Advanced Research

MAY 2025

Project Title:

Guidance on Roadside Units (RSU) placement for future deployment of Connected and Automated Vehicle (CAV) Applications

Task Number: 4081

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Task Manager:

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DRISI provides solutions and knowledge that improves California's transportation system.

Guidance on Roadside Units (RSU) placement for future deployment of Connected and Automated Vehicles (CAVs)

Planning tool to provide California Department of Transportation (Caltrans) Districts Engineers guidance on RSU placement for CAV applications

WHAT IS THE NEED?

To facilitate future deployment of CAV applications, it is critical to upgrade existing road infrastructure with RSU to enable Vehicle-to-Everything (V2X) communications for various CAV applications. When a freeway or an arterial network is selected, the current approach, like in the California Connected Vehicle Testbed, is to install RSUs at all road intersections. However, this approach is not cost-effective for network-level deployment due to limited budgets to install and maintain RSU facilities and low penetration rates of CAVs on surface roads. Therefore, it is crucial to develop a generalized tool that can guide Caltrans District Engineers at the planning stage to pick the right locations to install RSUs for selected CAV applications with cost effectiveness.

WHAT ARE WE DOING?

This task will take care of the following activities.

1. Conduct a literature review on existing CAV applications. Generate a list of CAV applications to be implemented in this project in consultation with the project panel.

2. Implement the selected CAV applications in the integrate microsimulation platform in Aimsun program.

3. Generate subnetworks, networks and design simulation scenarios from the I-210 corridor in consultation with the project panel.

4. Conduct simulations, summarize simulation results, and develop the sketch-level planning tool.

5. Document all findings in a final report and provide a workshop to Caltrans engineers on how to use the sketch-level planning tool.

WHAT IS OUR GOAL?

The end goal of this task is to have a fully functional planning tool to provide Caltrans Districts Engineers guidance on RSU placement for CAV applications.

WHAT IS THE BENEFIT?

The sketch-level planning tool can help Caltrans Engineers identify best locations in a targeted project area to install RSUs so as to achieve desired performance for selected CAV applications. In the long run, this sketch-level planning tool can be further enhanced with more CAV applications, more test networks and scenarios, and more interactive features to provide Caltrans better guidance on the installation of RSUs at the network scale.

WHAT IS THE PROGRESS TO DATE?

Progress 1/1/2025 – 3/31/2025

The project team has implemented the architecture for the following applications:

- Curve Speed Warning
- Queue Warning
- Speed Harmonization
- Eco-Approach and Departure at Signalized Intersections
- Intersection Safety Warning and Collision Avoidance
  - Red Light Violation Warning
  - Pedestrian on Crosswalks

The project team has overcome the following technical challenges while developing the above applications:

- Generation of Signal Phase and Timing (SPaT) messages from intersections under Coordinated Actuated Signal Control.
  - The project team has developed algorithms to provide a reasonable estimate of the element "TimeChangeDetails" in the SPaT messages.
- Managing the SPaT and Intersection Geometry (MAP) messages from narrowly spaced signalized intersections equipped with RSUs.
  - A connected vehicle will receive SPaT and MAP messages from two or more nearby signalized intersections when they are narrowly spaced. The project team has developed functions to use a connected vehicle's current position and route information to select the right signalized intersection and the corresponding SPaT and MAP messages to use.
- Integration between the Pedestrian Simulator and the V2X Software Development Kit (SDK) in Aimsun
  - The Pedestrian Simulator and the V2X SDK are running separately in Aimsun. In developing the application of Pedestrian on Crosswalks, the project team has developed functions to connect these two modules to enable the positions of pedestrians to be identified and broadcasted to nearby connected vehicles in real-time.

The project team is working on the Technical Memo and will include it in the Final Report.
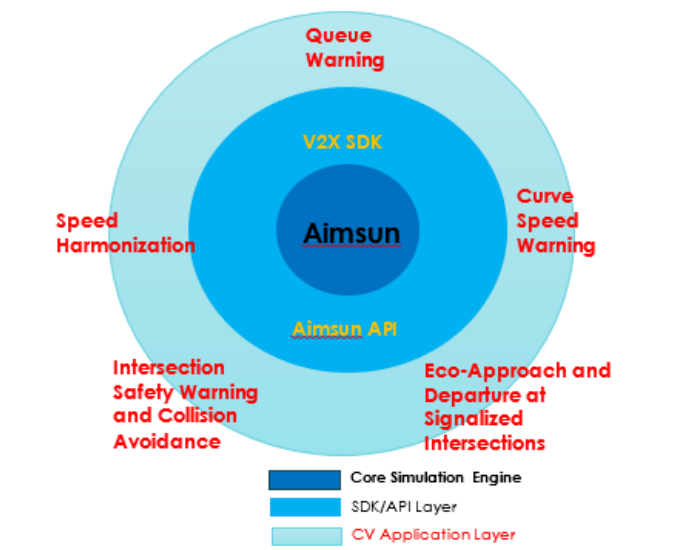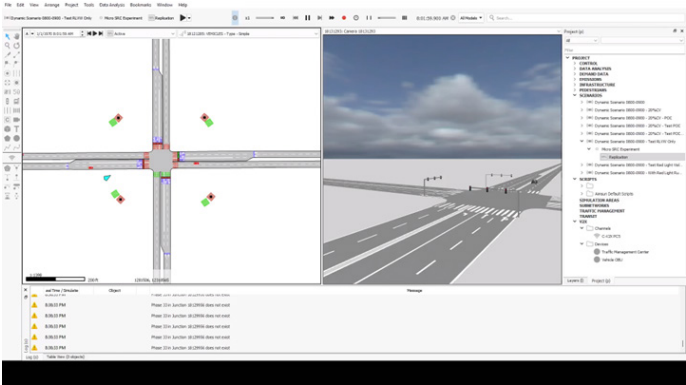
IMAGES

Image 1: A V2X Microsimulation Platform.

Image 2: Simulation of Red Light Violation Warning .