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CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

Research Results

Truck Platooning Early Deployment Assessment Phase 2

Develop an innovative and synergistic truck platooning pilot deployment concept, prepare a comprehensive deployment plan and proposal that enables the assessment of such a concept.

Advanced Research

DECEMBER 2023

Project Title:
Truck Platooning Early Deployment Assessment Phase 2

Task Number: 3639

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WHAT WAS THE NEED?

Traffic volumes and vehicle miles traveled continue to increase. Constructing new highway facilities is becoming more problematic and mitigating the environmental, societal, and economic impacts becomes more difficult and less sustainable. Partial or fully automated vehicle control systems in conjunction with vehicle-to-vehicle (V2V) communications, have the potential to reduce fuel useand emissions while improving highway and commercial vehicle operations and safety without the expense and impacts of constructing new highways. While fully automated vehicles are years away from widespread commercial deployment, partially automated driver-assist technologies are currently available and when combined with V2V communications, they have the potential to realize those benefits sooner.

V2V communications between the platooning trucks has two significant effects 1) it reduces reaction time allowing the trucks to be safely operated with smaller gaps between platooning trucks and 2) it supports coordinated movements among the vehicles in the platoon so the truck can operate more like a train. Smaller gaps and coordinated movements lead to aerodynamic benefits such as reduced fuel use and the ability to move more vehicles through a segment of highway which increases existing highway capacity. This is the second of two federal grant projects examining the benefits and impacts of integrating V2V communications with commercially available adaptive cruise control (ACC) to create cooperative adaptive cruise control (CACC) and then using the CACC to safely perform close-spaced truck platooning operations. Under the first grant project Caltrans partnered with UC Berkeley, Volvo, and Cambridge Systematics. PATH with, with Volvo's support, integrated vehicle-to-vehicle

(V2V) communications into Volvo's commercial ACC to create CACC on three Volvo trucks. CACC development continued throughout the project in tandem with testing, demonstrations, driver acceptance and fuel-consumption experiments on a test track.

Modeling and simulation work based on test results looked at how wide-spread adoption and use of CACC systems can increase highway capacity and smooth traffic flow leading to significant improvements to highway operations and safety in addition to reductions in fuel use and emissions The current project picked up where the first project left off by upgrading the CACC system developed in the first project and integrating that system into four new trucks and performing tests and examining how truck platooning operations impacts commercial fleet operations, highway operations, truck drivers and other roadway users.

WHAT WAS OUR GOAL?

The overall goal of the project was to gain a better understanding of how CACC based truck platooning works on a real-world highway environment and the impacts from those operations.
Specific project objectives include:

- Determine truck driver preferences for automatic following gap size and implications for fuel savings.
- Assess impacts on driver performance and alertness over an extended period of usage in traffic.
- Better understand the impacts of truck CACC or platooning on safety, fleet operation logistics and truck operating costs in typical long-haul trucking.
- Assess interactions between platooning trucks and other vehicles.
- Understand how platooning operations affects fuel use and emissions.

WHAT DID WE DO?

The existing CACC control system was modified and adapted for the four new Volvo trucks. Task 6 was partially accomplished under joint funding with Federal Highway Administration (FHWA). The system was initially tested and demonstrated to the Independent Evaluator. However, coordinated emergency braking was not tested on the track. FHWA decided to stop the project as issues between PATH research team and Volvo team could not be resolved. The lower-level control actuation was the strategy that was used in the previous FHWA Exploratory Advanced Research (EAR) Program Project with Caltrans Match Funding. However, this approach was not accepted by Volvo. Research team and Volvo collaborated to implement the control actuation approach that was preferred by Volvo based on its safety considerations. The main difficulty was that, once the service brake was applied, whether automatically or manually, the engine torque control (for Adaptive Cruise Control) would be disabled, so the driver would have to reactivate it, which is also true for the manufacturer's production Adaptive Cruise Control feature. To resolve this problem, it would be necessary for Volvo and Bendix, the provider of the service brake control Electronic Control Unit (ECU), to work closely to change the hardware and/or software, which the project team was not be able to do. A whole year was spent trying to come up with multiple solutions, including shipping a truck to Volvo US in Greensboro. But a successful solution could not be found in the expected timeframe. This unexpected process significantly delayed the project. This was the main reason for FHWA to stop the project.

WHAT WAS THE OUTCOME?

The work throughout this project showcased the Comprehensive Deployment Plan of the FHWA Truck Platooning Early Deployment Phase 2. It includes the following plans:

- Technical Approach for CACC implementation

- Progressive Test Plan
- Data Acquisition and Management Plan
- Human Use Approval Plan
- Partnership and Outreach Plan.

The following lessons were learned during this project:

- Retrofitting vehicle control functionality into modern motor vehicles is much more difficult than it was with vehicles made 5 or 10 years ago because of heavy dependence on proprietary embedded control firmware and software
  o Problems are subtle, difficult to isolate and identify
  o Technical support by manufacturers of vehicle and key subsystems is necessary
- Even Level 1 driving assistance functions like ACC are viewed as safety critical by manufacturers, requiring production-level safety cases before use by naive drivers
- Implications of both are significant for future Field Operational Test (FOT) research project on vehicle Driver Assistance Systems or automation
- Selection of vehicle platform to use for FOT is critical and challenging, and needs careful consideration by all project participants, to ensure there are no "surprises" later regarding limitations in capabilities
- Include functional hazard analysis in project plans as a means of focusing attention on assessment of risks and potentially inconsistent assumptions about significance of each hazard

WHAT IS THE BENEFIT?

Caltrans supports the continued development and testing of freight transportation technologies, such as cooperative adaptive cruise control (CACC). In the long-term these types of technologies offer the potential to lead to transformational changes and advances in freight and highway operations. The potential benefits include increased safety and capacity, and reductions in fuel use and emissions, reducing the need to build new costly infrastructure.

LEARN MORE

TBD- Final report link.