



Caltrans Division of Research,  
Innovation and System Information

# Research

# Notes

Transportation  
Safety and  
Mobility

MAY 2020

Project Title:  
Testing of Combined Variable  
Speed Advisory (VSA) and  
Coordinated Ramp Metering (CRM)  
for Freeway Traffic Control

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## Combined Variable Speed Limit and Coordinated Ramp Metering Along SR 99 Corridor

Field test of combined CRM and VSA, and to evaluate the performance of those two control approaches on freeway corridor traffic.

### WHAT IS THE NEED?

Coordinated Ramp Metering (CRM) and Variable Speed Advisory (VSA) are Active Traffic Management measures for freeways. The CRM concept is to balance the ramp metering rate (flow) from onramps into the freeway mainline considering the differences of demands and lengths (storage capacity) of all onramps along the corridor to maximize the throughput. However, CRM cannot completely control the traffic since, after the vehicles enter the freeway, they are beyond control in the sense that the freeway mainline traffic will still be dominated by the driver behavior.

Therefore, CRM can only improve traffic from the demand aspect. On the other hand, the VSA concept is to affect the driver behavior on freeway mainline. It would function at a macroscopic level for traffic harmonization -and it may reduce the shockwaves and maximize the bottleneck flow, if the algorithm is designed appropriately and if the driver compliance rate is reasonably high.

These two freeway traffic control methods are complementary to each other in function, with the goal of modulating traffic from different aspects. The CRM field test along State Route (SR) 99 was a success; it showed freeway traffic improvement without any infrastructure addition. Consequently, District 3 requested using the system developed by Partners for Advanced Transportation Technology (PATH) after the field test was completed. The field test of VSA on SR78 East Bound (EB) in District 11 was also a success. The combined effect of the two control approaches will need to be investigated quantitatively.



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The following tasks need to be addressed in this project:

- Combine/integrate the previous field-tested CRM and VSA algorithms into one algorithm
- Combine/integrate the previous independently field-tested CRM and VSA systems (hardware and software) into one system
- Improve the systems based on the lessons learned in previous projects when CRM and VSA were tested independently
- Investigate the dynamic interactions of the functionalities of CRM and VSA for real-world freeway corridor traffic
- Quantitatively evaluate the performance improvement for joint function of CRM and VSA
- Investigate the driver compliance to VSA and its influence on traffic

## WHAT ARE WE DOING?

The purpose of the project is a field test of combined CRM and VSA on SR99 North Bound (NB), and to evaluate the performance of the joint effect of those two control approaches on freeway corridor traffic. The research team will conduct the following tasks:

- Task 1: Form a project panel
- Task 2: Refine the concept of operations for combined CRM and VSA including overall control system design
- Task 3: Select hardware and obtain VSA signs
- Task 4: Select trailer; design, obtain, develop, and integrate trailer with VSA sign
- Task 5: Develop software for interfacing with VSA sign
- Task 6: Implement and refine real-time traffic state parameter estimation for a combined CRM and VSA
- Task 7: Develop website for a combined system of VSA and CRM
- Task 8: Combine CRM and VSA Algorithm into one algorithm and implement on PATH Real-Time computer
- Task 9: Conduct project outreach

- Task 10: Collect extensive data for current traffic
- Task 11: Integrate system for the combined CRM and VSA
- Task 12: Perform field preliminary test of combined VSA and CRM
- Task 13: Conduct extensive test of combined VSA and CRM with data collection
- Task 14: Conduct data analysis for performance evaluation of combined CRM and VSA
- Task 15: Perform project management

## WHAT IS OUR GOAL?

The goal is to use combined CRM and VSA to control both the demands from the onramps and affect the driver behavior in mainline for traffic throughput and safety improvement.

## WHAT IS THE BENEFIT?

CRM and VSA are two complementary control approaches for freeway corridor traffic management: the former controls the demand into the freeway while the latter affects the driver behavior and reduces mainline shockwaves.

A previous field-test of the VSA strategy on SR78 EB indicated that the traffic throughput could be improved about 8.7% in morning peak traffic. Another previous CRM field test in SR99 NB corridor showed that the performance was improved about 7.25% for congested morning traffic. The combined effect of the two control approaches could be cumulative. If successful, those control approaches can be widely implemented on California freeway corridors for mobility and safety improvement.

## WHAT IS THE PROGRESS TO DATE?

The PATH project team has continued talks with Caltrans Division of Research, Innovation, and System Information (DRISI) and the American Signal Company (ASC) on the Portable Changeable Message Signs (PCMS) -while working in parallel

on the integration of CRM/VSA algorithms for the field test on State Route 99 in Caltrans District 3. The selected ASC signs meet all the technical requirements including radar detection and modem connection through the cloud. They are also larger than the ones used for SR-78 EB.

The team also started writing up a summary on the combined VSA & CRM algorithm which will be discussed in the upcoming quarterly meeting with District 3.

The team is also working with Caltrans Headquarters Traffic Operations/Control Devices on the agenda for the next CA Traffic Control Devices Committee (CTCDC) meeting that will be held on July 9, 2020.