, Port of Portland, TriMet, Metro, and Cities and Counties of the Region.

### Clackamas County Central Signal System

This project interfaces with the existing City of Portland Traffic Management and Control project (TransPort Project OR0212) and will include the installation of a central traffic signal system computer and software to remotely manage and monitor traffic signals. This project will include enhanced county-to-state and county-to-city traffic management system integration, provide for future adaptive control in response to real-time traffic conditions, accommodate regional signal priority needs, and allow more efficient integration of existing and planned roadside system enhancements.

### 511 Traveler Information Phone Number



This is an active regional project that will replace the 800-number that is currently used for traffic information. Eventually, the

public will be able to access construction information, incident information, transit information, and other traveler information by dialing 511. 511 implementation projects around the country are also attempting to tailor the traffic information to specific users.

Currently, ODOT is offering to operate the 511 system, but there are regional discussions ongoing about which agency or agencies should bear the burden for operating and maintaining the system. To provide traveler information on Clackamas County roadways via 511, the County will need to have a communications connection to the Regional Data Warehouse and field equipment to collect traveler information.

### Regional Data Warehouse

This regional project (TransPort Project OR0188) will develop and deploy an integrated regional ITS planning subsystem

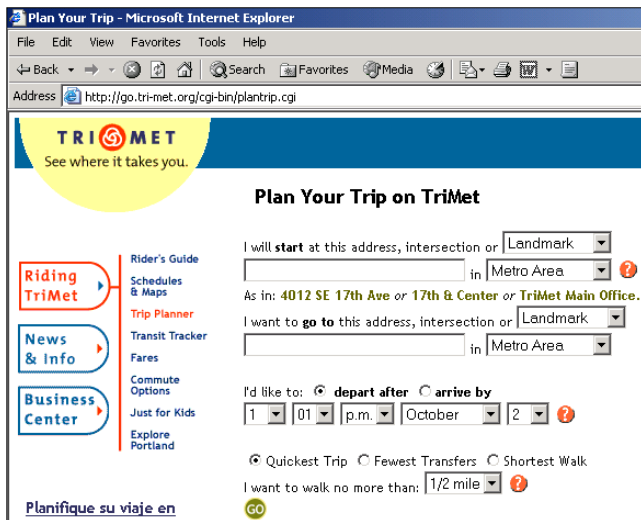


(regional data warehouse) that provides for near real-time access, collection and archiving of regional operational and performance data from traffic (freeway and arterial), transit (TriMet bus and rail, SMART bus), incident management, and emergency response sources. The Metropolitan Planning Organizations, such as Metro and the Southwest Washington Regional Transportation Council (RTC), will use this data access and archive for regional and national modeling, research, analysis and planning activities.

### Transit Buses as Traffic Probes

The region is currently developing and deploying a system for using real time transit bus operational data to determine the traffic network status (TransPort Project OR0518). Using buses as traffic probes, TriMet will report travel speeds over key corridors determined to be of interest to Clackamas County. This data could be used to monitor congestion information on key corridors in near real-time or to collect historical travel time information.





**Regional Inter-Modal Transit Traveler Information and Security System**

This regional project (TransPort Project OR0206) will deploy an integrated and upgraded regional multi-modal Traveler Information and Security System that seamlessly serves transit riders with a variety of services and information to include pre-trip planning, fare and schedule information, en-route rider information, and traveler information on inter-modal choices and transfer points. This system enhancement also facilitates the safe and efficient use of the regional transit systems.

**Commercial Vehicle Operator Information Network System (COINS)**

This project will deploy traffic information dissemination infrastructure at key commercial trucking facilities in Clackamas County that will be linked to a regional project (TransPort Project OR0216). Enhancements will also be added to the regional traveler information systems to include linkage to commercial vehicle operations (CVO) specific information including regional truck movement restrictions. This project will

also provide the private trucking industry an opportunity to subscribe to a service that provides traveler information pertinent to the trucking industry. The traveler information provided may include construction information, weigh station information, and real-time traffic conditions. Information may be disseminated through a web site such as ODOT's TripCheck web site or through other means.



**Construction Planning and Scheduling Database**

This project will deploy an integrated regional subsystem that provides construction related information including current and planned construction projects. The project objective is to provide advanced information to maintenance and operations personnel to coordinate traffic control and better manage vehicle diversion. This project is identified as a portion of the regional transportation status web site (TransPort Project OR0217).