



Caltrans Division of Research,  
Innovation and System Information

# Research



# Results



## Field Test of Coordinated Ramp Metering

Real-time coordination of ramp meters in response to traffic condition changes that can optimize highway performance during congestive periods by reducing bottlenecks.

### WHAT IS THE NEED?

Although ramp metering (RM) has been widely implemented for California highways, they are mostly local responsive ramp metering (LRRM). LRRM determined RM rate only based on its immediate upstream mainline detection. Therefore, the traffic throughput along the freeway corridor is not optimized.

### WHAT WAS OUR GOAL?

The objective is to develop a workable Coordinated Ramp Metering (CRM) strategy which optimizes the traffic throughput along the freeway corridor by increasing Total Vehicle Miles Travelled (VMT) and decreasing Vehicle Hours Travelled (VHT).

### WHAT DID WE DO?

This project has conducted the test on California State Route 99 Northbound (SR99 NB) in Sacramento between Calvine Road and 12th Avenue for both AM peak hours (6:00am-9:00am) and PM peak hours (3:00pm-6:00pm). The CRM algorithm used a simplified Optimal Control. 'Optimal' means that the CRM algorithm calculates the RM rate for maximizing VMT (Vehicle-Miles-Traveled) and minimizing VHT (Vehicle-Hours-Traveled).

The CRM algorithm intends to control the SR99 NB corridor as a long discharging stretch in the sense that the downstream should not be more congested than the upstream traffic.

## JUNE 2019

**Project Title:**  
Field Test of Coordinated Ramp Metering

**Task Number:** 2445

**Start Date:** July 2, 2014

**Completion Date:** June 30, 2016

**Task Manager:**  
Hassan AbouKhadijeh  
Transportation Engineer (Electrical)  
hassan.aboukhadijeh@dot.ca.gov



Caltrans provides a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

ADA Notice: For individuals with sensory disabilities, this document is available in alternate formats. For information call (916) 654-8899 or 711 TTY or write Caltrans Division of Research, Innovation and System Information, P.O. Box 942873, Sacramento, CA 94273-0001.

The project was completely based on currently available infrastructure without adding any new sensors etc. A very simple ConOps was adopted: a Partners for Advanced Transportation Technology computer located in the District 3 RTMC directly linked with 2070 controllers in the field through the Caltrans intranet. Every 30 second, it polled traffic detector data, estimated traffic state parameters, calculated the optimal CRM rate for each onramp, and sent it back to the individual 2070 controllers for activation.

URMS was the application software on each 2070 controller. The field tests were conducted progressively to avoid any negative impact on the daily traffic operation.

## WHAT WAS THE OUTCOME?

For an objective evaluation and for addressing traffic demand fluctuations and differences along the freeway corridor, the ratio VMT/VHT (understood as the “efficiency”, or average speed) in PeMS, independent from the field data used in CRM, was used as the performance parameter.

Comparison of performances in the same period and similar weeks/weekdays (e.g., Tuesday was compared with Tuesday) of year 2015 and 2016 for five weeks in October and November, VMT/VHT was increased by 7.25% on average for AM peak congested traffic. There was no improvement for PM peak hours since the traffic was not heavy.

## WHAT IS THE BENEFIT?

The direct benefit is the mobility improvement and congestion reduction. Indirect benefits include but not limited to: energy and emission reduction and safety improvement.

After the project has been accomplished, Caltrans District 3 RTMC traffic engineers made the following request after the performance analysis:

- a. To continue using the CRM control as the daily operation for the SR99 NB corridor;
- b. To develop a computer interface for the CRM algorithm so that Caltrans freeway traffic engineers could apply it to other similar freeway corridors.

## LEARN MORE

Link to the final report:

[http://www.dot.ca.gov/research/researchreports/reports/2017/CA16-2445\\_FinalReport.pdf](http://www.dot.ca.gov/research/researchreports/reports/2017/CA16-2445_FinalReport.pdf)