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Research Notes

Advanced Research

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Project Title: Vehicle Infrastructure Integration

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Connected Vehicle Application Development (CVAD)

Test bed expansion to 31 intersection and development of Transit Signal Priority (TSP) Application

WHAT IS THE NEED?

In the past, the United States Department of Transportation has provided financial and technical support to the California Department of Transportation (Caltrans) test bed site in Palo Alto, CA, for developing the Connected and Automated Vehicles (CAV) infrastructure.

Currently, the test bed site is fully operational and consists of 16 intersections. As Caltrans is preparing to achieve the deployment of at least 20 CAV upgraded intersections on the test bed to meet the Signal Phase and Timing (SPaT) challenge by January of 2021. Expanding the intersections from 16 to 31 at the test bed will provide a better setting for application developers to complete the testing and development of both the vehicle and infrastructure components as many of the CV applications require longer CV equipped corridors for applications to work properly.

WHAT ARE WE DOING?

This research entails the following tasks:

1. Expand the California CV test bed to meet the National Operations Center of Excellence's requirements for the SPaT challenge.
2. Develop, implement, and conduct field tests for Transit Signal Priority (TSP) application
3. Support the deployment of CV in California

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WHAT IS OUR GOAL?

The objective of this research is to achieve a fully functional test bed with 31 intersections that will allow various private and public entities to develop CV applications.

WHAT IS THE BENEFIT?

The improved test bed will provide a platform for software engineers to develop various CAV transportation applications that will improve the throughput and safety for vehicular movements on highways, arterial, and surface streets; and ultimately help drivers in cutting travel times, saving fuel and improving safety.

WHAT IS THE PROGRESS TO DATE?

Lab testing of connecting two 2070-1C CPU processor using ether connection has been successfully completed. Image 1 illustrates the settings of the lab testing.

The CV equipment used in this testing include:

- A 2070LX controller with 2070-1C CPU processor which hosts CV roadside applications (the same applications running on the Linux computers in the California CV Test Bed)
- A 2070E controller with 2070-1E CPU processor which runs the Caltrans TSCP software
- A Savari RSU
- A Savari OBU

The 2070-1C CPU processor communicates with the TSCP running on the 2070-1E CPU processor via the AB3418 protocol over Ethernet. The 2070-1C CPU processor communicates with the RSU over Ethernet using the Immediate-Forward, Store-and-Repeat, and DSRC-Message-Forward APIs as defined in USDOT v4.1 RSU specifications. The RSU and OBU exchange messages over DSRC. The 2070-1C CPU processor also communicates with the server located at Richmond Field Station (RFS) for status update and obtaining RTCM messages. The settings duplicate the field intersections in the test bed, with the 2070-1C CPU processor replacing the Linux computer. 2070-1C CPU processor with ported CV roadside applications performed the same as the standard-alone Linux computer.

Testing of Siemens RSU was completed for equipping the reaming 15 expansion test bed intersections with dual DSRC and C-V2X radios. Although the tested Siemens RSU has DSRC radio only, the interface APIs to Siemens DSRC radio is the same as that to Siemens C-V2X radio. This testing includes three settings:

1. A Linux computer communicates with the TSCP over serial ports and communicates with a Savari RSU over Ethernet
2. A 2070LX controller with 2070-1C CPU processor communicates with the TSCP over Ethernet and communicates with the Siemens RSU over Ethernet
3. A Cohda RSU

A Savari OBU and Cohda OBU were used to verify message exchanges between RSUs and OBUs. J2735 messages tested include:

- RSU broadcasts: MAP, SPaT, RTCM, SSM, PDM, and RSM
- OBU broadcasts: BSM, SRM, PVD and PSM

The Savari and Cohda RSUs broadcast unsigned J2735 messages, and Siemens RSU was tested with both signed and unsigned J2735 messages. The outcome of the testing was successful. All the messages (signed or unsigned) are exchanged between various RSUs and OBUs as expected.

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Installed 15 Siemens dual mode (DSRC and C-V2X) RSUs has been installed in the 15 intersections. Two of the 15 intersections are fully functional and the remaining 13 intersections will be functional by the end of January 30, 2022.

The new Model 2070LX-Plus has gone through Caltrans Lab testing and we are waiting Econolite to provide us with one finished unit for software testing. Caltrans software group is nearing finishing the porting of TSCP program to Linux platform. We should have the Linux based TSCP in the first quarter on 2022.

IMAGE

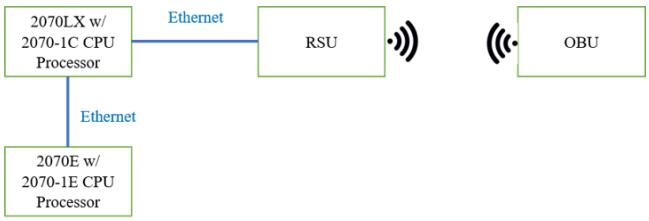

Image 1: Testing of CV Applications running on 2070-1C CPU Processor

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