Prepared for

City of Portland

Intelligent Transportation System Implementation Plan

Final Draft

Prepared by

DKS Associates

June 1997

DKS Associates

1400 SW 5th Avenue, Suite 500
Portland, OR 97201
Phone: (503) 243-3500
Fax: (503) 243-1934

June 10, 1997

Mike Bauer
City of Portland
1120 SW Fifth Avenue, Room 730
Portland, OR 97204

Subject: Portland ITS Plan Summary P96278x0

Dear Mike:

DKS Associates is pleased to submit this final draft report of the Portland Intelligent Transportation System (ITS) Implementation Plan. This plan reflects your input in the plan development and summarizes the use of modern technology to better manage congestion today and in the future. The plan focuses on the Bureau of Traffic Management's role in development of ITS and outlines areas for coordination within the City and between other agencies. Should you have any questions and need further assistance, please feel free to contact me.

Sincerely,

***DKS** Associates*
A Corporation

Ransford S. McCourt
Principal

Attachment

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City of Portland
ITS Plan Summary

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• Introduction

The term Intelligent Transportation Systems (ITS), refers to using technologies to enhance mobility by making more effective use of the transportation network. This is accomplished through existing and emerging technologies that provide systematic monitoring, management-control, and information sharing. These strategies and tools can allow for improved management of traffic flows, congestion, and incidents. One of the most critical functions of ITS is improving the efficiency of the transportation system by informing the public about travel conditions and choices they may encounter in real time.

This report documents how the City of Portland can best use ITS to meet its future needs and outlines the type of benefits associated with the plan. The plan will provide the public, staff, decision makers, and regional agencies an understanding of the City's future direction, allowing them to share in the direction and development of ITS in Portland.

At this time, this report is considered a Final Draft. As comments and feedback are received from others through a public review process, this document will be refined to best reflect input.

The maps and listings of specific locations for ITS devices are preliminary. The logical deployment of ITS is within corridors to maximize the benefits to the public. As corridor design plans are developed, the specific locations and design of devices will then be completed. The locations are illustrative of what can be done along corridors. This helps understand the magnitude of the investment in terms of devices and dollars. While the locations of ITS devices are preliminary, a rationale has gone into identifying these preliminary locations. The criteria and reasoning for locating a particular device is described in the appropriate sections in this document.

The development of ITS in the Portland region will be a coordinated effort between many public agencies and private partners. This plan focuses on the Bureau of Traffic Management's (BTM) role in ITS. The estimated cost for BTM's role in ITS is estimated at about $14 million (1997 dollars). Benefits can be achieved immediately by implementing the ITS Plan over a period of years on a corridor basis. This incremental approach reduces the risks associated with full scale, rapid deployment.

The ITS Plan is not a system unto itself, but a base of support for the City's and regions transportation systems and policies. The ITS elements support the transportation policies outlined in the regions many transportation initiatives. Optimal deployment of ITS complements transit, freeway, trucking, bicycle and pedestrian operation and mobility.

• ITS Plan Description

The City of Portland is a major partner in managing travel in the Portland region. In the past, the tools used to address the impacts of growth and congestion on transportation facilities have focused on major capital investment (constructing more roads, building more rail, buying more buses). Today, technology provides more sophisticated tools to better manage and operate existing facilities which produce the maximum value out of our transportation infrastructure. Intelligent Transportation Systems (ITS) provide many of these tools.

ITS encompasses a variety of projects that use computers and communication technology to collect process, share and act on information in real time. ITS will increase safety, reduce congestion, promote the use of alternative modes of transportation, improve air quality and reduce fuel consumption. Optimizing performance of the region's transportation systems is one of seven goals related to streets in Metro's Regional Transportation Policy. The 1994 *Region-wide Advanced Traffic Management System Plan* completed for the Oregon Department of Transportation provides a framework for regional development of ITS operational strategies.

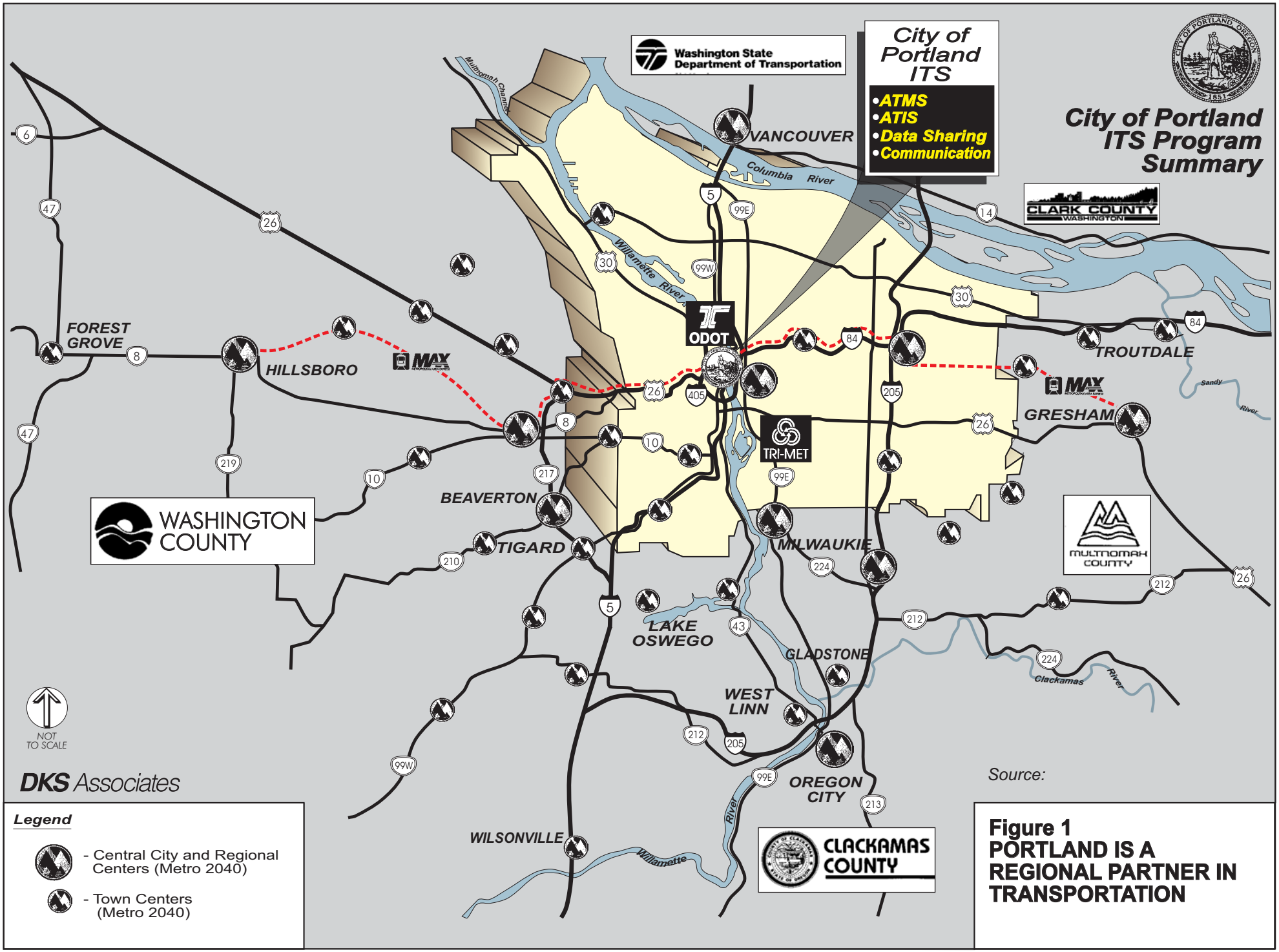
The City of Portland has developed a program, building from the regional policies and framework, that specifically responds to the needs of the city. It reflects the city's position as a transportation partner in the region (**Figure 1)**. In identifying the elements of ITS tailored to the City of Portland, three core ITS elements and three implementation strategies were outlined. Advanced traffic management and traveler information would be supported through key elements of:

- Traffic Monitoring
- Traffic Control
- Traveler Information

ITS implementation strategies outlined in this plan include:

- Communication System Deployment
- System Operation and Maintenance
- Information Sharing

This paper outlines the challenges that the City of Portland faces in efficiently operating its transportation system, given the future increases in density and population anticipated for the region. Based upon future needs of the City, a vision of ITS as a integral element in future transportation solutions is summarized. Key elements of an ITS Plan tailored to Portland are identified with a specific set of implementation strategies.

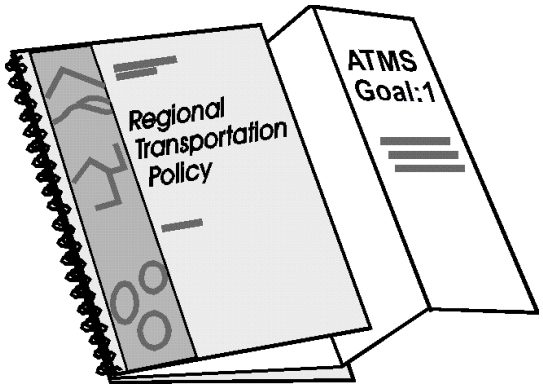

City of Portland ITS
•ATMS
•ATIS
•Data Sharing
•Communication
City of Portland ITS Program Summary
Washington State Department of Transportation
CLARK COUNTY WASHINGTON
VANCOUVER
Columbia River
Multnomah Channel
Willamette River
ODOT
TRI-MET
MAX
FOREST GROVE
HILLSBORO
BEAVERTON
TIGARD
TROUTDALE
GRESHAM
Sandy River
MILWAUKIE
LAKE OSWEGO
GLADSTONE
WEST LINN
OREGON CITY
WILSONVILLE
Clackamas River
Willamette River
WASHINGTON COUNTY
MULTNOMAH COUNTY
CLACKAMAS COUNTY
NOT TO SCALE
DKS Associates
Legend
- Central City and Regional Centers (Metro 2040)
- Town Centers (Metro 2040)
Source:
Figure 1
PORTLAND IS A REGIONAL PARTNER IN TRANSPORTATION

• Challenges of the Future

Operating the transportation system of the future in Portland will present challenges that have not yet been experienced in our region. While the existing systems for managing arterial traffic flow in Portland have been adequate when facing the past and current level of congestion, these systems will fail to adequately address future congestion levels.

In the past 25 years, the tri-county region has grown from 880,000 to over 1.3 million people. Growth is expected to continue over the next 25 years, as the City and region implement the 2040 growth concepts. This growth will result in a failure of the existing transportation systems as we know them today. Our transportation system users will experience congested conditions more frequently.

Maximizing the performance of our transportation infrastructure in the future will require more advanced systems. These systems will need to be able to respond immediately, in real time to transportation operational problems. This will mandate that systems communicate with one another without waiting for someone to call or go into the field. Without this ability in the future, response to incidents and events which impact transportation operation will become longer and longer as traffic in non-peak times grows. Growth in not only peak hour but non-peak traffic impacts the recovery time (the length of time between congested periods and normal operation). What were small incidents in the past will become major problems for passenger cars, on-schedule transit service and freight mobility. Addressing major emergencies in a congested environment will require more sophisticated communication, operating techniques and systems than are used today.



In addition, as the system becomes more congested, the need to share accurate information with the public becomes essential for efficient travel behavior. A better informed public makes better transportation choices. This has been particularly evident in this region during major events such as ice storms or the recent flooding. The City of Portland ITS Plan focuses on meeting these challenges.

• ITS Vision Statement

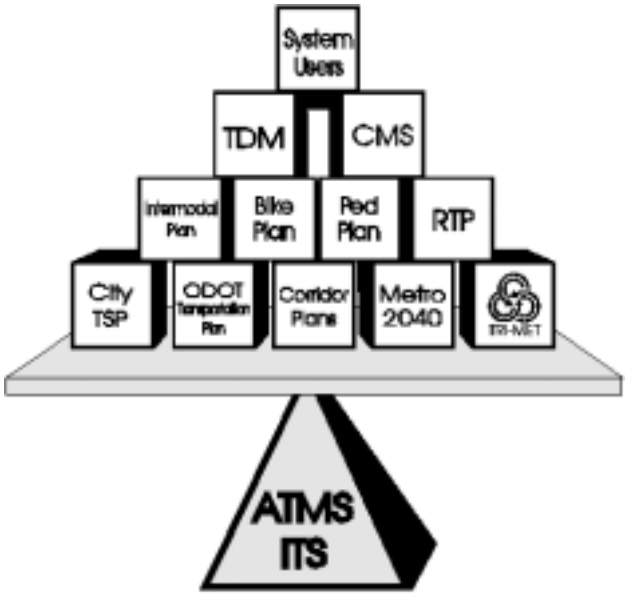
As the 21st century approaches, Portland faces significant mobility, environmental and economic challenges. The City cannot financially or environmentally support only the traditional, capital-intensive approach to solving transportation demand issues - building additional roadway capacity to address congestion problems. The City will need a smarter transportation system in the future; one that functions as an integrated intermodal system offering increased performance and expanded options for people and goods movement.

Portland has the opportunity and responsibility to provide leadership and meet these challenges now and into the next century. In this role, Portland is committed to developing a dynamic ITS Program.

The ITS Program Vision for the City of Portland is:

- To maximize transportation productivity, mobility, efficiency and safety.
- To provide faster and better sharing of information between agencies and to the public
- To work as an integral member of a regional team using cost-effective ITS technologies and systems to promote efficient use of all modes of transportation.

The ability to share information between agencies and to the public is the foundation of good planning and operation of the transportation system. ITS provides information and operational support to many of the city's and region's transportation initiatives..



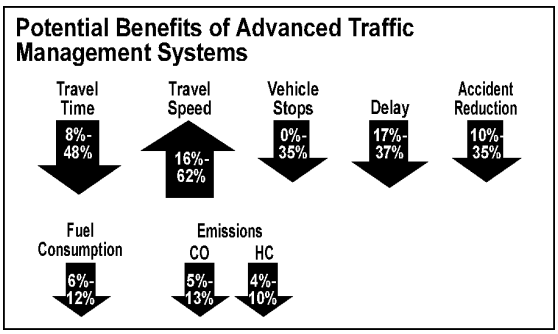
ITS is the base for other City and Regional transportation programs, policies and plans

• ITS Benefits

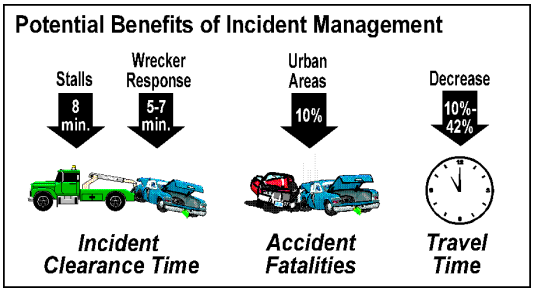
The ability to measure the benefits of ITS technologies is important to making decisions regarding their implementation. The benefits of ITS projects are best evaluated through their positive impact on the traveling public. Evaluation factors include:

- reduction in travel delay
- reduction of accidents
- reduction in fuel consumption
- improvement in air quality

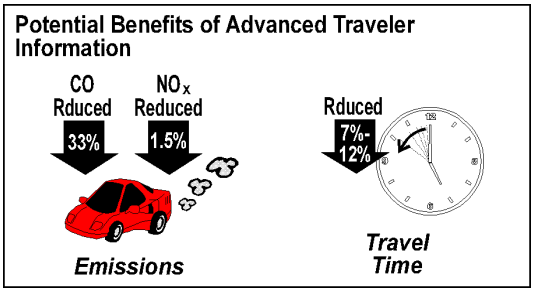
State-of-the-art traffic signal systems, with communication to a central computer and coordinated timing plans have proven to produce substantial benefits to the public. Examples in Portland include projects on 82nd Avenue, 122nd Avenue, Martin Luther King, Jr. Blvd, and SW Naito Parkway where improved signal timing reduced travel times on these arterials by 10 to 25% during peak periods. Other parts of the country, such as Chicago, Minneapolis, Las Vegas, and Los Angeles, have also documented the potential benefits of Advanced Transportation Management Systems as shown in the graphics below:



Potential benefits of the ITS Plan core elements go beyond just improved signal timing. When coordinated with freeway management, these systems can deliver improved incident management, which can have the benefits shown below:



These benefits could be converted into direct cost savings using vehicle-miles of travel (VMT). The percentage increase benefit is provided here to demonstrate the positive impact to the traveling public.

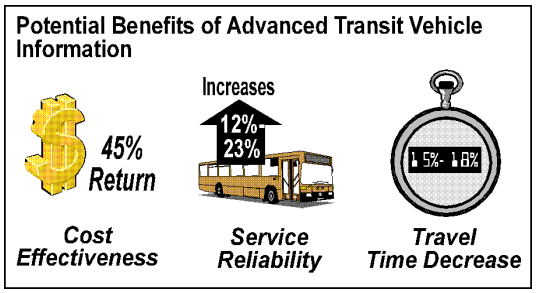


Additional benefits include the collection and dissemination of congestion information. While this information is useful for planning purposes, the information has a real-time use by travelers to make intelligent travel choices, which could even include the decision to not make a trip during certain periods.

The benefits of ITS reach all travel modes. The City's operational center can provide Tri-Met real time in-

formation regarding route operating conditions, including notification of incidents. Tri-Met's new dispatch center will be able to provide the public more reliable data regarding schedules of transit vehicles. This information will be available on web pages, at major transit stops and kiosks (located in employment, shopping or event centers) using data from a Global Positioning System (GPS). This GPS transit system data will be shared with ODOT and the City; improving the monitoring and operation of the freeway and arterial systems.

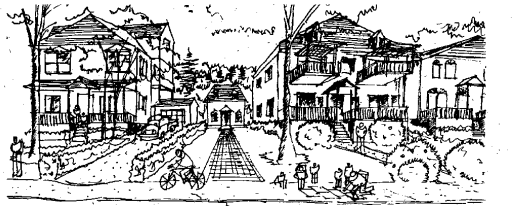
Also, ITS technologies can help to reduce overall corridor transit travel times. This can be accomplished using the GPS system and devices at traffic signals that allow transit vehicles to proceed through the signal by providing an early green, or green extension. In a test of the early green-green extension priority system on SE Powell Boulevard, travel times were reduced 5-10% during the peak hours.



Incidents on the transportation system significantly impact all travel modes. ITS can be used to reduce response time and incident clearance time. Improved incident management through ITS reduces incident related congestion and secondary accidents.

Specific to fire emergency response, studies have shown reductions of 15 to 20% in travel times for emergency vehicles with ITS signal pre-emption capabilities.

Weigh in motion technologies are being used by ODOT to reduce travel times for interstate and intrastate truck hauling companies. Coupled with potential real time traffic information to trucking companies regarding congestion, or major incidents, delays to goods movement can further be reduced.



Elements of the ITS Plan help mitigate the impact of vehicular traffic shifting to residential streets to short cut congestion, especially during major incidents; thereby helping to protect the livability of residential neighborhoods.

Photo radar, school signs that are programmed only to flash when students are present, and pedestrian/bike detection for extended signal timing when needed, are examples of creative use of ITS technology currently in use in Portland. This technology improves the safety in neighborhoods, and of pedestrians and bicycles at key locations.

• ITS Plan Core Elements

The full development of ITS includes various elements of transportation and goods movement. Five system components of ITS include:

- Advanced Traffic Management Systems (ATMS)
- Advanced Traveler Information Systems (ATIS)
- Advanced Vehicle Control Systems (AVCS)
- Advanced Public Transportation Systems (APTS)
- Commercial Vehicle Operations (CVO)

These components are described in the *1994 Regionwide Advanced Traffic Management Plan* completed by ODOT. Many of these components are being deployed by various agencies and private companies in the region. The following table outlines some of these current activities in the region. A common feature of most ITS initiatives is the partnerships among public agencies and public/private which result in benefits and efficiencies for all parties. The City of Portland is in a position to address certain key components of ITS. As the system is developed, these partnerships will need to be developed to capture full benefits of ITS for the traveling public.

Based upon the City of Portland's needs and capabilities, the City ITS Plan focuses on core elements of ATMS and ATIS deployment. This plan also outlines implementation programs to aid communication and data sharing within the City and between other public and private entities deploying ITS in the region.

The core elements of ATMS and ATIS are interrelated. Operating conditions on the transportation system must be determined in real time, actions need to be taken to respond to changing conditions to efficiently manage congestion and information collected must be shared with travelers to aid them in making better transportation choices. The Portland ITS plan includes three core ITS elements that broadly support ATMS and ATIS and three key implementation strategies to support deployment of ITS. **Figure 2** summarizes the core elements of ITS which relate to the City of Portland operation, including:

- **Traffic Monitoring**
- **Traffic Control**
- **Information Sharing**

To implement and deploy the core elements of ITS will require

- Communication System deployment
- System Operation and Maintenance
- Information Sharing

Each of the ITS core elements and implementation strategies are described in the following sections.

Figure 2
PORTLAND ITS CORE ELEMENTS

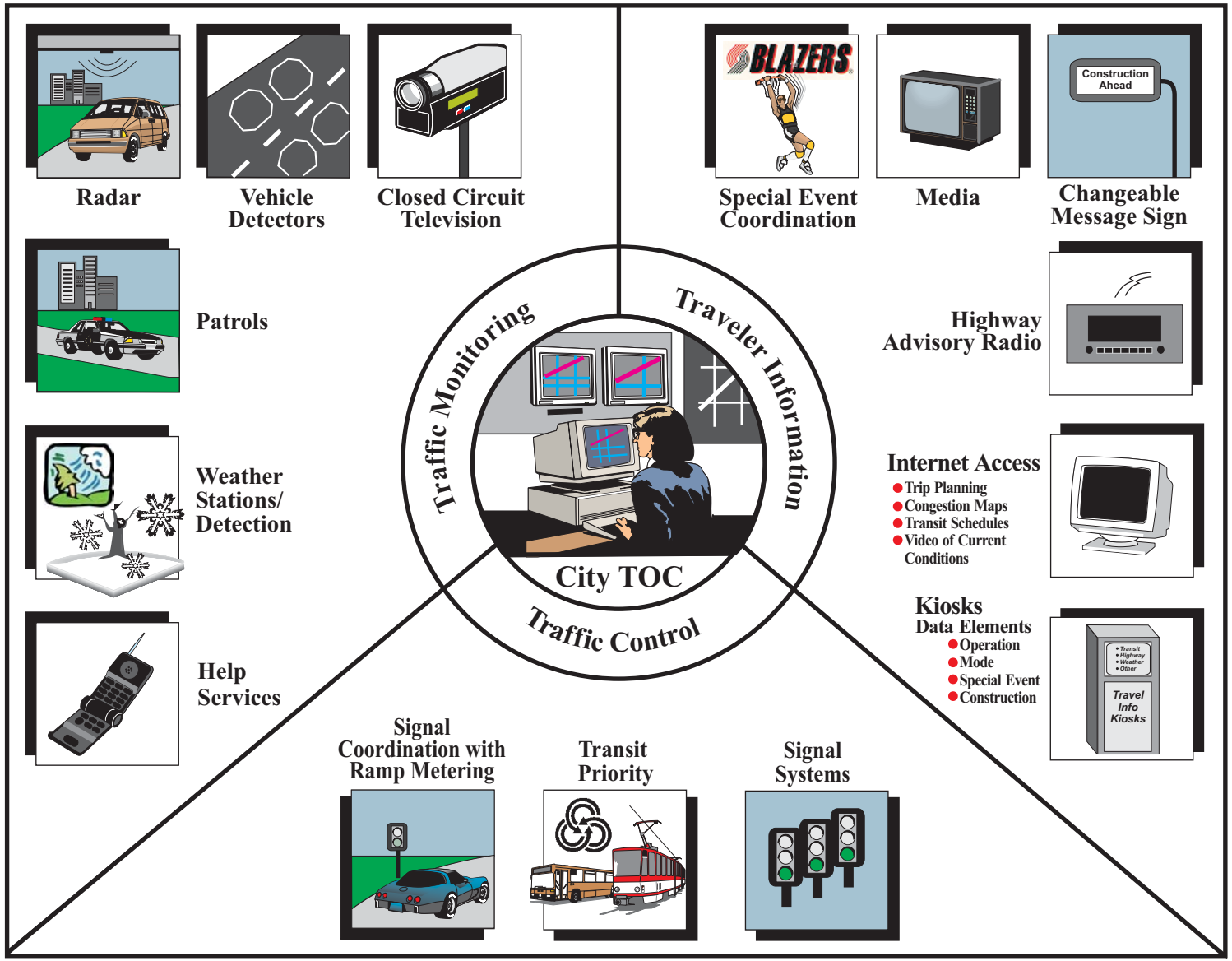


Table 1
Examples of Current ITS Deployment in the Portland Region

ATMS Advanced Traffic Management Systems	• ODOT Freeway Management: The Traffic Management Operations Center at Region 1 will operate various traffic monitoring, traffic control, and traffic information devices in the Portland region (Ramp meters, Changeable Message Signs, CCTV Cameras, *77 Calls). • ODOT Freeway Incident Response Program: Five Incident Response Vehicles traverse the regions freeway system to monitor conditions, pick-up debris, help stranded motorists, and to help manage and clear incidents. • Portland Arterial Management: The City of Portland monitors traffic conditions with a limited number of CCTV cameras and several detection stations, and monitors and controls 450 of 950 signalized intersections from the Series 2000 central computer system in the City's Traffic Operations Center. • East Multnomah County/City of Gresham Arterial Management: The first phase of this project will optimize signal operation/monitoring at 31 signalized intersections, with an agreement with the City of Portland to communicate with the signals utilizing the Series 2000 central computer system.
ATIS Advanced Traveler Information Systems	• ODOT Freeway Message Signs: There are 8 Changeable Message Signs on the freeway system within the Portland region. These signs will give real time information on incidents and special events, and recommended alternate routes. • Traffic Reports: Currently the media does a fine job of reporting incidents, and traffic conditions to their radio and TV audience. By sharing traffic information between regional centers and the media, even more informative and timely news could be reported. • Real Time Bus Schedule Data at Stops: Tri-Met is proposing to feed real time LRT information at selected stops. This program is proposed to be expanded to included most LRT stations and major Bus stops.
AVCS Advanced Vehicle Control Systems	• UPS and FEDEX Route Selection: Package delivery companies in the Portland area utilize automated route selection (pre-determined), vehicle tracking and use two-way communication through use of the cellular network. • Freightliner Automated Truck Guidance: Freightliner, as well as other companies, are developing longitudinal and lateral collision avoidance systems to prevent head-on and rear-end collisions, and to prevent vehicles from leaving lanes or the roadway.
APTS Advanced Public Transportation Systems	• Tri-Met Automatic Vehicle Location: Currently 27 (entire fleet by end of 1997) buses have full operational Global Positioning System hardware, that is capable of transmitting exact bus location back to the dispatch center. This will significantly help scheduling, give real time transit information, and the bus will act as a probe to give system status back to region operation centers. • Tri-Met Mobile Road Temperature Conditions: Bus supervisor vehicles have temperature devices that can send information to the dispatch center and eventually on to other regional centers, in severe weather conditions.
CVO Commercial Vehicle Operations	• Port Automated Gate: The Port of Portland has implemented automated gate control features to Terminal 6 (a container terminal), to reduce delays to truckers. • ODOT Green Light Project: Will enable commercial vehicles to have their safety status, credentials, and weight checked at mainline speeds. • Weigh-In-Motion (WIM) Project: Oregon has several weigh stations where commercial vehicles have their weight determined without having to stop.

Traffic Monitoring

Issue
The ability to quickly identify congested operating conditions and incidents (such as accidents, or hazardous materials spills), as quickly as possible, is a key element of the City's ITS Plan. Impacts to the system caused by incidents can be reduced by quickly informing the motoring public, by implementing special signal timing plans, and by quicker emergency response and incident clean-up.

Problem
Reducing the impacts of congestion is dependent on real time monitoring of traffic to detect problems in system operation. Also, congestion on the system can vary dramatically rendering one solution ineffective in a rapidly changing condition. The growth in congestion due to increased land use density and incidents will continue, unless the system can be more effectively managed by utilizing real time information from the field.

Goal
Provide real time monitoring of the transportation system, and integrate this information into traffic control scenarios, traveler information, and emergency response. Another important use of the monitoring program is to gather and maintain historical traffic information. This information can be used in Congestion Management Plans, and future traffic modeling projections for regional transportation projects, and development impacts.

Solution
Develop a series of monitoring plans utilizing the most dependable and cost effective detection techniques (inductive loop stations, video detection). Install emergency vehicle detection equipment at all signalized locations within the City. Partner with Tri-Met to utilize the bus fleet as traffic "probes", for identification and confirmation of incidents. Develop agreements with ODOT and other local agencies to partner and share monitoring information, and equipment.

Description
The use of closed circuit television cameras (CCTV) and vehicle detection systems, will be the primary source of system wide monitoring.

Figure 3 shows the locations of existing and future traffic detection/count stations. The locations for the traffic detection count stations are identified at strategic points along key Regional and Major City corridors. The locations were determined based on the need to meet real time system operation needs and to match transportation monitoring locations recommended for the Congestion Management System (CMS) and Transportation System Plan (TSP).

Figure 4 shows the locations of existing and potential future CCTV camera locations. The locations for the CCTV sites are proposed at strategic locations, including:

- Regional & Major City corridors
- Freeway/Arterial ramp interchanges
- Willamette River bridgeheads
- City Center, Regional, & Town Centers
- Unique locations: flooding, slides, neighborhood impacts

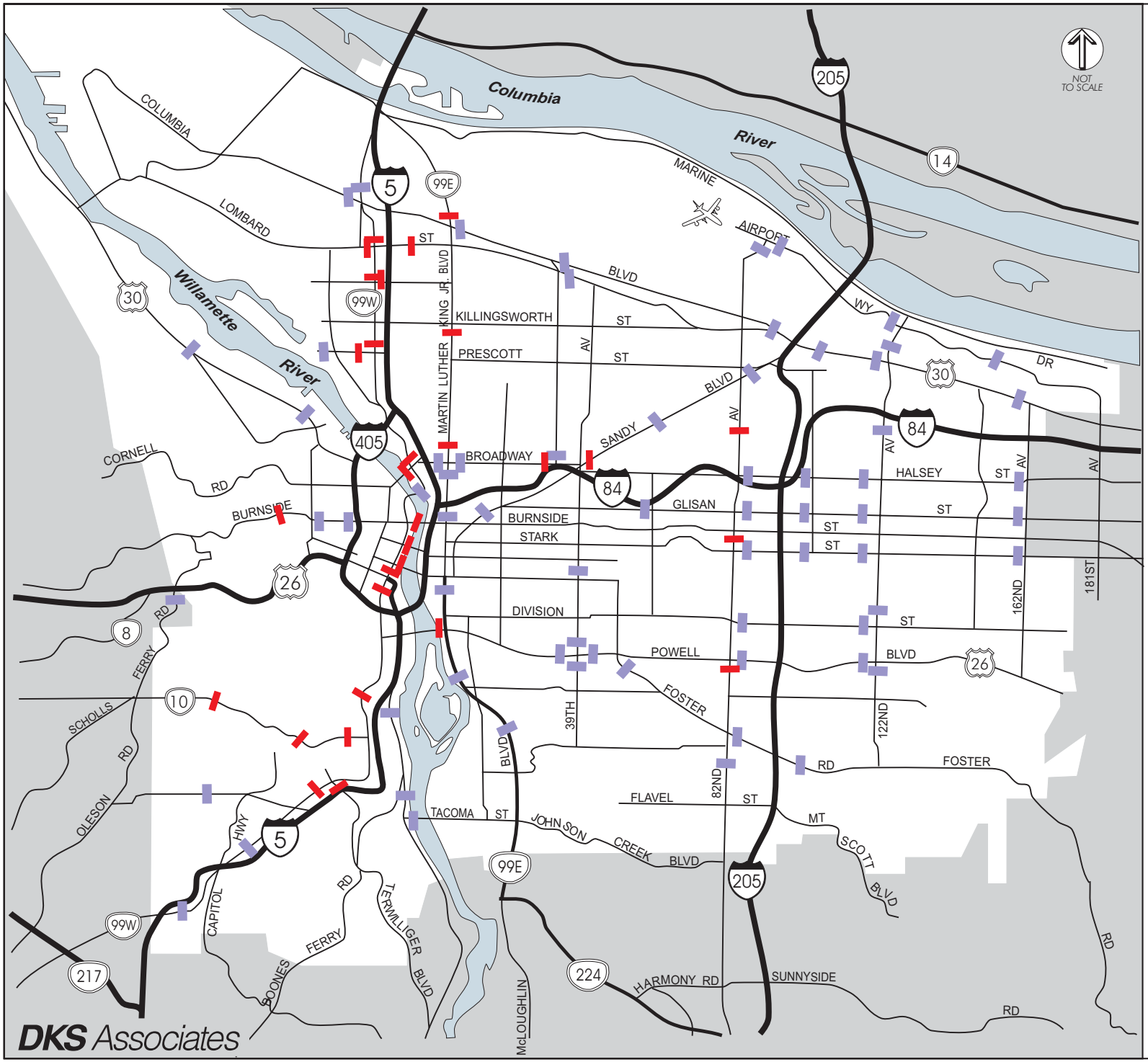
While the count detection stations tell what is happening, the CCTV information tells why it is happening. In the future, video detection capability will merge these two functions. This allows for timely system operation changes or notification (signal timing changes, incident clearance needs, etc.).

Today

The City currently has approximately 30 locations on key arterials that utilize inductive loop detection for system monitoring. Trial studies are underway testing infrared, microwave, and video detection techniques. As part of the Rose Quarter development, six CCTV cameras were installed, and are generating video data to the City's Traffic Operations Center (TOC). A seventh CCTV camera is providing video feed to the City's TOC, and was installed under a collaborative project with ODOT, Portland State University and the City of Portland.

Tomorrow

The City will have an integrated monitoring program using the most effective and low cost technologies available. Information developed in the monitoring program will be used to develop optimal strategies to manage congestion and respond to incidents rapidly. Data from the monitoring stations will be shared with the public to improve traveler information. Monitoring efforts of other agencies will be reviewed to produce an adequate level of data from the least expensive sources. Data between agencies will be shared to maximize benefits and resources. As an example ODOT has a contract under construction that will install 10 CCTV cameras at key freeway locations in the City. The City will share the video operation and feed from these cameras, and ODOT will share the operation and video feed available from the City's CCTV camera locations.



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City of Portland ITS Program Summary

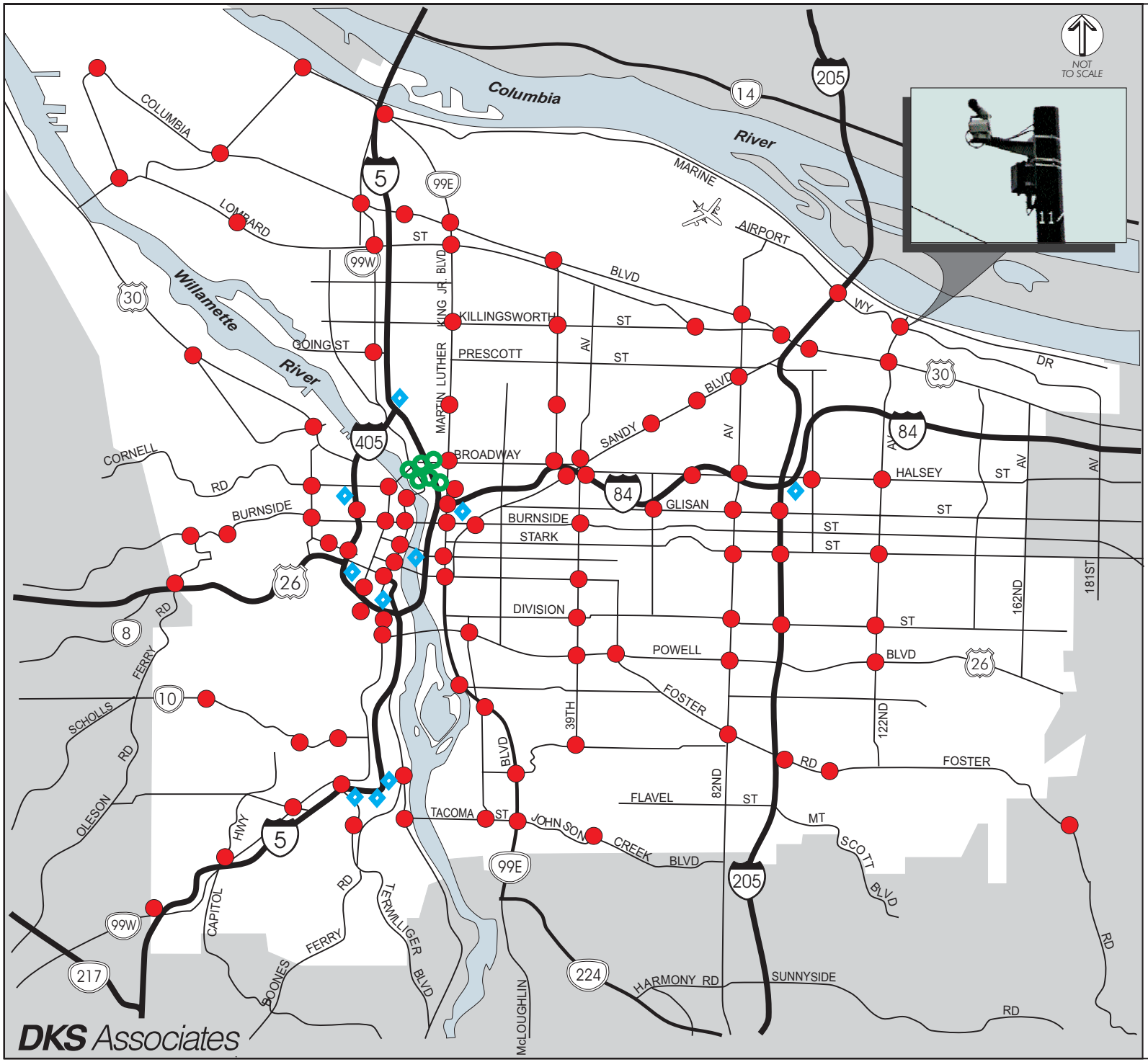
Legend

- Existing City Count Stations
- Proposed City Count Stations

Note:
The Proposed City Count Stations will be finalized during the final design stage of the corridor projects. The locations picked will attempt to match the needs of the Congestion Management Systems (CMS) and Transportation System Plan (TSP) programs, data collection needs.

Source: City of Portland

Figure 3
TRAFFIC DETECTION/ COUNT STATIONS



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City of Portland ITS Program Summary

Legend

Closed Circuit Television (CCTV)

- Existing ODOT CCTV Locations
- Existing City CCTV Locations
- Proposed City CCTV Locations

Note:
The Proposed Video Monitoring Locations will be finalized during the final design stage of the corridor projects.

Source: City of Portland

Figure 4
VIDEO/MONITORING LOCATIONS

Traffic Control

Issue
Efficient operation of Portland's arterial streets requires sophisticated traffic control strategies. The most common and effective strategy is coordination of traffic signals. With future congestion caused by year 2040 levels of development, traffic signal systems that were adequate in the past (addressing morning peak, evening peak, non-peak) will need to address additional time periods of heavy traffic (midday shopping, seasonal shopping, multiple peak period plans, Saturdays, incidents). In addition, the integration of activities between operating agencies will require greater capacity than current systems provide.

Problem
Optimization of traffic signals does not currently extend to all major corridors in the City. The "Series 2000" central computer system controls only about half of the City's traffic signals. Some of the City's traffic signal equipment is over 40 years old and is unable to operate in a optimal fashion.

Goal
Extend central control to all major streets in the City. Develop capability to manage future congestion levels and efficiently serve incidents/special events.

Solution
- Upgrade out-dated field equipment (signal controllers) to meet current communication and control standards.
- Expand central computer and communication systems to address all major corridors in the city .
- Produce optimal arterial signal timing for multiple periods/scenarios including incident management scenarios.
- Provide bus priority features in corridors with high person throughput.
- Develop agreements with adjacent jurisdictions to provide seamless signal timing on all major corridors.
- Develop corridor traffic management plans to provide optimum operation during incidents.

Description
Federal research has indicated that traffic control through the use of advanced signal systems can provide optimum benefits for the movement of people, goods and vehicles only when they are properly designed , operated and maintained. Signal systems providing optimum traffic control frequently produce benefit/cost ratios in excess of capital intensive transportation options such as road widening. Coordinated use of signal systems for incident management is an emerging element of ITS development throughout most major cities in the United States and abroad.

Today
The City maintains a Series 2000 central traffic signal computer and a communication system that provides central control to 450 of the City's

950 traffic signals. This system has capacity to handle 1,100 intersections. Optimal corridor timing plans have been implemented on 6 of the 30 major streets in the City. Approximately 140 intersections have emergency vehicle priority systems (Opticom). A bus priority demonstration project has been completed, identifying the potential for a 5-10% peak hour reduction in bus travel time using special priority.

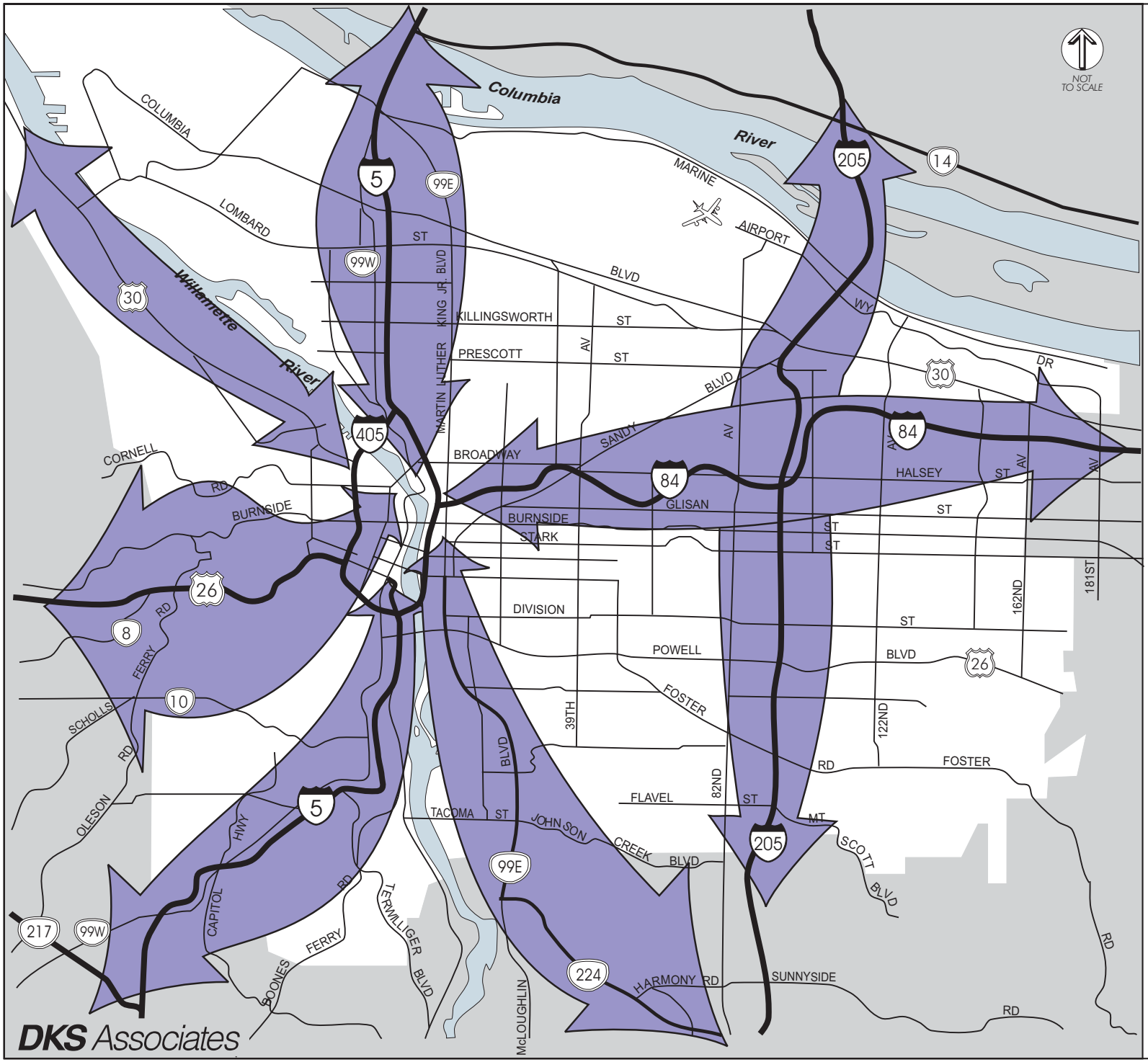
Tomorrow

Implementation of the ITS Plan elements will extend the traffic signal system to all Regional and Major City corridors**.** Traffic signals in these corridors will be optimized for various periods and scenarios (including incident management). Integration will be developed between ODOT, Multnomah County/Gresham and other agencies' traffic signal systems as outlined in the *Regionwide ATMS Plan.* Use of NTCIP (National Transportation Communication for ITS Protocol) standards will lead to more available and advanced traffic signal equipment (eg. Model 2070 controller). Video will be used to enhance the performance of the traffic signal system, improving detection and allowing responsive variations in coordination plans. Integration between ODOT freeway ramp meters and Portland traffic signals will also be developed.

A key need for traffic control occurs during major incidents. Therefore, an integrated plan for Safe Advanced Fire and Emergency response (SAFER) is being proposed to improve emergency response and system management during incidents. The 'SAFER" proposal developed by the City of Portland includes the following four major elements:

- Improved public safety and improved response time to incidents using Opticom signal preemption.
- Incident identification and clearance to maximize the ability for early detection of accidents and emergencies and the timely clearance of an incident on the transportation network.
- Management of the transportation system to improve vehicle flow and reduce secondary accidents.
- An analysis tool for modeling street system policy impacts on emergency vehicle response.

This Incident Response Program would include signal timing plans and detour signing plans along major transportation corridors **(Figure 5)**. It will also incorporate a snow/ice warning system and a direct feed of CCTV video cameras to the 911 center, the Bureau of Maintenance (BOM), and the Emergency Operations Center (EOC). During major events BOM and EOC staff will use the video feed from the CCTV cameras for "real-time" information, resulting in improved response time and more efficient operation.



City of Portland ITS Program Summary

Legend

- Incident Management Corridors

Note:
Regional Freeway and Arterial System where incidents and diversion occur, causing major transportation impacts.

Source: City of Portland/ODOT

Figure 5
INCIDENT MANAGEMENT CORRIDORS

Traveler Information

Issue
The existing and planned ITS infrastructure provides the City with an opportunity to distribute information to travelers for more efficient trip-making decisions.

Problem
An uninformed public makes inefficient transportation choices which places a greater strain on limited capacity of the transportation infrastructure, adding to congestion levels.

Goal
Provide travelers with real-time information regarding major incidents and overall system operation to help them make more informed and more efficient transportation decisions.

Solution
Provide transportation network information collected through the City's Traffic Operations Center to other agencies. This information could also be provided at work and at home for pre-trip decisions on a Web site, through the media and from private companies.

Specific information could also be transmitted directly to the motoring public through changeable message signs (CMS) and variable message signs (VMS), and by highway advisory radio (HAR).

Description
Advanced Traveler Information Systems (ATIS) includes technologies to assist travelers with planning, perception, analysis and decision-making to improve the convenience and efficiency of travel. ATIS technologies are capable of presenting information to travelers regarding traffic conditions, transit schedules, pre-trip routing information and travel alternatives.

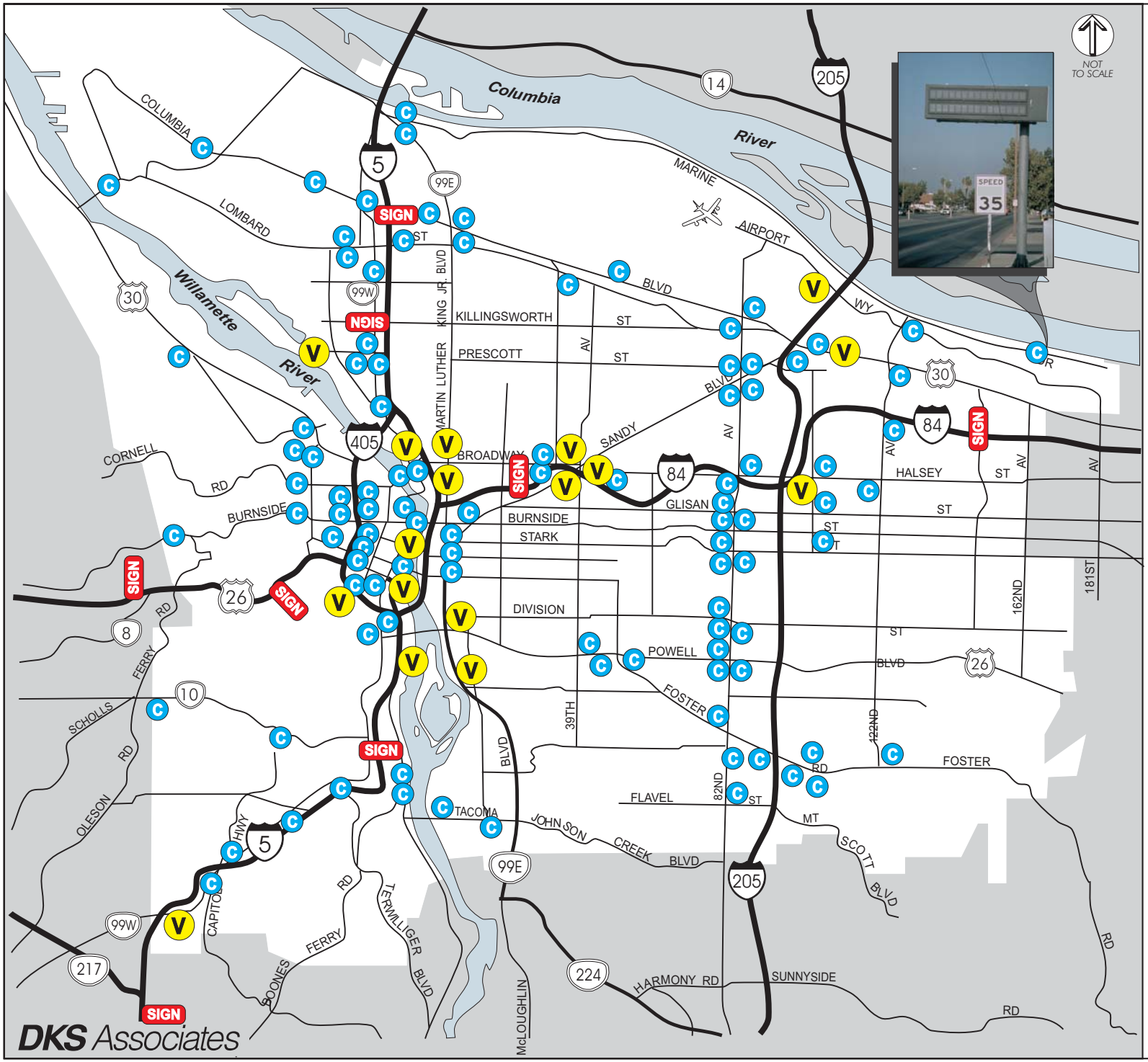
Today
Currently, video camera pictures of traffic conditions are available on the City's Transportation Web page. The video shots are updated every minute from one of the camera locations at the Rose Garden.

The media supplies traffic information to the public on a daily basis. Twenty-two local radio and television stations receive traffic information from a private company, Metro Traffic Control.

Tomorrow
Implementation of the ITS Plan elements will provide an expanded Web page where people could "call up"

any camera location and view real-time traffic situations. A system operation map would show the location of incidents and major congestion areas. A bus map would also be provided showing stops and schedule information. **Figure 6** illustrates the location of existing and proposed information system devices.

The proposed CMS/VMS devices are shown located on Regional and Major City corridors. These devices are located in the vicinity of Regional freeway interchanges, in areas with numerous events (i.e. Rose Quarter, Expo Center/Delta Park), and at the Willamette River bridgeheads. Specific devices will be located strategically to inform the traveling public of special events or incidents providing them with information to make better travel choices (mode or route).



City of Portland ITS Program Summary

Legend

- SIGN - Existing ODOT VMS
- V - Proposed City VMS Sign
- C - Proposed City CMS*

* The type of CMS would vary from an electronic message sign to a fold door sign.

VMS: Variable Message Signs
CMS: Changeable Message Signs

Note:
The proposed variable message and changeable message sign locations will be finalized during the final design stage of the corridor projects.

Source: City of Portland

Figure 6
TRAVELER INFORMATION SYSTEM SITES

• ITS Plan Implementation Strategies

The ability to effectively and efficiently implement the ITS Plan is key to addressing the transportation needs of the 21st century. The three strategies for implementation of ITS identified below are described in more detail on the following pages.

- Communication System deployment
- System Operation and Maintenance
- Information Sharing

Installation of the various programs will be accomplished in manageable levels on a corridor basis, with the highest need corridors implemented first. Partnerships will be developed with other regional agencies and private businesses to share knowledge, facilities and data to the highest extent possible.

Local and regional agencies will need to focus on sharing systems, rights-of-way, operation and management of systems. Partnerships (public/private and public/public) will need to focus on optimizing the coordination and deployment of ITS elements. The result will present to the traveling public a seamless flow of data and operation between various regional centers, regional systems and partners.

A key strategy of the ITS plan is the operation and maintenance of these sophisticated systems. The City will need to commit to a reasonable level of operations and maintenance support if these systems are to be successful.

Figure 7 ITS Implementation

Communications

Issue
One of the most critical components of the ITS Plan is the communication system. Portland must monitor, control and operate traffic devices from the City's Traffic Operations Center (TOC) to effectively manage the movement of passengers and goods.

Problem
The existing communication system relies upon a cable TV franchise agreement which expires within the next two years. Without this "backbone" system, the City is unable to transfer video and data from remote field sites. An affordable and reliable communication system is necessary to transfer data, operating control and information with ODOT, Tri-Met and other local agencies. Without a backbone communication system, the City will be unable to efficiently operate and manage its transportation system in the future. In addition, the demands of 1990's level of communication (digital data, video, etc.) are beyond the current system's capabilities.

Goal
The goal of the communication system is to support the efficient transfer of data and information to effectively monitor, control and operate the devices located in the field from the City's TOC. A secondary goal is to create an intertie with other agencies for coordinated control, surveillance and response.

Solution
Establish a comprehensive City communication system for transportation that combines fiber optic, radio frequency transmission and copper wire mediums. Develop partnerships with public agencies in the development and use of the system. Consider links to private groups that can produce and use transportation information.

Description
A hybrid communication system is recommended that will build upon the most efficient mediums available to the City. A looping fiber optic backbone (spine, trunk line - basically a large electronic pipeline for sending and receiving information) will be the foundation of the system. Other twisted pair (copper wire) and coaxial cable will form the collector/ distributor system. Radio technologies will be used for special applications.

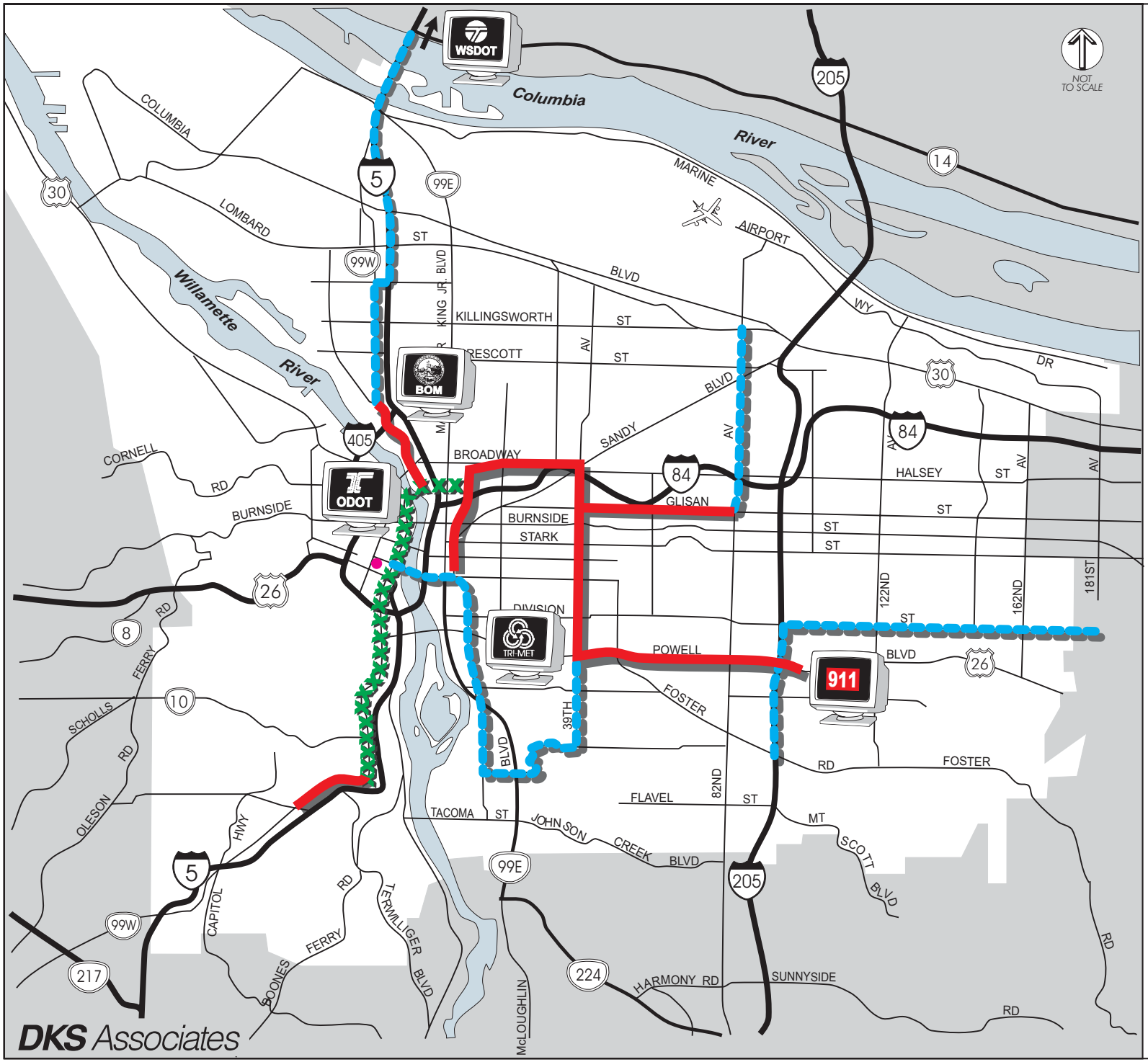
Today
The existing communication system is already a hybrid system using twisted pair wire, the cable TV coaxial backbone and one-way pagers.

The twisted pair wire is the distribution system going to each connected traffic signal. Paragon Cable/INET is currently used to transmit video images from the Rose Quarter to the City's TOC. INET (Institutional Network) forms the current backbone communication system for the City. A fiber optic link between ODOT's Region 1 TMOC and the City's TOC is currently under construction.

Tomorrow

The current franchise agreement with Paragon Cable that has supported INET will be ending in the next two years. The cost to effectively operate the City's transportation system in the future will require a fiber optic communication backbone system as illustrated in **Figure 8.** In the near future, fiber communication via Tri-Met conduit from the Rose Garden's 6 video camera locations across Steel Bridge to the CBD hub will be built. Along with ODOT's CCTV project, the initial core elements of the fiber optic backbone system will be built. Implementation of the ITS Plan elements will allow the City's TOC to be linked to ODOT, Tri-Met, Multnomah County, Emergency Services 911, Bureau of Maintenance and other operating agencies, sharing information and improving the operation of the transportation system.

Through partnerships with other agencies, regional linkages can be developed. One example may be ODOT leading construction of segments of the fiber optic system (such as the I-5 north corridor), while the City maintains and operates the system. Links such as the I-5 north corridor provide the potential for regional links to other agency's operation centers, such as WSDOT in Vancouver. Another example would be sharing Tri-Met's fiber optic trunk line which has been implemented regionally with the LRT construction.



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City of Portland ITS Program Summary

Legend

- XXXX - Fiber Optic Backbone in Progress (1996)
- Stage 1 Backbone Expansion
- Proposed Stage 2 Backbone Future Build Routes

* *Loops built to assure redundancy and keep communications open*

Source:

Figure 8
PROPOSED FIBER OPTIC COMMUNICATION BACKBONE SYSTEM

Operations and Maintenance

Issue
To maximize the benefits of the ITS Plan will require an on-going commitment to maintenance, and operation of, the sophisticated ITS equipment and software. Failing to recognize the need to operate and maintain the ITS Plan will result in unnecessary delays, increased emissions, fuel consumption and safety problems. The ITS elements themselves require consistent staffing for effective system operation, as well as requiring trained staff to do routine maintenance.

Problem
The City's Bureau of Traffic Management will require additional staffing to support the specialized and continuous operation of ITS systems. The potential for congestion is growing with the increase in development density called for in the Regional 2040 plan. Additionally, Bureau of Maintenance will need new staff to maintain the additional equipment identified in the ITS Plan. Existing staff struggle to maintain significant numbers of traffic control equipment over 40 years old, and in need of substantial maintenance. Detection systems used primarily at present (inductive loops), continue to require significant maintenance (due to cut loops or malfunctions) and are dependent upon pavement integrity.

Goal
Provide adequate resources (equipment and staff) to operate, maintain and update ITS technological components. Seek and develop well trained and motivated professionals to support the ITS Plan. Identify opportunities to reduce maintenance needs when designing and specifying new equipment.

Solution
Fund adequate staffing levels to support the ITS Plan. Increase the level of staffing, in incremental steps, as system needs grow in the future. Specify easy to operate and low maintenance equipment in deployment of the ITS Plan.

Description
Incremental Increases in the levels of staffing, to operate and maintain the ITS Plan, will maximize benefits to the public. Efficient operation of the existing and future transportation systems will be necessary to retain our quality of life, in face of future growth projected for this region. Areas which will require specific attention include:

I. Procurement procedures which ensure compatibility of equipment throughout the City;
II. Design standards for equipment that produce efficient results with low maintenance and support needs;

III. Agreements between the Portland region agencies for consistent standards of equipment, and software;
IV. Operation, maintenance, and ownership agreements between Portland region agencies;
V. Technology transfer with other operating agencies; and
VI. Quality recruitment and training programs.

Today

Operations:

The Traffic Operation Center (TOC) is used to provide basic ITS features (traffic signal coordination and special event traffic plans, etc...). The TOC is currently staffed intermittently between the hours of 6AM and 5PM by staff from Traffic Management, primarily assigned to design tasks. The existing central computer system communicates with 450 traffic signals (approximately half the current inventory) every second to confirm correct traffic signal timing and to monitor conditions for malfunctions. A full time position is exclusively dedicated to developing, implementing and fine tuning coordinated traffic signal plans for the City's system. With current staff levels it will require several years to coordinate each major arterial in the city.

Maintenance:

The Bureau of Maintenance provide the maintenance for all City owned illumination and signal devices in the City. Traffic signal equipment alone accounts for over 950 locations. Maintenance of the signal equipment includes all signal components (controllers, loops, poles, signal heads, opticom devices, communication, etc...).

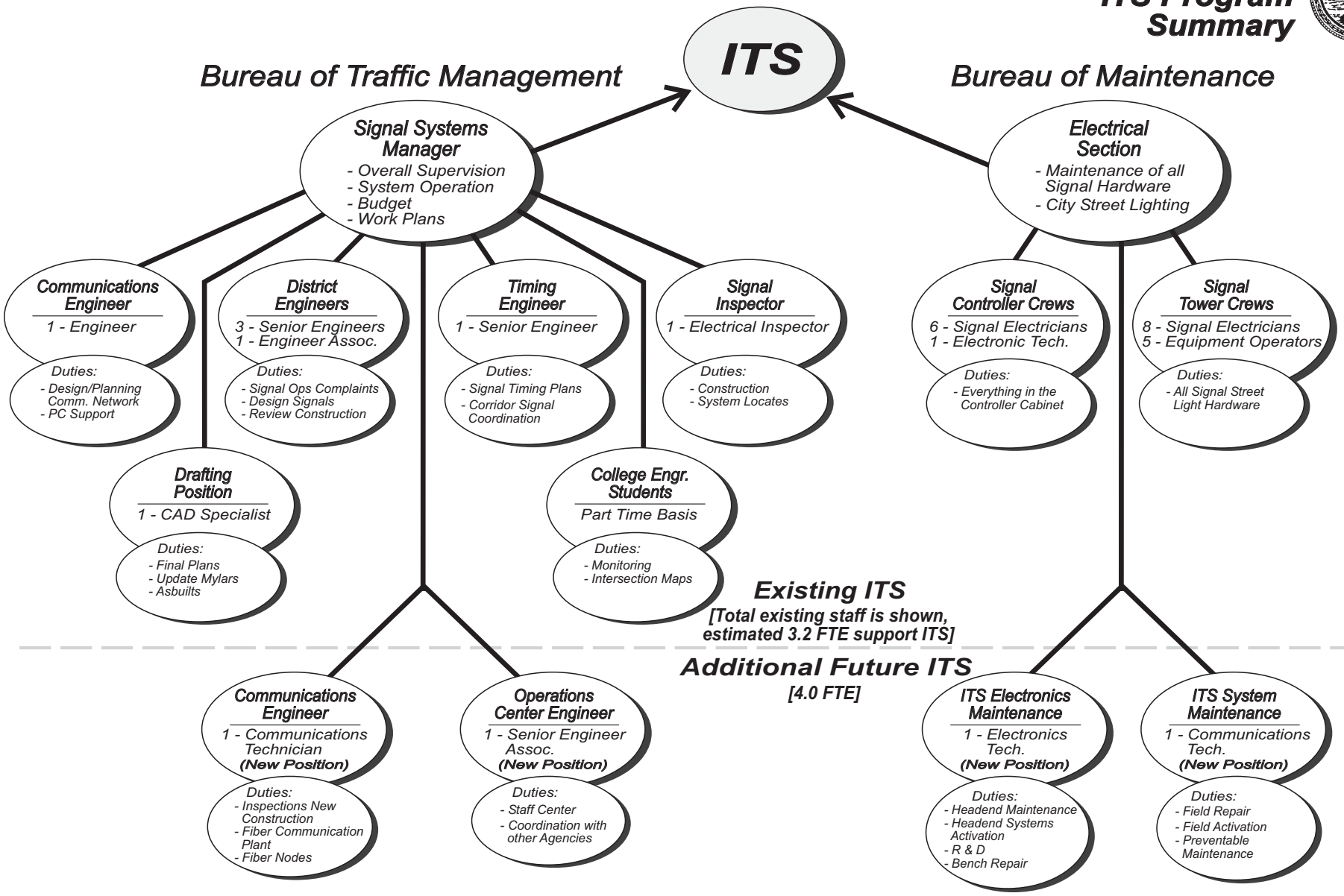
Tomorrow

Operations:

New specifications for ITS equipment will result in easier to operate systems, better maintenance characteristics, along with greater operational benefits. All traffic signals will be connected to the TOC central system. The TOC will be staffed continuously Monday through Friday, 6AM to 6PM. New arterial operating plans will be developed and continuously fine tuned to handle the increased growth of traffic in the City. The new arterial plans will address congestion, reduce impacts caused by incidents, and will support transit programs. Operations will expand into Advanced Traveler Information Systems and Traffic Management Systems. Staffing will be developed to support these increased responsibilities.

Figure 9 outlines how the future staffing needs will be organized within the City to address both operation and maintenance of the ITS Plan.

City of Portland ITS Program Summary



FTE = Fulltime Equivalent Staff

DKS Associates

Figure 9
STAFFING THAT SUPPORTS ITS

Maintenance:
The ITS Plan will require additional maintenance support to address the needs of expanding to more efficient, but higher technical operating systems for transportation. The Bureau of Maintenance will continue to maintain the existing traffic systems equipment, and will be required to maintain a significant increase in new technology. Some new maintenance equipment and staff training will be required (additional vans, bucket truck, skills needed to service fiber optic communications systems).

Table 2 presents the potential future staffing needs of the full ITS system at build out (additional details are provided in the appendix).

Table 2
ITS Plan Staffing
Person Years of Staff

Program	Existing Operations & Maintenance	Additional Future Staffing Needs of ITS	Future Operations & Maintenance
ATMS Program	2.3	2.1	4.4
Incident Management	0.2	0.4	0.6
ATIS Program	0	0.8	0.8
Communications Program	0.5	0.4	0.9
Implementation Program	0.2	0.3	0.5
TOTAL STAFF Operations & Maintenance	**3.2**	**4.0**	**7.2**

Information Sharing

Issue
There is a great demand for regional transportation information. This information serves planning (such as Transportation System Plans) and operation functions (such as signal timing or incident management). Much of this information is collected by individual agencies or firms and currently serves only one function. In other cases, information which could be useful for decision making is not easily accessible to planners and operating agencies. With the scattering of resources and no ability to fuse information efficiency, substantial public resources will be wasted.

Problem
Individual agencies operate control devices, collect data and monitor situations without having a plan or the ability to share public resources and data.

Goal
A key element of the ITS Plan is a central location for the collection of data on network operation. In this region there are three major operation centers (Portland's TOC,

ODOT's Traffic Management Operation Center and the Tri-Met Operation/Dispatch Center) and one major regional planning data center (Metro).

"Data fusion" is a term commonly used to represent assembling various sets of independent and scattered data (such as traffic counts, video, weather information, etc...) and merging them together in one database for common use, such as incident management or transportation planning. The goal is a seamless information infrastructure which allows the City of Portland to communicate internally and coordinate with other agencies such as ODOT, Tri-Met, Metro and adjacent cities/counties.

Solution
Develop a technical linkage through computers and fiber optic communication to integrate operation and planning activities between departments, agencies and partners in real time. Use information sharing to improve transportation system oper-

ating efficiency and reduce future costs to deliver services to the public.

Description
Sharing of information requires partnerships among agencies and firms (public and private). These partnerships require identification of information needs for operation and planning to identify common applications. This system level analysis is necessary to determine the most efficient overall use of information.

Examples of data sharing are numerous. Four examples include:

- Traffic counts automatically being collected from traffic signal systems could be used for adaptive arterial traffic signal timing, local or regional planning, truck route planning during peaks, transit bus route planning, and updating regional traffic condition maps (developed jointly with ODOT).

- Video data collected for freeway management could be used for arterial monitoring, traveler information through television, radio and internet connections, special event route plans, maintenance monitoring (weather or incidents)
- Arterial traffic signal timing plans developed in Portland could be coordinated with adjacent agencies to optimize traffic flow on roadways across jurisdictional boundaries.
- Weather data provided through CCTV's could be fused with BOM weather data to provide improved traveler information.

Figure 5 illustrated the corridors where incident management teams should be developed in the future and provides a means to group the sharing of information to specific corridors.

Today
The current communications system for the City relies upon a cable TV franchise agreement which expires within the next two years.

Arterial traffic is managed by a central computer system with central control of 450 of the City's 950 traffic signals. This allows for constant update and monitoring of the signal operation and system monitoring locations. The system is capable of handling approximately 1,100 intersections.
This also includes system detection at several locations and 6 CCTV camera locations for monitoring traf-

fic situations. All of this data is transmitted to the City's TOC located on the 3rd floor of the Portland Building.

The City is in the process of developing an agreement with Multnomah County/City of Gresham for sharing the City's Series 2000 system data.

The I-5/Terwilliger Task Force presents an existing example of representatives from State and City agencies. The group meets monthly to review efforts to control speed and reduce the number of incidents in this section of I-5. This task force is in the process of expanding its focus to include other freeway corridors.

Tomorrow

Implementation of the ITS Plan elements will allow data and information to be transferred to ODOT's Traffic Management Operations Center (TMOC), Tri-Met's Operations Center, Metro, 911 and the BOM. This "data fusion" will provide for efficient information sharing between all agencies within the region that are responsible for planning, operating and maintaining the transportation infrastructure.

Coordination with private firms which can use information from the TOC could include companies that can distribute data to the public more efficiently than the City. Firms that need operation data for efficient routing of fleet, and companies that produce information that is useful to the City's current and future applications.

An example of future data fusion would be the use of proposed Tri-Met AVL information as "probe" information on key corridors, producing speed data and collecting vital information about incidents. This data could automatically be transmitted to ODOT's TMOC and the City's Operations Center, instead of spending resources on additional detection needs.

The future fiber optic backbone will allow the regional agencies to coordinate and share information resources. The resources shared depend upon the individual regional agency's requirements and systems. **Figure 10** shows the agencies, a sample of their associated information sources and what they get and receive from the fiber backbone. The backbone structure will be based upon the world communications standard SONET (Synchronous Optical Network). The SONET system allows for a large volume of data to be exchanged, using any number of protocols and interfaces to be simply plugged in. This will allow easy information exchange among all of the users and allow for convenient expansion of system information sources.

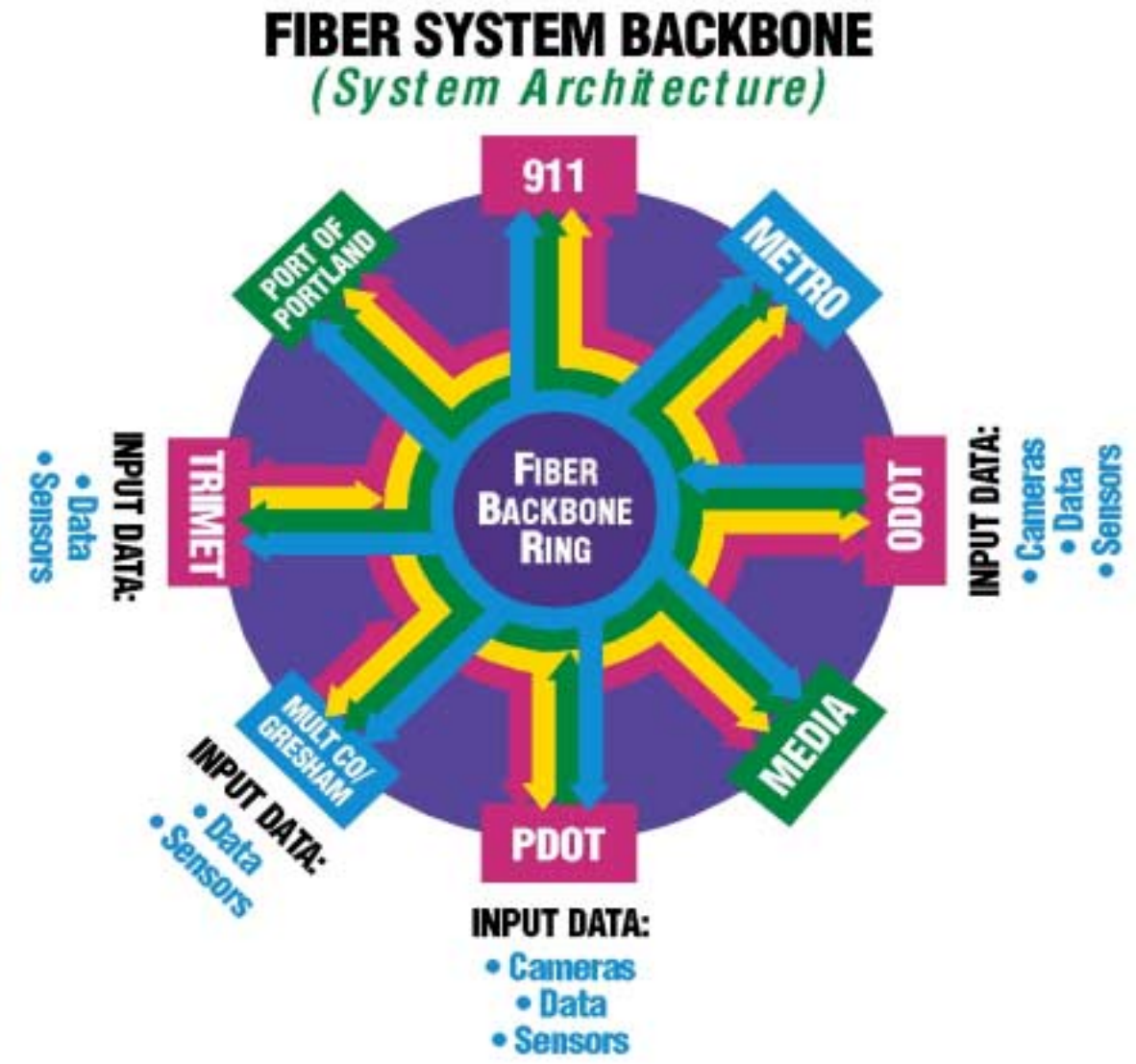


Figure 10
Concept Fiber Optic Network

• ITS Plan Budget

Capital, operating and maintenance costs for the Portland ITS Plan have been developed for budgeting purposes. Elements of the plan have been considered for their cost efficiency and ability to be self maintaining or require as little maintenance as possible. A two phase approach was developed which outlines initial and enhanced ITS implementation.

The initial phase would install elements of the ITS Plan for all key access routes in Portland. This level of deployment allows for some video monitoring and a beginning level for the traveler information program. The enhanced phase further develops the video monitoring capabilities in all corridors to provide more extensive coverage and fully deploys the traveler information systems.

The primary budget elements of the plan include: emergency detection (Opticom), CCTV, communication and message sign elements. Two of the more critical implementation elements of the ITS Plan implementation are the data fusion (inter- and intra-agency) and communication. Data fusion (which makes sharing of information possible) and communication are key strategies within the implementation plan that support all of the ITS core elements.

While the budget for the ITS Plan is extensive, it is important to put these costs in perspective with the costs of roadway expansion projects, which can cost several million $ per mile. The system wide benefits gained from a full ITS deployment have a high benefit/cost ratio and are a substantial benefit to the general public.

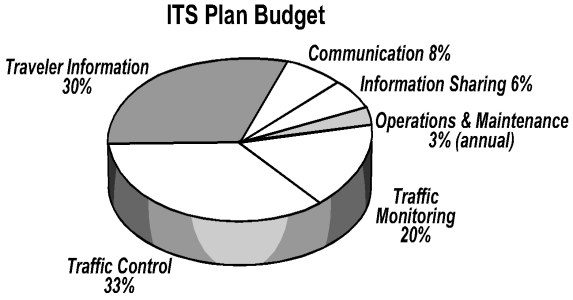


Table 3 summarizes the budget for the ITS Plan by corridor in the City, including allocation by phase. The nearly 14 million dollar investment is anticipated to yield over 50 million dollars in benefits over twenty years (in current dollars). The benefits will be accrued through improved emergency response, reduced delay to cars, trucks and transit, reduced emissions, reduction in accidents, reduced number of incidents, and improved operation / maintenance efficiencies. Detailed cost summaries included in the appendix provide further detail regarding cost assumptions.

Over the last 10 years approximately $5 million has been spent on the expansion of the signal system (installation of a central computer, system detectors, new controllers, and communication to 450+ of the 950 signals within the City). However, with recent funding constraints, spending for ITS projects has dropped to only $200,000 per year,

used for expansion of the citywide signal system.

To reduce costs, the City will jointly share facilities with other area agencies to the maximum extent possible. For example, the joint use of cameras being installed on freeways will facilitate the City's need to monitor certain arterials, thereby reducing the need to install separate cameras.

Table 3
ITS Plan Budget Estimate Summary

CORE ELEMENTS	**Initial Phase**	**Enhanced Phase**	**Total**
Traffic Monitoring			
• Closed Circuit TV Cameras	$ 1,840,000	$ 400,000	$ 2,240,000
• Detection/Monitoring Stations	$ 620,000	$ 0	$ 600,000
Subtotal	**$ 2,460,000**	**$ 400,000**	**$ 2,840,000**
Traffic Control			
• Series 2000 Central Signal Computer	$(Existing)	$ 0	$ 0
• Emergency Signal Pre-emption	$ 0	$ 4,607,000	$ 4,607,000
Subtotal	**$ 0**	**$4,607,000**	**$ 4,607,000**
Traveler Information			
• Changeable Message Signs	$ 1,035,000	$ 600,000	$ 1,635,000
• Variable Message Signs	$ 150,000	$ 2,400,000	$ 2,550,000
Subtotal	**$ 1,185,000**	**$ 3,000,000**	**$ 4,185,000**
IMPLEMENTATION SYSTEMS	**Initial Phase**	**Enhanced Phase**	**Total**
Communication			
• To/From Devices and TOC's	$ 1,102,500	$ 0	$ 1,102,500
Operations & Maintenance			
• Equipment	$(Existing)	$ 150,000	$ 150,000
Information Sharing			
• System Data Fusion	$ 750,000	$ 0	$ 750,000
TOTAL (Capital)	**$ 5,497,500**	**$ 8,157,000**	**$ 13,654,500**
ANNUAL OPERATIONAL COSTS	**$ 240,000**	**$ 300,000**	**$540,000**