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EVALUATION OF ADVANCED
TRAFFIC CONTROL SYSTEMS

Researchers from Portland State University develop performance measures and algorithms for evaluation of state-of-the-art traffic signal control technologies..

The Issue

Powell Boulevard, an east-west arterial corridor in southeast Portland, Oregon, has been the focus of several research studies by Portland State University researcher Miguel Figliozzi and the Transportation, Technology and People research lab. The street is a key route for public transit buses as well as pedestrians and cars, but heavy traffic at peak hours often results in delays.

On Powell there are two systems operating concurrently: a demand-responsive traffic signal system called Sydney Coordinated Adaptive Traffic System (SCATS) and a Transit Signal Priority (TSP) system. The TSP in the Portland metro region is designed to give priority to late buses and to boost transit performance. In previous studies, Figliozzi's research team analyzed a multitude of factors on Powell Boulevard including traffic congestion, transit times, air quality and cyclists' intake of air pollutants, and a before-and-after evaluation of SCATS.

This study is the first research effort to propose and evaluate TSP performance measures at the intersection level. Figliozzi and co-author Wei Feng used a novel approach to evaluate how well SCATS and TSP work together, integrating three major data sources and video recordings. The fine-grained level of data allowed the researchers to focus their attention on developing a methodology and algorithms to study a single intersection at a time, rather than on the overall performance of the corridor.

The Research

Figliozzi's team worked closely with the city of Portland and the Tri-County Metropolitan Transportation District of Oregon (TriMet) to integrate

THE ISSUE
Researchers evaluated how TSP and SCATS perform together.

THE RESEARCH
This study offers two novel contributions:

• An algorithm that integrates bus data, SCATS phase log data and vehicle count data at the intersection level;

• Novel performance measures to evaluate the TSP system effectiveness at the stop-to-stop segment level.

IMPLICATIONS
This study provided valuable information to TriMet and the city of Portland about improving their TSP system as well as a methodology for other practitioners to use.

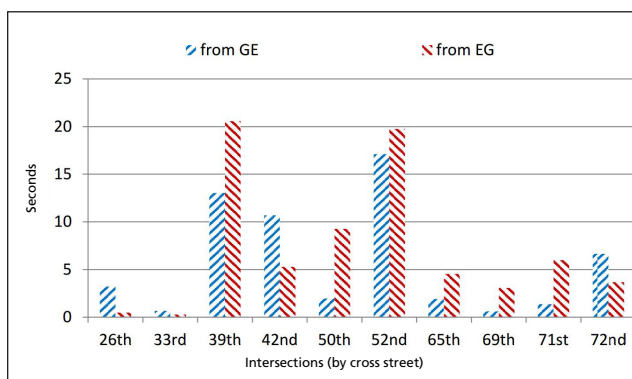*Photo: A TriMet bus at SE Powell and 26th Ave in Portland, Oregon*

bus and traffic signal data: archived SCATS phase log data, bus automatic vehicle location (AVL) and automatic passenger count (APC) data, and transit dispatching logs. When necessary they supplemented the data with video recordings along the corridor.

They developed a novel algorithm to integrate the data sources and calculate the signal phase attributes, and used it to evaluate the relationships between TSP requests and TSP phases, the effectiveness of TSP phases (percent of effective TSP phases), and the expected benefits (time savings) and delay due to TSP phases.

The research team also investigated how these results vary by TSP phase type (green extension or early green); by bus-stop location type (near-side or far-side bus stop); and by user type (bus, passengers, automobiles on the major street and the side street). Results indicate that more than 80% of the TSP phases were granted within the same cycle when a bus arrived at the intersection. However, the TSP timeliness was relatively low during the study period, and a sizable gap remains between the ideal TSP effectiveness and its actual performance. Early green (EG) phases were timelier than green extension (GE) phases because too many GE phases were granted late or lost. Results also show that EG phases are more efficient than GE phases. Passenger time savings per second of EG phase is higher than passenger time savings per second of GE phase. Despite TSP's relatively low performance, the TSP system did not increase delays for passengers and vehicles even when side street traffic was considered.

Implications

This research shows that TSP systems can be challenging to implement so that they are both timely and effective. Although TSP system design and pre-implementation evaluation is important, the results of this study demonstrate that post-implementation performance evaluation is also essential. TSP systems require not only maintenance but also continuous monitoring to promptly detect problems. The low numbers of granted TSP phases at some intersections showed that TSP settings were not working properly and that adjustments were needed. Researchers proposed four new performance measures for TSP: frequency, responsiveness, timeliness and effectiveness.

The TSP performance evaluation results provided worthwhile information for the city and the transit agency to identify potential problems and improvement opportunities for the TSP system. The algorithms and performance measures are general and can be applied to other corridors where TSP is implemented with or without SCATS or adaptive traffic signal control.

Estimated total passenger time savings per TSP request

This graph shows the total passenger time saved, in seconds, by TSP at each intersection in the study area. Blue bars represent Green Extension phases and red bars represent Early Green phases.