LRRB
LOCAL
ROAD RESEARCH
BOARD

TECHNICAL SUMMARY

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PROJECT COST:

$70,000

National Traffic Signal Report Card 2007

Management	D-
Signal Operation at Individual Intersections	C
Signal Operation in Coordinated Systems	D
Signal Timing Practices	C-
Traffic Monitoring and Data Collection	F
Maintenance	C-
OVERALL	**D**

Traffic monitoring received the worst possible grade in this report card issued by the National Transportation Operations Coalition.

RESEARCH
SERVICES SECTION

Real-Time Arterial Performance Monitoring Using Traffic Data from Existing Signal Systems

What Was the Need?

Reducing traffic congestion, and the costs and quality-of-life issues that come with it, has been identified as a major focus area for Minnesota's transportation agencies. One promising and relatively inexpensive avenue for responding to this challenge is improving the operational efficiency of traffic signals, as this allows improved use of existing roadways without additional construction. Though traffic signals have been shown to play a critical role in managing urban traffic networks, there is room for improvement in how the signals are managed.

Managing traffic signals requires data. While most signal systems are capable of generating the data needed to manage signal timing, data collection and calculation of performance measures such as delay and travel time must be done manually. Data collection accounts for over 50 percent of the estimated $2,500 to $5,500 cost to retime traffic signals for a single intersection. Mn/DOT and Minnesota's city and county public works agencies needed a more cost-effective way to gather the data required to better manage urban traffic network signal systems.

What Was Our Goal?

The goal of this project was to develop and test a real-time performance measurement system to automatically collect traffic signal data on arterial road networks. This would involve developing a set of mathematical models that would be applied to the collected data to estimate performance measures such as queue length, delay, travel time and number of stops. This information could then be used by engineers to reset timing schedules for individual traffic signals.

What Did We Do?

Researchers reviewed existing literature and then developed a system architecture and data collection techniques that constitute the SMART-SIGNAL (Systematic Monitoring of Arterial Road Traffic Signals) system. SMART-SIGNAL collects and archives high-resolution traffic signal data and automatically generates real-time performance measures. The system uses advance detectors that record vehicles as they move through the intersection, and stop-line detectors that record through-movement and left-turning vehicles. A computer in the signal controller cabinet records the data collected without affecting the usual operation of the signal controller.

In February 2007, with the assistance of Hennepin County Public Works, researchers installed SMART-SIGNAL on an 11-intersection arterial corridor along France Avenue in Hennepin County. The system continuously collected and archived data during the study period. The system collected two primary pieces of data: a detector event, which indicates that a vehicle is arriving, and a signal phase change event that is recorded whenever the traffic signal changes.

This real-time information was sent continuously via a digital subscriber line to a database at the University of Minnesota's Traffic Lab. Using the raw data, performance measures were automatically generated in the database by applying two mathematical models developed in the study:

• A time-dependent queue length estimation model that can handle long queues under both low-volume and congested conditions.

SMART-SIGNAL's data collection devices installed in a France Avenue signal controller cabinet received data from vehicle detection units and the traffic signal controller.

• An arterial travel time model that uses data from existing signal controllers and vehicle detection systems to mimic typical travel behavior in order to determine the total time from a given origin to a given destination. This traces virtual probe vehicles from origin to destination.

What Did We Learn?

Researchers used performance measures generated by SMART-SIGNAL to examine the benefits of new signal timing plans implemented by the Hennepin County Transportation Department along the France Avenue corridor. An examination of data collected before and after implementation of these plans demonstrated improvements in performance measures such as travel time, delay, number of stops, and level of service under the new plans. Hennepin County reports that SMART-SIGNAL's performance data confirmed the results of an engineering consulting firm's signal timing study of the corridor. SMART-SIGNAL's estimated arterial travel times were also found to be highly consistent with real travel times recorded along the France Avenue corridor.

What's Next?

Hennepin County has removed the SMART-SIGNAL prototype from the France Avenue corridor but is funding research to install a retooled prototype near Southdale.

This project is regarded as a definite success and received the 2009 University of Minnesota Center for Transportation Studies Research Partnership Award. SMART-SIGNAL development continues, with additional research funded by the university's Intelligent Transportation Systems Institute under way to automate signal retiming and develop predictive models to determine performance measures for signalized arterials.

Mn/DOT has also initiated additional research to continue development of the eventual end-user product by installing SMART-SIGNAL at 15 intersections along Trunk Highway 13. This new research is focused on fine-tuning SMART-SIGNAL's data collection equipment to prepare for the next generation of signal controller cabinets, and creating a Web interface for end users.