



Caltrans Division of Research,  
Innovation and System Information

# Research

# Notes

Transportation  
Safety and  
Mobility

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Project Title:  
Adaptive Coordination Algorithm  
for Arterial Traffic Signals

Task Number: 2652

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## Developing an Adaptive Arterial Signal Coordination Algorithm

Designing an adaptive signal coordination algorithm to operate with existing Caltrans traffic signals and Traffic Management Center software

### WHAT IS THE NEED?

Caltrans has a need to improve progression and reduce delay on signalized state highways by employing adaptive signal control techniques. However, vendor supplied systems with per site licensing fees tend to be prohibitively expensive, overly complicated for signal technicians to operate both effectively and efficiently, and often require additional detection not included in Caltrans design standards. Research is needed to develop an adaptive signal control algorithm for arterials that Caltrans can incorporate into its own signal control software for a one-time cost. Additionally, the algorithm needs to function with standard detection and be simple and intelligent enough for technicians to operate it effectively without spending too much time on field reviews.

Previous tasks in this project have evaluated commercial adaptive signal control systems to see if they meet Caltrans' needs. However, the results have shown that statewide implementation of these systems would be too expensive because of per site licensing fees and requisite additional detection. Caltrans needs to develop its own adaptive capability to incorporate into its existing software and field hardware.

### WHAT ARE WE DOING?

University researchers, working closely with Caltrans staff, will develop an adaptive arterial signal coordination algorithm that will make real-time adjustments to the splits and offsets of baseline time-of-day (TOD) plans, within specified bounds, in response to current traffic demands. Caltrans staff will specify the algorithm expectations, description of available data, and other system constraints. The university research team will design and test an algorithm to suit these requirements and accommodate the input data types available. Caltrans signal timing engineers will work with the researchers to



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ensure that the adaptive algorithm's inputs are feasible and its outputs are acceptable. Any additional algorithm requirements will be discussed at the beginning of the project, and addressed by the research team.

The algorithm will include a suite of tests to validate the data received from each detector. For example, it will check for missing data by looking for state changes from the detectors at least once within a specified interval. The researchers will test the algorithm by incorporating its logic into the AIMSUN microscopic simulation software. They will first verify through sample tests that the algorithm is working correctly. They will then compare the algorithm performance against the baseline time-of-day (TOD) plans for a range of traffic and geometric scenarios. This will include exploring the algorithm's performance under faulty or missing detector data.

The scope of the work will not cover the deployment of the proposed algorithm in the field. Translation of the algorithm into the proper programming code for use on Caltrans' controllers and/or TSMSS (Traffic Signal Management and Surveillance System) server is intended to be completed separately by the Traffic Operations Division and its contractors.

### WHAT IS OUR GOAL?

The goal of this project is to reduce travel times on and around state arterials through the development of an adaptive traffic control algorithm for coordinated signalized arterials. This algorithm is intended for deployment on a field master controller or TMC (Traffic Management Center) server that manages all of the signal controllers on a corridor as part of the Caltrans TSMSS control software. It should operate with data provided by typical, i.e. existing, detector configurations for coordinated actuated signal control.

### WHAT IS THE BENEFIT?

This project will provide direct benefits to Caltrans by developing an adaptive algorithm that would be available for Caltrans' unrestricted use and modification without

licensure fees. The resulting algorithm could also benefit any agencies with which Caltrans collaborates on signal timing plans and corridor improvement projects. This algorithm would not only provide everyday signal performance improvements as a result of refinements to timing parameters as conditions change throughout the day, but would also allow for automatic updating of the underlying time-of-day (TOD) plans as volumes change over time. By doing this, the algorithm could reduce Caltrans' labor costs associated with manually updating the signal timing plans periodically at the locations where it is deployed. This would be of significant value considering the large number of intersections under Caltrans' jurisdiction and the limited staff available to manage them. Traffic flow improvements on the corridors that Caltrans operates would also benefit the cities that these state routes traverse, both by improving mainline progression and reducing side street delay; and providing an automated system for addressing atypical traffic conditions that may arise as a result of local events or incidents. It would ultimately provide the traveling public with reduced transportation costs in the form of improved fuel efficiency and reduced travel times.

### WHAT IS THE PROGRESS TO DATE?

This is a new task under an existing project. The next step is to get PSC approval to submit as a research project for 14/15 FY funding approval by the Executive Committee.