

Transportation  
Safety and  
Mobility

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**Project Title:**  
Advanced Traffic Signal Control  
Algorithm

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## Improving Traffic Flow with Advanced Signal Controls

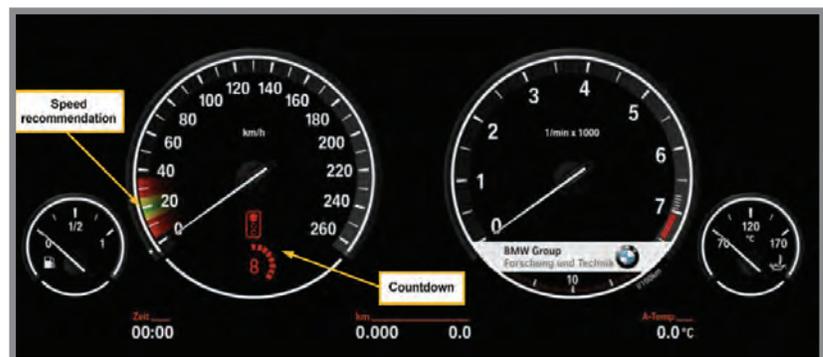
*Strategies to improve traffic mobility using probe data  
and connected vehicle technologies*

### WHAT WAS THE NEED?

Highway congestion is in large part caused by the inefficiency with which the capacity of the roadway network is managed. Traffic signals are used to control the flow of arterial thoroughfares, relying on informative methods that basically have not changed over the past several decades. The main impediment to improvements in traffic signal control systems has been the limited ability of the fixed-point surveillance detectors to measure the true state of the traffic network. With advances in electronics, sensors, communication technologies, and software, probe data and connected vehicle technology can provide comprehensive real-time information regarding the movements and interactions of vehicles in the entire road network and transform traffic control methods.

### WHAT WAS OUR GOAL?

The goal was to develop advanced traffic signal control strategies based on the impending widespread availability of probe data from connected vehicles to improve traffic management along urban arterials and networks.



*An electronic instrument panel used in a  
BMW as a driver speed advisory for fuel savings.*



## WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Partners for Advanced Transportation Technology (PATH) program, developed performance measures for evaluating probe-based, signal-control systems and procedures for estimating the performance measures based on connected vehicle data. The researchers also developed and evaluated algorithms for new control strategies enabled by the availability of connected vehicle data for the following:

- Queue spillback avoidance—Reduces spillback, which occurs when a queue on a downstream link affects the output volume of the upstream link or the links connected to it.
- Dynamic lane grouping—The turning movement assignment for each lane is adjusted dynamically based on the level of traffic congestion (saturation).
- Dynamic all-red extension—The ability to detect vehicles running red lights and control traffic signals to prevent hazards.
- Driver speed advisory—A prototype system that notifies drivers of the optimal speed based on real-time information to minimize fuel consumption and emissions.

## WHAT WAS THE OUTCOME?

- Testing the proposed performance estimation methods requires at least a 50% presence of connected vehicles on the road in under-saturated conditions to accurately assess the average travel time, delay, and stops.
- The occurrence of spillbacks was correctly detected in more than 80% of the cycles for a range of penetration rates.
- The dynamic lane grouping strategy can achieve better performance compared to fixed lane allocation: For three-lane approaches, it reduced the maximum flow ratio by 41% and the average delay by 35%. Dynamic lane grouping produces higher benefits when the intersection is oversaturated.
- The dynamic all-red extension algorithm can effectively detect red light hazards, with a false alarm rate of less than 5%.
- Fuel savings of up to 28.4% were observed with the speed advisory algorithm.

## WHAT IS THE BENEFIT?

Connected vehicle data can enhance mobility and safety. Detecting spillback situations early and using dynamic lane assignments effectively improves traffic flow through intersections, reducing congestion and idling cars. Better detection of red light runners helps law enforcement agencies catch violators and reduce collisions. Connected vehicle data can also play an important role in reducing fuel consumption and greenhouse gas emissions by advising drivers of the optimum speed.

## LEARN MORE:

To read the complete report on developing advanced signal control strategies:

[www.dot.ca.gov/research/researchreports/reports/2013/final\\_report\\_task\\_2157a.pdf](http://www.dot.ca.gov/research/researchreports/reports/2013/final_report_task_2157a.pdf)

To read the report on reducing fuel consumption:

[www.dot.ca.gov/research/researchreports/reports/2013/final\\_report\\_task\\_2157b.pdf](http://www.dot.ca.gov/research/researchreports/reports/2013/final_report_task_2157b.pdf)



Placement of radar sensors on San Pablo Avenue and Brighton Avenue in Albany.