The Exploratory Advanced Research Program Fact Sheet

Investigating Advanced Traffic Signal Control

Examining the Effect of Traffic Probe Data on Traffic Signal Operations

Exploratory Advanced Research . . . Next Generation Transportation Solutions

Poor traffic signal timing accounts for an estimated 10 percent of all traffic delay—about 300 million vehicle-hours—on major roadways alone, according to a study by the Oak Ridge National Laboratory. A fundamental rethink of traffic signal operations, based on the impending widespread availability of traffic probe data, is the goal of "Advanced Traffic Signal Control Algorithms," a project of the Federal Highway Administration's (FHWA) Exploratory Advanced Research (EAR) Program in partnership with California Department of Transportation, University of California at Berkeley, BMW, and University of California at Riverside.

Changing Signals

This study is focused on the concept of vehicle-to-infrastructure (V2X) cooperation via the Intelligent Transportation Systems (ITS) initiative; something which could provide comprehensive real-time information on the movements of vehicles throughout the entire road network, lead to a transformational change in how traffic is controlled, and address the significant problem of congestion along arterial routes. Until recently, the main impediment to improvements in traffic signal systems has been the limited ability of available fixed-point detectors to measure the true state of the traffic network and its response to signal changes. However, the widespread availability of traffic probe data can now provide real-time measures of effectiveness that allow objective signal control and measurable improvements in the efficiency of the traffic network.

According to Alex Skabardonis of the University of California at Berkeley, this 2-year project has some ambitious goals. "We are trying to see what connected vehicle information can do with traffic signal control and want to come up with new ways to time signals and develop new control strategies," explains Skabardonis. "Our research makes it clear that adaptive control produces benefits over fixed-time control but implementation in real-world driving scenarios makes widespread adoption very challenging."

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Traffic crossing an intersection.

Control Concepts

The study looks at three control concepts: mobility, environmental, and safety. The first, mobility, looks at strategies to avoid traffic saturation in the middle of a grid network. The aim is to use measurement samples to predict traffic, average travel times, and the proportion of stopped vehicles. From this data, schemes like "gating" can be developed, where queues are prevented from forming at the periphery of a network. The environmental concept examines fuel consumption and emission results, and how signal phase and timing (SPAT) can be used to save fuel and lower emissions. These savings could be quantified and then used to design optimal trajectories to enhance savings as a vehicle drives through a signalized corridor. The final concept, safety, looks at how to take full advantage of connected-vehicle data to analyze intersection geometry and detect approaching and waiting vehicles that may conflict.

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In addition, intersection priority could be given to emergency vehicles, transit vehicles, or individual vehicles under low-traffic conditions, reducing delays and the need to stop.

Efficient Solutions

Project partner BMW is focusing its research on the vehicle itself. This part of the study looks at the development of algorithm sequences for a connected vehicle to inform only relevant traffic signals about the vehicle's proximity, velocity, and signal request. Information is sent from a traffic signal to a cloud-based data center, and then communicated over a 3G/4G network to in-car applications. With this data, the car is able to display SPAT information to a driver and, if required, adapt the cruise control in real-time, according to the vehicle trajectory, to get through a signal corridor without stopping. The technology, called "Smart Cruising," also allows a driver to choose between reduced travel time or increased fuel efficiency. Using Motor Stops Automatically technology, the vehicle can drive while the engine is switched off, effectively "sailing" along a corridor.

Moving Forward

By basing traffic signal control on a more complete knowledge of the state of the traffic network, this study could bring major improvements to the operational efficiency of arterial traffic signal systems. "This research will pave the way for many future works to be carried out by the U.S. Department of Transportation and its partners in an effort to develop a new generation of traffic signal control strategies," says David Yang at FHWA. "Ultimately this could lead to reductions in travel time and the frequency and duration of stops, in addition to reductions in pollutant emissions and fuel consumption." Before implementing a new control strategy at a real intersection, the research team plans to use real-world traffic and vehicle data to calibrate a traffic simulation, which can then be used to represent a wide range of intersection configurations and traffic patterns. It is expected that the simulation results will show how effectively probe-based control strategies can improve travel times, stopping frequency, fuel consumption, and emissions.

Learn More

For more information on the Advanced Traffic Signal Control Algorithms project, contact David Yang at FHWA, 202-493-3284 (email: david.yang@dot.gov).

EXPLORATORY ADVANCED **RESEARCH**

What Is the Exploratory Advanced Research Program?

FHWA's Exploratory Advanced Research (EAR) Program focuses on long-term, high-risk research with a high payoff potential. The program addresses underlying gaps faced by applied highway research programs, anticipates emerging issues with national implications, and reflects broad transportation industry goals and objectives.

To learn more about the EAR Program, visit the Exploratory Advanced Research Web site at www.fhwa.dot.gov/advancedresearch. The site features information on research solicitations, updates on ongoing research, links to published materials, summaries of past EAR Program events, and details on upcoming events. For additional information, contact David Kuehn at FHWA, 202-493-3414 (email: david.kuehn@fhwa.dot.gov), or Terry Halkyard at FHWA, 202-493-3467 (email: terry.halkyard@fhwa.dot.gov).

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