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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Connected and Automated Vehicle (CAV) Application Development

To facilitate the Multi-Modal Intelligent Transportation Signal System deployment in California, there is a need to document the existing software that has been deployed in the California Connected Vehicle Test Bed, to improve MMITSS source code readability via better commenting, and to provide manual/user-guide for developers, management staff, and maintenance staff.

Traffic Operations

May 2025

Project Title: Connected and Automated Vehicle (CAV) Application Development

Task Number: 4346

Start Date: March 3, 2025

Completion Date: December 31, 2026

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WHAT IS THE NEED?

The Multi-Modal Intelligent Traffic Signal System (MMITSS) is the next generation of traffic signal systems that seeks to provide a comprehensive traffic information framework to service all modes of transportation, including general vehicles, transit, emergency vehicles, freight fleets, and pedestrians and bicyclists in a connected vehicle environment. Under the sponsorship of the Connected Vehicle Pooled Fund Study (CV PFS) and Federal Highway Association, MMITSS has been deployed in the California connected vehicle Test Bed. The California Department of Transportation (Caltrans) statewide Traffic Signal Control Program (TSCP) has been enhanced to support MMITSS operations, including Signal Phase and Timing broadcasts, Connected Vehicle-based vehicular service calls and actuations, pedestrian service calls, Connected Vehicle-based signal priority, and dynamic force-off to adapt signal timing to the prevailing traffic conditions. However, due to the low market penetration of connected vehicles and the lack of multimodal road user detection and classification data, the effectiveness of traffic adaptive features cannot be tested and evaluated in real-world condition.

The current coordinated traffic control systems utilize a few time-of-day timing plans (cycle length, green split, and offset) for time-based coordination and utilize loop detectors for phase service calls and vehicle actuations. The time-of-day timing plans are preset based on traffic data collected through site surveys. Inductive loops are usually installed near the intersection stop-line and cannot detect and measure the fluctuation of traffic demand in real-time so that the traffic control systems are not well informed about the state of the

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traffic and are unable to select the appropriate timing plan that adapts to the prevailing traffic conditions. Furthermore, in the current systems, pedestrian service requests are detected by pedestrian pushbuttons, the systems are not necessarily aware of how many pedestrians and their location on the crosswalk.

In a Connected Vehicle environment where equipped vehicles and pedestrians communicate their state (type, location, speed, heading, etc.) to the roadside infrastructure via Basic Safety Messages (BSM – vehicle) and Personal Safety Messages (PSM – pedestrian), this rich data set allows the traffic control systems to measure the fluctuation of traffic demand in real-time, adapt timing plan to the prevailing traffic conditions, and provide cooperative services to each mode.

Although the anticipated benefits of Connected Vehicle technologies on improving safety and mobility are promising, due to the low market penetration rate of connected vehicles, the benefits of Connected Vehicle technologies are difficult to assess in a real-world condition.

WHAT ARE WE DOING?

The project team has introduced the existing MMITSS installation, configuration, and maintenance procedures to Caltrans engineers to receive feedback on tools needed to support MMITSS operation and maintenance and to help prepare Caltrans to adapt connected smart intersections implementation. The collected key feedback and actionable items include for this task include:

1. Simplify the installation and configuration procedures such that a traffic operation engineer without programming and MMITSS background can install and configure the MMITSS software with simple clicks. To achieve this goal, the project team will develop and implement a Web-Based Dashboard to Support MMITSS operation and maintenance. The web-based dashboard shall be easily understood, with a user-friendly and multi-layer visualization of real-time analytics about MMITSS operational status. The dashboard shall also generate alerts for intersections with operation issues and assist the Caltrans operation engineer to fix the issues.
2. Further enhance MMITSS interfacing capability to a broader range of roadside unit (RSU) and traffic system control (TSC) vendors by using vendor preferred protocols. The US Department of Transportation standard amendment CTI 4001. v01.01 for roadside units. These two interfaces are Immediate Forward (IMF) protocol and the National Transportation Communications for Intelligent Transportation Protocol (NTCIP) 1202 v03A^7.
3. Create easily understood web-based documentation such as Wiki-pages about the MMITSS software which also assists basic tasks such as installation, procedures, access to design documentation, and troubleshooting.

WHAT IS OUR GOAL?

The goal of this project is to assist in preparing Caltrans to add adaptive and multimodal enhancements for improved mobility and safety on California roadways.

WHAT IS THE BENEFIT?

The State would be able to better assess the effectiveness of traffic adaptive features that support multimodal transport and impacts of market penetration of CVs and providing better safety and mobility for all modes of travel.

WHAT IS THE PROGRESS TO DATE?

The contract was recently executed, and a project kickoff meeting was held in April of 2025.