# SMART-Signal (Systematic Monitoring of Arterial Road Traffic Signals)

Although measuring and archiving freeway traffic performance using commonly available loop detector data has become a norm for many transportation agencies, similar approaches for urban arterials do not exist. In practice, operational data from traffic signal systems are neither stored nor analyzed, which prevents the proactive management of arterial streets.

The development of the SMART-Signal (Systematic Monitoring of Arterial Road Traffic Signals) system fills in this gap. The SMART-Signal system simultaneously collects event-based high-resolution traffic data from multiple intersections and generates real-time arterial performance measures including intersection queue length and arterial travel time. The development of the system has laid the groundwork for better traffic models and control strategies and opens up entirely new opportunities for managing traffic on congested roads.

In the SMART-Signal system, a complete history of traffic signal control, including all vehicle actuation and signal phase change events, are archived and stored. At each intersection, an industrial PC with a data acquisition card is installed inside the controller cabinet, and event data are transmitted to the data server in real-time using an Ethernet connection.

Using the event-based data, a set of arterial performance measures, especially intersection queue length and arterial travel time, can be estimated. SMART-Signal uses a newly developed algorithmic approach to queue length estimation based on traffic shockwave theory. Cyclic traffic shockwaves at an intersection can be reconstructed using event-based data, allowing for queue length estimation even when the queue of cars extends beyond the upstream vehicle detector. To measure travel time, SMART-Signal simulates the movements of a virtual "probe vehicle" along the arterial road. As the virtual probe moves, it can modify its own state in response to the state of traffic around it by accelerating, decelerating, or maintaining a constant speed at each time step as it encounters queues, traffic signals, and changes in traffic density.

SMART-Signal can also optimize traffic signal parameters using the collected high-resolution data. Instead of relying on traditional offset optimization approaches, which are based on manually collected volume data on a typical day, SMART-Signal can account for traffic flow variations by using archived traffic signal data and the derived performance measures.

The SMART-Signal system has been field-tested on three major arterial corridors in Minnesota including six intersections on Trunk Highway 55 in Golden Valley, eleven intersections on France Avenue in Bloomington, and three intersections on Prairie Center Drive in Eden Prairie. A demonstration project is also being carried out on Orange Grove Boulevard in Pasadena, California. A large-scale SMART-Signal system implementation project currently under discussion with the Minnesota Department of Transportation will monitor 100 intersections in the Twin Cities area.

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