

EVALUATING AN ADAPTIVE SIGNAL CONTROL SYSTEM IN GRESHAM

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ABSTRACT

Cities and Counties are faced with increasing traffic congestion due to rapidly increasing population. Like many agencies, the City of Gresham has struggled with how to manage the increasing congestion with limited funds for major roadway widening projects. Gresham has recognized the need to optimize existing system capacity to get the most out of their current transportation system infrastructure investment.

In 2005, the City of Gresham, in cooperation with numerous agencies in the Portland metropolitan area, evaluated a variety of signal control systems including traditional time-of-day coordination, traffic responsive, and adaptive signal control systems. Based on that evaluation, the steering committee selected and deployed the SCATS adaptive signal control system on Burnside Road between Eastman Parkway and Powell Boulevard. The Burnside corridor in Gresham, OR is a 5 lane major arterial that carries approximately 38,000 ADT. Burnside serves as a main through route connecting I-84 to OR 26 and Mt. Hood. The SCATS system has been integrated with the existing shared regional traffic signal system and is available for expansion to other jurisdictions in the region.

This paper describes the process used to evaluate the results of the adaptive signal control system and how they compare to the original project objectives. The evaluation compares changes in travel time, delay, stops and fuel consumption associated with “free” (uncoordinated), time-of-day coordinated and the new adaptive signal system on Burnside Road. This paper should be of interest to other state and local agencies interested in trying to optimize existing arterial capacity.

PROJECT BACKGROUND

Since 1995, the City of Gresham and Multnomah County have partnered to improve traffic operations throughout the County by connecting traffic signals to a central traffic signal system and implementing traffic signal coordination. As part of this program, the City and County share the TransSuite central signal system at the City of Portland. As of 2007, the City has established communications to 92 of their 120 traffic signals and they operate coordinated timing plans on six major arterial roadways. Burnside Road between Eastman Parkway and Powell Boulevard was one of three initial corridors selected to demonstrate the effectiveness of coordinating traffic signals using preprogrammed plans that are activated and deactivated at designated times of day. By 1997, communications had been established to the intersections on Burnside Road and the first coordinated signal timings in Gresham were installed.

The previous signal timing projects on Burnside Road resulted in significant reductions in travel time, stops and delay. In 1997 new coordinated signal timings produced travel time reductions in excess of 10 percent and a benefit to cost ratio of 30 to 1. In 2005, the City and DKS Associates updated the coordinated signal timings to reflect changes in vehicle volumes. This effort produced travel time reductions in excess of 20 percent above and beyond the previous time of day plans and a benefit to cost ratio of 35 to 1.

Even considering these significant improvements, the City of Gresham felt that more could be done to operate the corridor efficiently while responding to the changing daily conditions.

In 2001, the City identified adaptive signal control as a potential system to help them achieve their goal to operate traffic signals efficiently in response to current and changing traffic conditions. Using a federal grant, the City led a regional effort to evaluate available adaptive traffic signal control and traffic responsive signal systems to determine whether a suitable system exists that will exceed the benefits (reduction in stops and reduced travel times) obtained from standard time-of-day (TOD) coordinated timings. The evaluation compared thirteen different adaptive traffic signal control systems and compared their potential performance with TOD plan selection and traffic responsive plan selection (TRPS) and ultimately selected the Sydney Coordinated Adaptive Traffic System (SCATS) for deployment.

The SCATS adaptive traffic signal control system was implemented in March, 2007 and fine tuned between early March and mid-April. Before and after travel time and delay surveys have been conducted to compare the SCATS system to TOD operation and that analysis is the focus of this paper.

A timeline of the City's coordinated signal timing and experience on the Burnside corridor is provided below.

Table 1. History of Burnside Road from Uncoordinated to Time of Day Coordination to Adaptive (1995-2007)

1995	Burnside Road operated uncoordinated
1995	Gresham <i>Traffic Signal System and Communications Master Plan</i> recommended a central signal system and coordinating signals
1997/1998	Implemented coordinated signal timings on Burnside Road (Eastman to Powell)
2001	Updated Gresham <i>Traffic Signal System and Communications Master Plan</i> . Plan identified adaptive signal control as a potential solution
May, 2005	Updated coordinated signal timings on Burnside Road
October, 2005	Evaluated TOD vs. TRPS vs. Adaptive. Selected SCATS adaptive
March, 2007	Implemented SCATS adaptive system

* SCATS – Sydney Coordinated Adaptive Traffic System

STUDY AREA DESCRIPTION

The SCATS adaptive signal control system has been implemented along a 1.88 mile segment of Burnside Road, in the City of Gresham as shown in Figure 1. Burnside Road is a 5 lane major arterial that carries approximately 38,000 ADT¹ through a growing commercial and retail district of the City. This section of Burnside serves as the primary

¹ Volume 4, Transportation System Plan, City of Gresham, 2002

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route through Gresham to Mt. Hood and other weekend destinations in Central Oregon connecting Interstate 84 (to the north) and State Highway 26 (to the south). Burnside Road also serves as a key freight route connection between I-84 and US26 and makes up one of only three freight routes through Gresham. The posted speed in the project area is 35mph.

The intersections of Burnside/Division, Division/Hogan and Burnside/Hogan form a **triangle** that poses a challenge for traditional signal coordination. All three arterial roadways (Burnside, Division and Hogan) carry significant traffic volumes throughout the day and their proximity to each other (approximately 1,000 foot spacing) dictates the need for coordination. East-west Division Street carries approximately 20,000 ADT and north-south Hogan Road carries approximately 28,000 ADT through the project area.

PROJECT GOALS AND OBJECTIVES

The overall goal of the Gresham adaptive signal control system is to improve the performance of the existing transportation system during peak and off-peak periods by dynamically adjusting to changing volumes. Another regional goal includes being able to expand the system to neighboring jurisdictions. Objectives of the project include:

- To reduce travel time by 10 percent or more over normal time of day coordinated plans
- To reduce overall corridor delay by 5 percent or more.
- To decrease overall system stops by 5 percent or more.
- To implement a system that is user friendly and reliable.

HOW THE ADAPTIVE SYSTEM WORKS

An adaptive traffic signal control system can adjust signal timings (offsets, cycle lengths and splits) incrementally based on real-time traffic volume information. Further, an adaptive traffic signal control has the ability to automatically respond to special events, annual changes in traffic volume due to growth and various other unpredictable incidents that cause significant changes in traffic volumes and speeds. The potential of an adaptive traffic signal control system to further enhance the City's previous traffic signal coordination successes lead the City to evaluate and implement an adaptive signal system.

Here's how the Gresham system works:

- Detectors at each intersection detect vehicles approaching and continuously analyze traffic flow.
- This information is communicated to the computer at each intersection.
- The intersection computer sends the information to a central server, which automatically adjusts the traffic signal green time to match the traffic flow.
- The central server monitors network wide traffic flow and adjusts all traffic signals in the network to match the traffic flow.

DATA ANALYSIS

Methodology

In order to capture anticipated benefits of the newly implemented Sydney Coordinated Adaptive Traffic System (SCATS), multiple types of traffic surveys conducted over multiple days and at multiple locations along the Burnside Street study corridor were conducted while the eleven traffic signals along the corridor operated in different respective operating modes. The operating modes evaluated as part of this project are:

- Time-of-day coordination
- Adaptive traffic signal control system – (SCATS)

Additional travel time data collected in 1997 and 2004 with the Burnside intersections operating in “free” uncoordinated mode is used for comparison. Both the free operation and time-of-day (TOD) coordination modes reflect the existing traffic signal operating modes along this corridor (base comparisons), while the adaptive traffic signal control system, SCATS, represents the current operating mode. Traffic surveys used in this evaluation consist of travel time surveys, queuing and delay surveys, cycle failure surveys, number of stops surveys, and agency staff perception surveys. All surveys were conducted while the traffic signals operate in the two respective modes as previously mentioned in order to make comparisons of traffic conditions under each operating scenario.

SCATS Data

The SCATS system records and stores a significant amount of useful field data including volumes, cycle lengths, splits, degree of saturation, and many others. This data was recorded during each of the analysis periods and will be used to compare the traffic volumes during “before” and “after” surveys.

Performance Measures

In order to quantitatively evaluate alterations in traffic conditions with the traffic signals operating under TOD coordination, and SCATS; several performance measures have been identified for comparison under each traffic signal operating mode. The degree of alteration between each measure evaluated will provide a level of benefit or detriment associated with the implementation of SCATS along the study corridor as compared to TOD operating scenario, which represent current traffic signal operations. The following performance measures have been selected for comparison with this project.

- Travel time
- Traffic volumes
- Delay and queuing
- Number of stops
- Average travel speed
- Agency staff perception

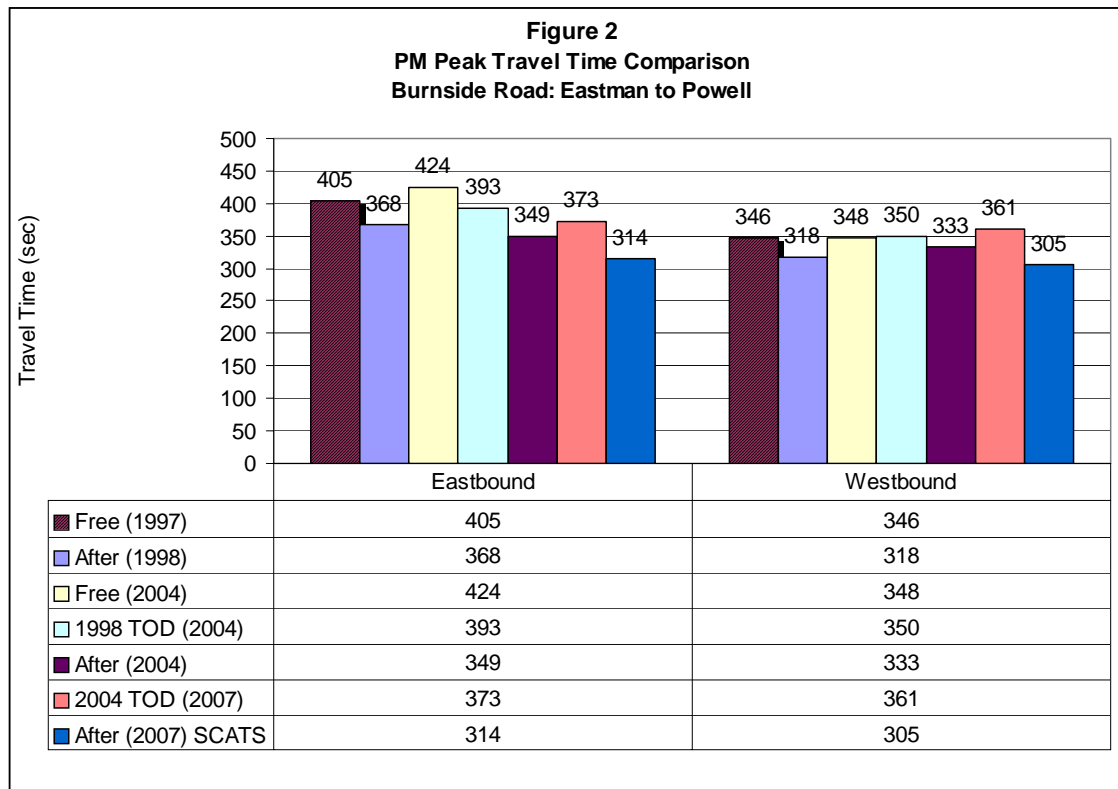
Analysis Summary

Travel Times

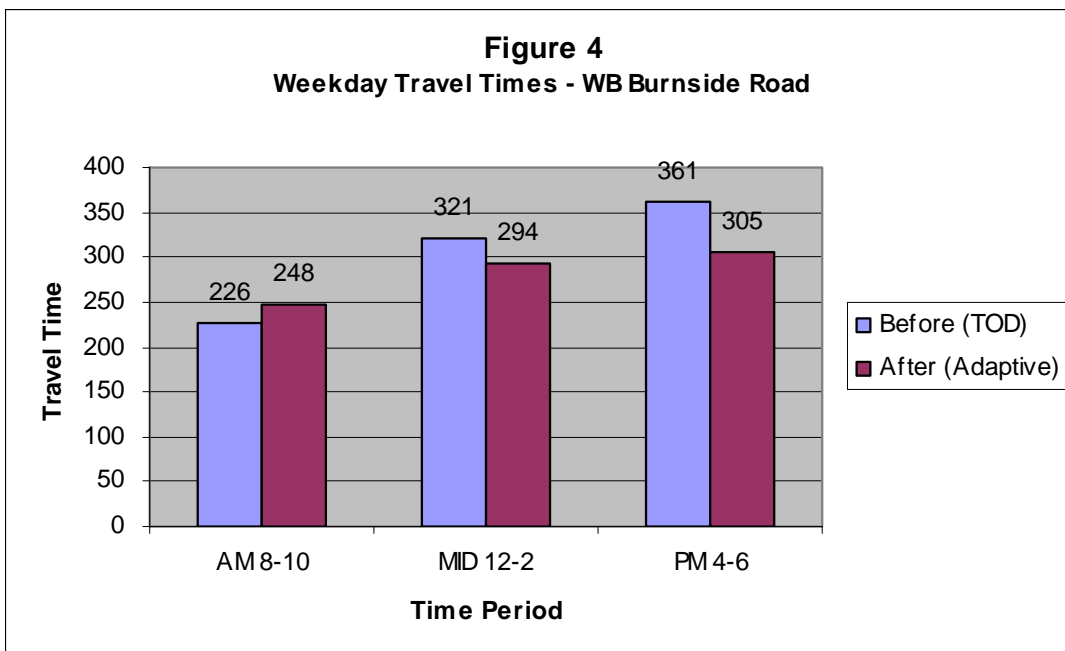
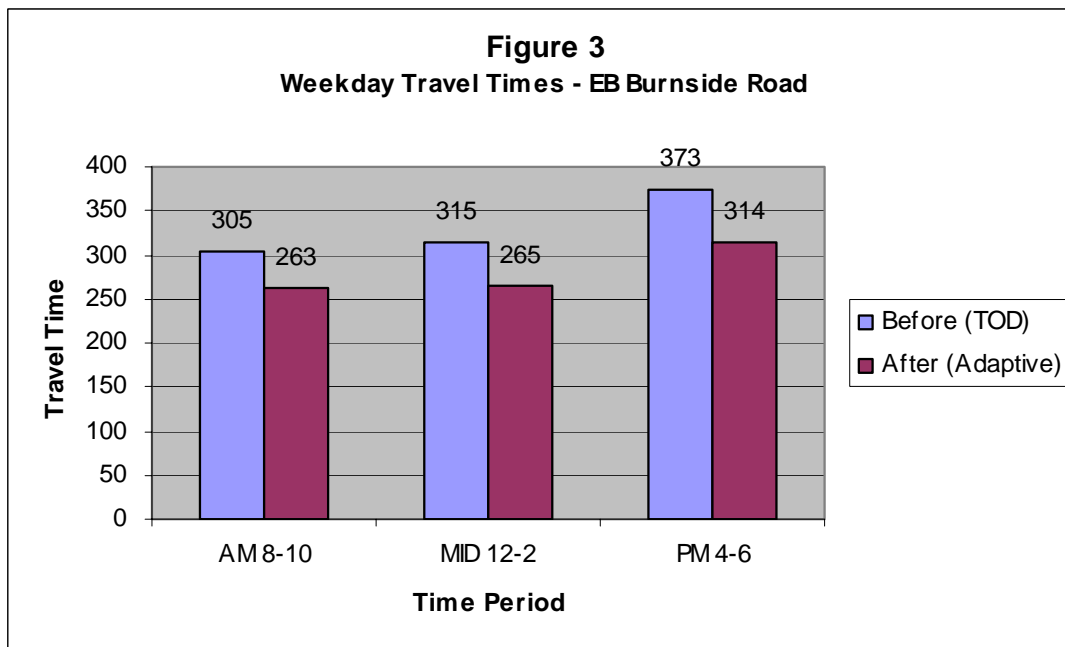
Travel time runs were collected along the Burnside corridor under both TOD and adaptive operation. This data is supplemented by substantial historical travel time data that the City of Gresham has collected before and after previous coordinated signal timing efforts on Burnside Road. The following is a summary of travel time data available on the Burnside corridor:

- 1997 – Corridor operating “free”
- 1998 – New TOD coordination plans
- 2004 – Corridor operating “free”
- 2004 – Corridor operating with TOD plans developed in 1998
- 2007 – Corridor operating with TOD plans developed in 2004
- 2007 – Corridor operating with SCATS adaptive

Figure 2 shows the eastbound (EB) and westbound (WB) travel times on the Burnside corridor for each of these scenarios. It’s interesting to note that after new timing plans were installed in 1998 the EB travel times averaged 368 seconds (6 minutes 8 seconds), but by 2004 operating those same timing plans the EB travel times averaged 393 seconds (6 minutes 33 seconds). This indicates that the TOD coordinated plans had degraded over time as volumes changed. This same effect is evident between 2004 and 2007. Now, after the implementation of the SCATS adaptive system, travel times on the Burnside corridor have reduced to their lowest levels in the history of travel time data collection within the corridor.



Figures 3 and 4 illustrate the comparison of EB and WB weekday travel times on Burnside Road between time of day coordination and the SCATS adaptive signal system. The TOD travel time surveys were collected in February, 2007 and the SCATS adaptive system surveys were collected in April, 2007. All but one of the directions resulted in a reduction of travel time operating with the adaptive system. The most significant improvements are represented in the PM peak period where both directions resulted in approximately one minute of average travel time reduction. The one time period and direction that resulted in an increase in average travel time was the WB AM peak period. The previous timing plans had focused specifically on favoring that direction and the plans were near perfect, travel time through the corridor at posted speed is 200 seconds and the average WB travel time in the AM peak period with the TOD plans was just 226 seconds.



Additional anecdotal benefits of the system have been observed by operations staff.

- The system monitors the health of the intersection computer and the detectors in the street. With the previous traffic signals, many problems were not identified immediately and required crews to drive out to the intersection to fix the problem. This system automatically alerts the City staff if there is a problem with the field equipment and many of the problems can be repaired remotely using a computer interface.
- During field fine tuning, TransCore, DKS and City staff observed the system adapt and provide additional green time to east-west Burnside when a Contractor closed a lane for construction. This increased cycle length in the middle of the day due to construction resulted in increased intersection capacity.
- The system creates a database of traffic information including traffic counts which can relieve other City departments from the need to do other traffic counts to support traffic studies.
- The system is proven with over 35 years of operation around the world. It uses proven field components that were familiar to City staff and the installation went extremely smooth.

SUMMARY

At the time of this printing, analysis of the data including mainline and side street delays, volume weighting travel time surveys, a comparison of volumes and cycle lengths is underway. The early results and observations by City and DKS staff indicate that the SCATS adaptive system is outperforming the previous TOD plans. Couple this with the powerful system monitoring capabilities and the ability for the system to adjust to changing conditions daily, during Holidays, during construction and over the longer term and the SCATS system has exceeded the expectations of the City and DKS staff.

Further analysis of the data will tell, but at this time the project is proving to be a great success.