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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION
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Research Notes

Maintenance, Operations, and Enhancement of C-V2X Infrastructure Phase IV

Continued work is needed to support maintaining and operating the El Camino Real (ECR) testbed to make sure it stays operational for testing Connected and Automated Vehicle (CAV) applications.

Traffic Operations

MAY 2026

Project Title: Maintenance, Operations, and Enhancement of C-V2X Infrastructure Phase IV

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WHAT IS THE NEED?

The existing El Camino Real (ECR) testbed is in the process of being upgraded with the latest Cellular Vehicle-to-Everything (C-V2X) equipment. Additional work is also needed to include enhancements to the testbed to test, validate and evaluate the performance and reliability of CAV applications that were previously tested using the Direct Short-Range Communication (DSRC) equipment. Continued work is needed to support maintaining and operating the testbed to ensure it stays operational for testing CAV applications. Also, there is a need to develop, test, and validate new C-V2X CAV use cases as needed.

Additional work is needed to support the transfer of the El Camino Real CAV server from PATH to District 4. New applications, including Pedestrian Crosswalk Alert, need to be developed and tested for the newly equipped High Intensity Activated Crosswalk (HAWK) signals. Infrastructure also needs to be maintained and supported so that it will be useful for other California Department of Transportation (Caltrans) and Partners for Advanced Transportation Technology (PATH) projects, as well as for projects to be conducted by a variety of other public and private sector organizations in the region. Lastly and most importantly, all critical software and knowledge needs to be either duplicated in Caltrans facilities (e.g., at the DRISI Lab) and/or handed off to Caltrans (e.g., allowing District 4 (D4) to manage operations), to ensure resilience and greater utilization of the testbed.

There are some new high-priority tasks related to the current testbed that are not covered by phase IV that need to occur while Phase III is still active. These are moving the ECR Server

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that hosts all CAV applications currently hosted at PATH to D4, and verifying applications as we convert the Road-Side Units (RSUs) from DSRC to C-V2X.

WHAT ARE WE DOING?

- Support of the Transfer of the ECR server to D4 Transportation Management Center (TMC)
  - Support the overall transfer of the ECR server to the D4 TMC. PATH has run the server from the PATH lab for the last few years, but having D4 TMC take overall control will help Caltrans' goals and enable greater utilization of the ECR.
- Prototyping a V2X Server to Support Cloud-Based CAV Data Aggregation and Applications
  - Integrate cloud-based activities on the ECR with broader Caltrans cloud-based goals, including in other districts.
- Development of Pedestrian Safety Alert Application for HAWK signals
  - The goals of this task are 1) to ensure that the HAWK crosswalks are effectively integrated into the overall ECR ecosystem, and 2) to assist in the development of a pedestrian safety alert application, and 3) compare the benefits and drawbacks of using direct V2X vs. cellular networks as the communication protocol for the application.
- Establish a Testing and Validation Framework for Performance and Reliability Evaluations
  - Comprehensive evaluation of the testbed facility is crucial for the developed and deployed technology asset. Obtaining measurements of reliability, efficiency, application-specific benefits will be meaningful to prioritize future directions of technical development and application promotions and convince and encourage new game players to participate.
- Stakeholder Engagement and Support
  - This task will continue engagement work that was started in Phase III, with the ultimate goal of ensuring that the ECR testbed is utilized in the most impactful ways, including being used more broadly throughout Caltrans, by the private sector, by researchers, and by other public transportation agencies.

WHAT IS OUR GOAL?

The objectives of the project are to support the ECR Testbed C-V2X upgrade initiatives, support the testbed maintenance and operation, showcase the application use cases, and support technical activities to increase public awareness and stakeholder participation.

WHAT IS THE BENEFIT?

This testbed will provide a platform for software developers who will be developing transportation applications that will help drivers cut travel times, save fuel, and drive with augmented safety. Caltrans will be the primary beneficiary as the developed applications will help Caltrans manage traffic flows better while reducing the carbon footprint.

WHAT IS THE PROGRESS TO DATE?

- Supported validation and verify the connection, configuration and communications of testbed facilities for all the 37 ECR Intersections.
- Supported the establishment of a V2X Management Server on D4 TMC Virtual Machines. The V2X Management design draft documents sent to Caltrans. Total of 23/37 intersection connected to KITS at D4 TMC.
- Supported the establishment of a Radio Technical Commission for Maritime Services (RTCM) Caster on D4 TMC Virtual Machines.
- Presented the ECR implementation and reactivation progress and roadmap in the DRISI Connected Research webinar. The ECR system, functionalities, and Digital Twin demos were

presented as one of the key activities at the Berkley Richmond Field Station Demo Day on October 24th.

- The V2X Management website prototype have been developed and implemented at PATH. Designed a V2X data exchange server, developed Application Programming Interface (API) for MAP and Signal, Phase, Time (SPaT) files.