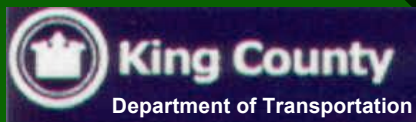


King County Intelligent Transportation Systems

Signal Synchronization and Beyond

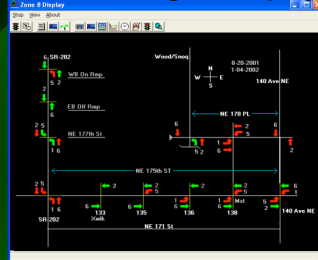
Presentation to the Transportation Leadership Forum



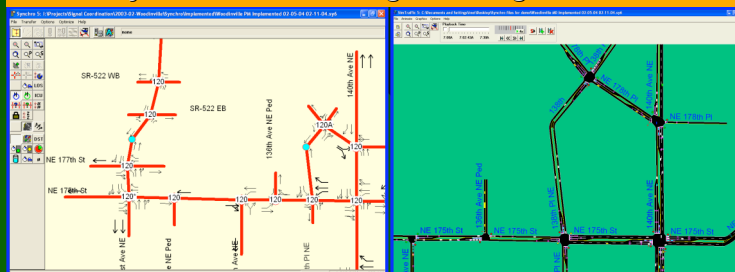
February 24, 2005

System Control & Evaluation

Real-time signal display



Synchro/SimTraffic signal timing software



Traffic Cameras

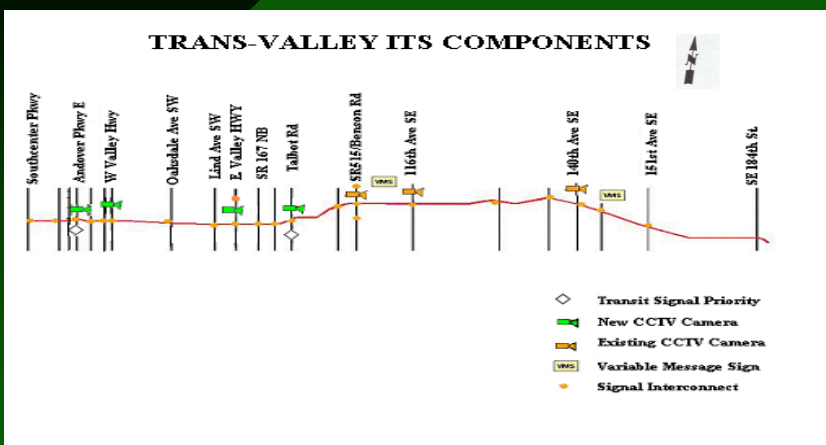
Traffic cameras provide real-time traffic information to TCC operators, the media, and the traveling public.



www.metrokc.gov/mycommute

Trans-Valley ITS Corridor

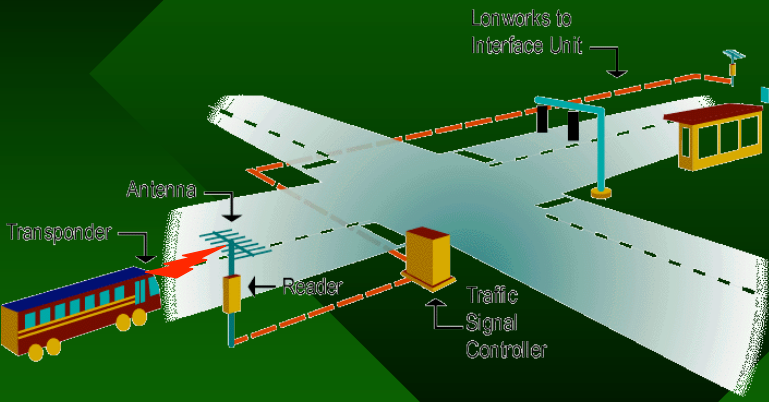
TRANS-VALLEY ITS COMPONENTS



Fast Facts

- * 23 Signals
- * New CCTV
- * Existing CCTV (To Integrate Into System)
- * Variable Message Signs (VMS)
- * Transit Signal Priority (TSP)
- * 6.3 Mile Corridor

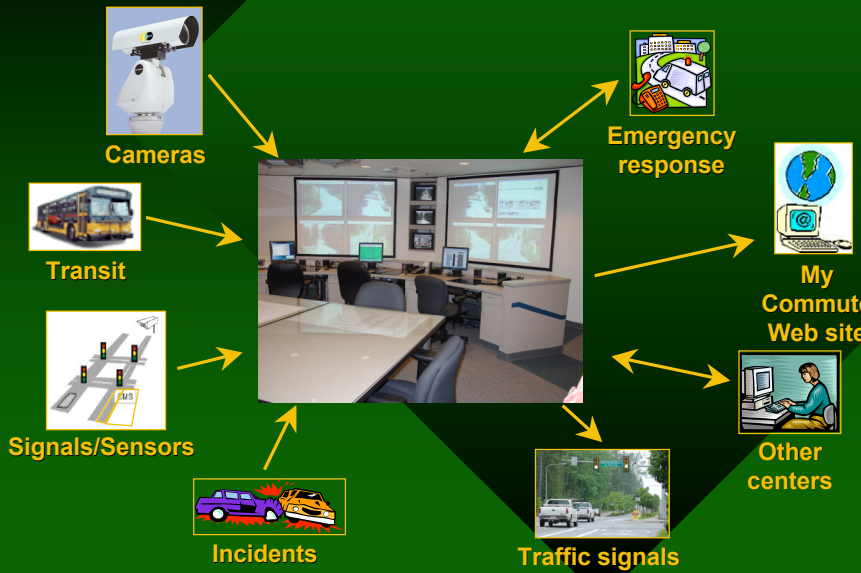
Transit Signal Priority (TSP) Field Equipment



Transit Signal Modeling



KC Traffic Control Center (TCC)



King County Signal Systems

The King County Signal Systems include signal synchronization and Intelligent Transportation System (ITS) improvements throughout King County as well as the operation of the King County Traffic Control Center. These projects implement cost-effective solutions such as signal system upgrades and Advance Traffic Management to improve traffic flow and increase efficiencies within the existing transportation infrastructure.

This paper provides a brief description of the different components of the King County Signal System, with a special section detailing the Transit Signal Priority program. King County implements ITS improvements in unincorporated King County and partners with local jurisdictions and agencies on projects in incorporated areas.

Traffic Control Center(TCC)

What is the TCC?

King County's Traffic Control Center (TCC) is a traffic management center that monitors and controls traffic flow on arterial roadways. The TCC employs the latest Intelligent Transportation Systems (ITS) tools to address transportation problems and enhance the movement of goods and services. These tools help reduce the cost of operating and maintaining transportation facilities and services through more efficient use of existing infrastructure and with the use of automated or remote control equipment.



The TCC uses advanced communication and computer technology to collect real-time traffic information from various sources such as traffic signal systems, cameras, and roadway sensors. Operators use this data to service traffic demand, share traffic status with other agencies and the traveling public, and operate and maintain the traffic signal control system.

What are its goals?

The TCC's goals are to

- Improve motorists' safety
- Enhance transportation system efficiency
- Improve mobility and accessibility
- Increase productivity of transportation system users
- Promote economic development in the region

Who does it serve?

The TCC serves the general public, transit operators and riders, traffic engineers and maintenance staff, incidence responders such as police and firefighters, and other transportation agencies.

How does it work?

The TCC allows various components of traffic management to be effectively managed by a team of traffic engineers and technicians who monitor, operate and maintain signals throughout King County. Using cameras and roadway sensors, these operators can monitor traffic flow, detect problems, and take action to return traffic flow to normal conditions.

The engineers can remotely modify signal timing plans or change the mode of operation of one or more traffic signals in response to unpredictable changes in travel demand or unforeseen

incidents that interrupt normal operation of roadways and transit systems. Staff members may also dispatch maintenance resources to address signal problems, and many request dispatch of law enforcement to direct traffic if signals become inoperable. The TCC operators monitor and manage Transit Signal Priority, a system that adjusts signal operation to favor approaching buses, along specific transit corridors to improve transit route reliability.

The TCC also acts as a branch of the Emergency Operations Center (EOC) during declared emergencies collecting and disseminating information to the EOC, media and emergency response agencies.

Traffic Cameras

Traffic cameras provide real-time traffic information to TCC operators, the media, and traveling public. Before leaving on trips, motorists can view traffic camera images at King County's "My Commute" Web site (www.metrokc.gov/mycommute) and adjust their travel time, routes, and modes based on current information.

The TCC operators have the ability to monitor the operation of signals in real time for congestion, incidents and efficiency. The operators can report incidents to police, fire and rescue and adjust signal timing to help alleviate congestion created by an incident or event.

Signal Synchronization

Signal Synchronization is a traffic management technique that maximizes the effectiveness of arterial roadways without building additional capacity. Signal coordination is the concept of synchronizing traffic signals along a corridor to minimize delay and the number of stops a driver has to make. Traffic signal coordination works to keep traffic flowing smoother by timing a series of signals to give motorists more green time.

Signal coordination can achieve significant timesavings for travelers. King County completed 16 signal coordination projects between 1999 and 2004. The average travel time improvement along these corridors typically ranged from 20% to 45% in the peak direction of travel.

Intelligent Transportation System (ITS) Corridors

With the opening of its Transportation Control Center, King County is positioned to operate corridors that take full advantage of Intelligent Transportation Systems. King County ITS corridor projects include the use of new technology to implement the following improvements:

- ❑ Signal Interconnect
- ❑ New Controllers and Cabinets
- ❑ Fiber Optic Communication
- ❑ CCTV Cameras
- ❑ Data Stations
- ❑ Transit Signal Priority
- ❑ Dynamic Message Signs
- ❑ Multi-jurisdictional Communication System



My Commute Web: Traffic Cameras

These ITS projects include the installation of the above equipment to coordinate signals, monitor traffic flow using video and data stations, report traffic conditions using the Internet, and remote operation of the corridor via the TCC over a fiber-optic communications system. Where applicable, these projects provide a link between the traffic control centers of the partnering agencies to allow for sharing of data, video and operation of the corridor.

There are currently two ITS corridors being implemented by the King County Department of Transportation that connect into the TCC via fiber optic cable. These projects are NE 124th Street ITS in Kirkland and the Trans-Valley ITS corridor in south King County.

Five additional ITS corridors have received Federal Grant funding for construction in 2005 and 2006. The three corridors identified for 2005 construction are:

1. South 277th St. between West Valley Highway and South 55th St.
2. Avondale Road/Novelty Hill Road ITS: Avondale between SR 520 and Novelty Hill Road and Novelty Hill Road between Avondale and 208th Ave NE
3. 140th Ave SE between SR 169 and Petrovitsky Road

Detection Technology

An important part of any intelligent signal system is detection. Detectors detect the passage of a vehicle at a given point and relay this information to the controller to elicit a green indication or extension of an existing green indication

- ❑ **Induction Loops:** Nearly all of King County's signals use inductance loops, and newer installations include right-turn count loops. New arterial signals with adjacent intersections include system loops, which will be used for a traffic-responsive coordination in the future.
- ❑ **Video detection:** CCTV cameras are primarily installed during construction at high volume, congested intersections to maintain continuity of vehicle detection. However, consideration is being given to installing video detection where the cost of installing loops exceeds the cost of video detection, and the frequency of foggy conditions is minimal-to-none. With video detection prices on the decline, it is become more cost-effective at major intersections.
- ❑ **Permanent traffic counters:** Nu-metrics Groundhog counter are being used in some of King County's ITS corridor projects and will provide information on lane occupancy, average speed, vehicle classification, surface temperature and some volume data. The Groundhog counters are installed by core-drilling the pavement and inserting a canister with a traffic analyzer. The Groundhog system employs Spread Spectrum technology to transfer the data to a master data collection PC, where the information can be downloaded and used.

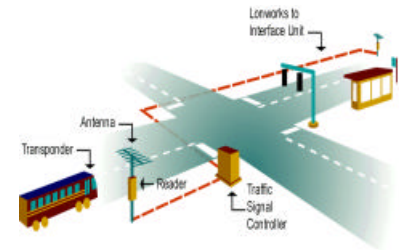


Groundhog

Regional ITS Communication Plan

King County received grant funding to study the communication needs throughout the County to provide communication between traffic management centers allowing for sharing of data, video, and operation of signals along major arterial routes within the County. This project will study existing and planned communication infrastructure, future communication needs, and available communication technologies to link neighboring jurisdictions to each other as well as to King County and WSDOT.

In Detail: King County Transit Signal Priority



Concept Overview

Transit Signal Priority is one of several solutions to the problem of providing improved efficiency to transit operations. Bus Rapid Transit is a program supported by the FTA and FHWA that encompasses a range of concepts that provide for efficiency improvements of transit travel. Strategies encouraged under this program include reducing boarding times, increasing transit vehicle running speeds, and reducing delay at intersections. Transit Signal Priority is one method used to improve transit operations by reducing delay at signalized intersections.

Transit Signal Priority refers to the concept of detecting a bus in the flow of traffic and providing more “green time” for the transit vehicle as it travels within the general traffic stream. In an urban area such as the Central Puget Sound Region, there are many competing demands on the traffic signal’s “green time”. It must be understood that providing priority to transit is a careful balance between the needs of the transit agency’s stakeholders and the limited resources of the arterial network. There are several guiding principals that illustrate this balance:

- Signal operations is under the purview of the Traffic Engineer, and green time is the resource that the engineer must manage, using sound engineering practice, professional judgement and local policy direction.
- The Traffic Engineer must balance the various user needs – prioritizing multiple user demands including general traffic, pedestrians, cyclists, commercial traffic, heavy and light rail, emergency vehicles, parking and transit.
- The Traffic Engineer must maintain a balance at the intersection providing for the safe and efficient movement of all types of traffic.
- The Transit Operator is the catalyst; they are motivated to extract benefit from the signal system to obtain better reliability/travel times for riders and to increase the efficiency of their fleet, but are compelled to work with the Traffic Engineer to affect change.
- The Transit Operator understands their operational parameters best, and how to maximize their system
- The Transit Operator and the traffic engineer need to share understandings of their respective systems in order to develop regional policies, best operational practices and control strategies.

King County Metro Transit Signal Priority System

King County Metro, working with its partner signal operation agencies, has selected a more sophisticated TSP system that provides the needed flexibility of control. Four major components comprise the Transit Signal Priority System (TSP): on-board equipment, on-street equipment, base computer and controller firmware modifications/TSP strategies.

On-Board Equipment

The main component of the on-vehicle equipment is the Amtech RF (radio frequency) tag. The bus has this dynamic tag mounted on upper right front corner of the bus. The tag or transponder contains a data packet that includes static data fields of System, Agency, Vehicle ID; and dynamic data fields of Driver Number, Route, Run, Trip, and Class. Future fields are reserved for Lateness and Ridership with the migration to a “smart” bus. The dynamic data is sent to the tag upon driver log-in via the on-board Tag Interface Unit (TIU). The tag remains passive until activated by the roadside antenna and Amtech tag reader unit.



Tag Interface Unit



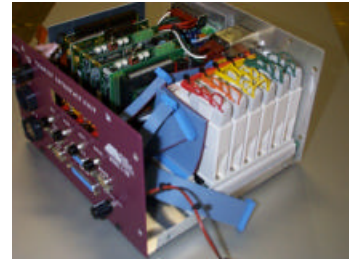
Amtech RF Tag

On-Street Equipment

On-street equipment consists of a pole or mast-arm mounted Amtech log periodic antenna; a pole-mounted Amtech tag reader enclosure; Lonworks Communication Network; and a Transit Priority Request Generator co-located in the signal controller cabinet. The reader assembly (including antenna and reader enclosure) is generally located 500 to 1000 feet in advance of the intersection. The pole-mounted tag reader controls the antenna, verifies tag read integrity and sends the tag information to the Transit Priority Request Generator in the signal controller cabinet.



The Transit Priority Request Generator provides the needed processing capability to determine conditional priority requests. This unit provides an interface between the reader and the traffic controller via 24 programmable Inputs/Outputs (I/Os).



The Transit Priority Request Generator provides conditional screening of the priority request once the tag read is validated and sent by the reader. The signal technician or engineer combines user-defined parameters and functions to dictate when and if a transit signal priority service call shall be requested.

Base Computer (TPR Server)



The base computer provides a remote means to communicate to the various Transit Priority Request Generator systems in the field. This system is designed as a dial up network, communicating to each Transit Priority Request Generator subsystem. The primary function of this system is to provide the ability to upload operations and transponder logs, and to download programmable settings to each reader/Transit Priority Request Generator subsystems. Operations logs provide daily records of all activities, including diagnostics, records of TSP requests, and information about what phase the controller was in before and after the TSP

request. Transponder logs records all tagged vehicles that pass through the intersection. These two sources of log data provide the needed feedback loop for system optimization.

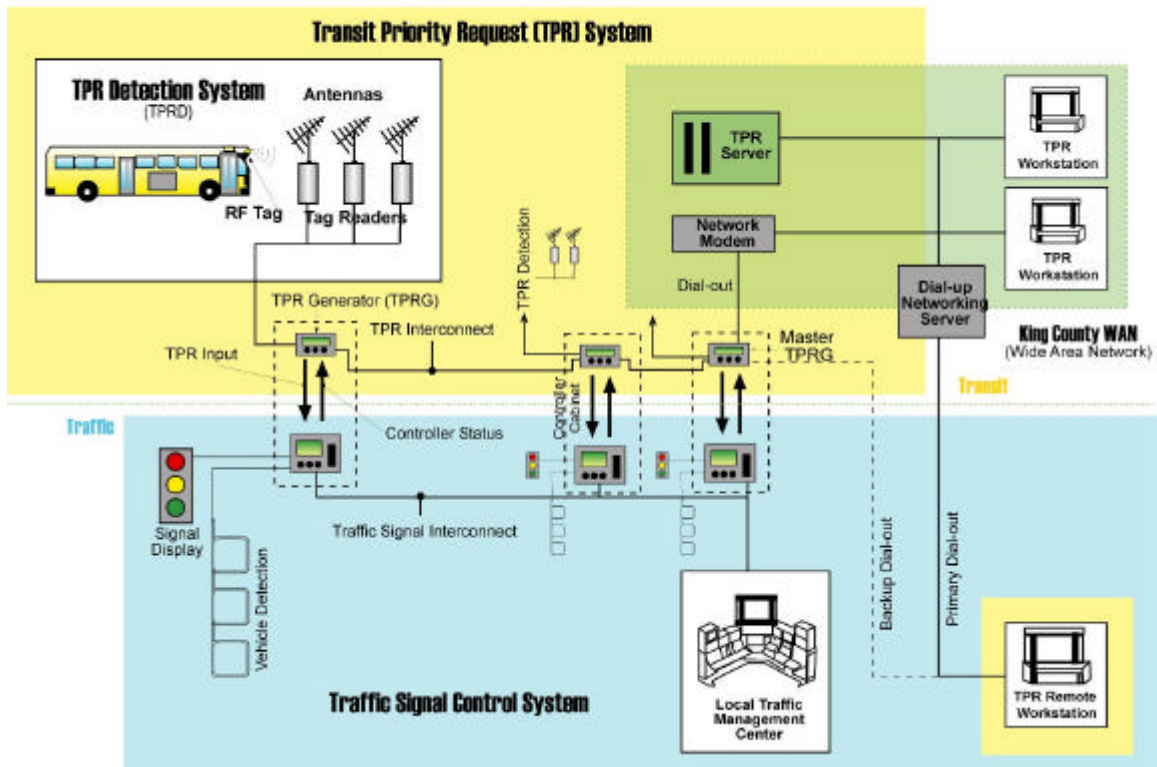


Controller Firmware Modifications/TSP Strategies

All of the controller types being used in this project have required the traffic controller manufacturers to provide specific firmware modifications for TSP control strategies. The degree of modification has varied depending on the flexibility of existing firmware and the specific traffic jurisdiction's signal operating policies and goals. The City of Seattle, for example, developed firmware implementation requirements that can be summarized as follows:

- Traffic signals shall extend their green interval for approaching priority vehicles
- Traffic signals shall shorten red displays for approaching priority vehicles
- Traffic signals shall not shorten any minimum or clearance intervals
- Traffic signals shall not skip any phases
- Traffic signals shall not break coordination

King County Transit Signal Priority (TSP) System



Efficiency Objectives

Transit signal priority is a tool to both improve schedule reliability and to reduce trip time. For the average rider, transit signal priority should create a better trip experience. It will take less time for the rider to get to their destination. As importantly, they will have a higher level of confidence that the bus will come when it is scheduled and fewer stops at signalized intersections should equate to a smoother ride.

Transit signal priority systems for buses must be integrated into the larger traffic signal system. Benefits for transit must be balanced against the needs of other modes, including general traffic, pedestrians, cyclists, emergency vehicles, and heavy and light rail.

Challenges

For both of the analyses described in this section, the projected operating savings in bus travel time from TSP should be viewed as an opportunity for cost deferral as opposed to an immediate cost reduction. There may be instances where absolute reductions can be achieved but typically the benefit of TSP will be the ability to defer schedule maintenance investments for a longer period of time. Other challenges include:

- Sustain policy support that embraces moving people over moving vehicles.
- Sustain good working relationships with the Region's various traffic engineering community in the development of enhanced features
- Work with local Traffic Engineers and Transit Operations to develop enhanced system features to maximize system performance
- Encourage the traffic controller industry continue to invest in control logic that supports TSP.
- Work with transit schedulers to realize time savings opportunities

Successes

The first of 26 intersections of the Regional Transit Signal Priority System has been successfully deployed at the intersection of Genesee Street and Rainier Avenue. The initial results, although not necessarily representative of all intersections under all conditions, represent a snapshot of system performance and are very encouraging. The results of this initial deployment are as follows:

- A 50% reduction of signal related stops by prioritized buses
- A 57% reduction in average delay for the prioritized buses
- A 13.5% decrease in intersection average person delay
- Average intersection vehicle delay did not change
- A 35% reduction in bus travel time variability for the prioritized buses
- Effects to side street delay were insignificant
- There was no significant change to the non-priority approach queue lengths

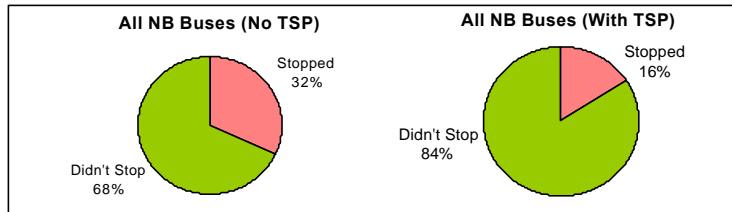


Figure 2: Number of Stops with and without TSP

The procurement of the TSP equipment is partially funded by the US Department of Transportation administered by the Federal Highways Administration with support from the Federal Transit Administration and the Washington State Department of Transportation. King County is the primary source of local funding and manages the work program. This is a collaborative project co-sponsored under agreements with the Washington State Department of Transportation, Seattle Transportation Department, the City of Shoreline, Community Transit, and the City of Everett. A Regional Oversight Committee has provided assistance in addressing transit and traffic operating issues including participation by additional agencies including the City of Bellevue, City of Renton, the City of Federal Way and others.

Contact Information:

Signal Synchronization:

Aileen McManus
Traffic Engineering
201 South Jackson Street
MS KSC-TR-0822
Seattle, Washington 98104
(206) 263-6135
Aileen.mcmanus@metrokc.gov

ITS:

Fay Schafi
Traffic Engineering
201 South Jackson Street
MS KSC-TR-0822
Seattle, Washington 98104
(206) 263-6143
Fay.schafi@metrokc.gov

Transit Signal Priority

Ronald Atherly
Transit Speed and Reliability Program
201 South Jackson Street
MS KSC-TR-0411
Seattle, WA 98104-3856
(206) 263-4954
Ronald.atherley@metrokc.gov