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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Deployment and Evaluation of Targeted Warning Messaging System

Developing and testing a vehicle-triggered warning system to enhance safety during lane closures.

Maintenance

November 2025

Project Title: Deployment and Evaluation of Targeted Warning Messaging System

Task Number: 4294

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WHAT IS THE NEED?

The California Department of Transportation (Caltrans) maintenance crews frequently operate in short-duration lane closures where traditional advance-warning signing is limited by time, geometry, or site constraints. Drivers may approach these closures at high speeds and do not always have adequate time to react to workers or equipment in the lane. This creates an elevated risk of rear-end collisions and near misses. A simple, deployable system that provides earlier and more targeted warnings is needed.

Previous Caltrans research (Project 3919) demonstrated a preliminary concept in which a field vehicle detects approaching traffic and automatically triggers a changeable message sign to display a warning message. While the earlier project confirmed feasibility, additional development is required to integrate a more robust communication link, refine hardware selection, and evaluate performance under real maintenance conditions. Task 4294 continues this effort by expanding system integration, improving reliability, and conducting controlled and field evaluations.

This task supports Caltrans' efforts to reduce crashes at active work sites and provide safer operating conditions for maintenance personnel. The task builds directly on the previous work and advances the system toward an operational prototype suitable for potential broader deployment.

WHAT ARE WE DOING?

This research will complete the development and integration of a targeted warning messaging system designed for deployment in temporary highway maintenance lane

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closures. The system uses a vehicle identification module mounted on the advance-warning vehicle to automatically detect approaching traffic in the merging lane. When a vehicle is identified as approaching the closure at an unsafe speed or trajectory, the system will transmit a signal to a portable message board to display a targeted warning message intended to influence driver behavior before reaching the physical taper or truck-mounted attenuator (TMA).

To support this, the research team is finalizing the hardware and software integration between the detection system and the message board controller. The TraffiCalm 6036 message board will be configured and its API customized to allow real-time, automated message activation. Point-to-point wireless communication options are being evaluated and tested to ensure adequate reliability, latency, and operational range under field conditions.

After completing integration work and confirming system functionality in controlled test environments, the project will conduct pilot testing in active maintenance work zones. These pilot tests will evaluate system performance, message activation timing, communication reliability, and the system's ability to respond to vehicles that engage in unsafe lane-use behavior, such as late merging, rapid approach speeds, or "leapfrogging" toward the closure point. Field observations, operator feedback, and system data will be used to assess overall effectiveness and support refinement of deployment guidance and recommended practices for future Caltrans use.

WHAT IS OUR GOAL?

The goal is to develop and test an integrated, real-time vehicle-triggered warning system capable of enhancing driver awareness during short-duration lane closures. The final deliverable will include system documentation, test results, and recommended implementation practices.

WHAT IS THE BENEFIT?

The system has the potential to improve safety at active maintenance sites by providing targeted warnings to drivers based on actual traffic conditions. Early warning can reduce sudden braking and near-miss incidents, particularly at locations where placement of advance signs is difficult or where workers are exposed for short intervals. The system may also reduce the amount of traffic control equipment required for short operations, minimizing worker exposure during setup and retrieval.

If successful, the system could be adopted for various field activities including debris removal, guardrail repair, sweeping, and minor corrective maintenance. The work supports Caltrans' broader goals for worker safety and more efficient maintenance operations.

WHAT IS THE PROGRESS TO DATE?

A project kickoff meeting was held and regular coordination meetings continue between Caltrans and the research team. Multiple message board options were reviewed; due to lead-time constraints, the existing TraffiCalm 6036 board was selected. API customization has been initiated to enable communication with the detection unit.

Point-to-point wireless communication devices have been reviewed and initial bench testing has been conducted. Work on communication integration is slightly behind schedule due to the condensed timeline following delayed project approval. No field tests have been initiated yet.

Next quarter, the team will continue refining the API integration and finalize the wireless solution. Controlled field tests will begin once reliable communication is confirmed.