U.S. Department of Transportation
Federal Highway Administration

Office of Safety and Operations
Research and Development

Cooperative Driving Automation (CDA) Applications for Port Drayage

The transport of freight from an ocean port to a destination (i.e., port drayage) is an important part of maritime supply chains. Port drayage is a short-haul trucking service for moving shipping containers from the port to a storage area and back (figure 1). This process often accounts for a high percentage of overall transportation costs and a large proportion of truck arrivals at container terminals. Due to its complexity, the drayage process contributes to recurring congestion at entry and exit points at ports, which leads to severe emissions problems and economic impacts. CDA offers ample opportunities to help ease these challenges.[1]

Source: Federal Highway Administration (FHWA).

Figure 1. Image. Freight vehicle with a cargo container.

BENEFITS TO TRANSPORTATION

IMPROVING MOBILITY

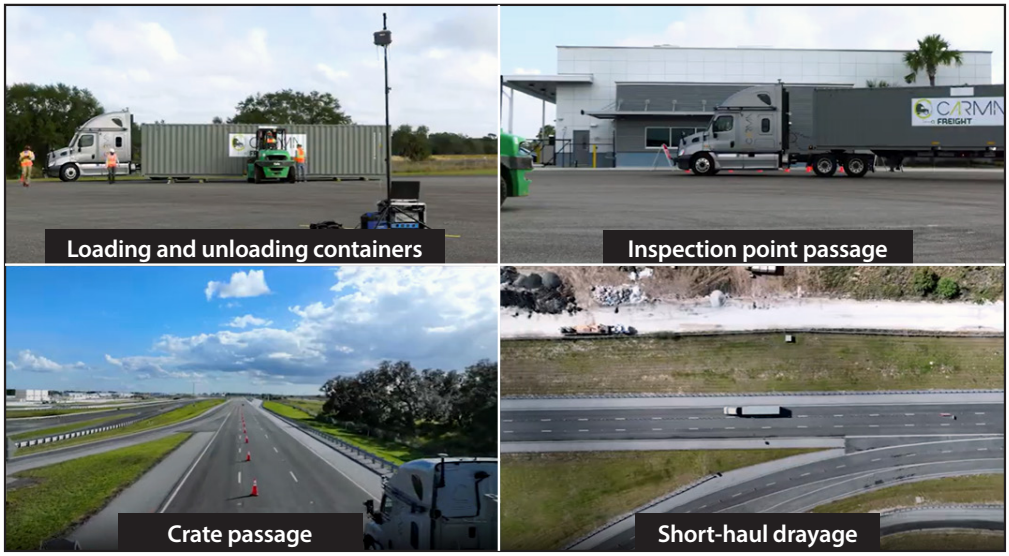
- Reducing congestion in and around ports.
- Enabling safe and optimal movement of freight vehicles

IMPROVED EFFICIENCY

- Improving throughput capability and productivity of container terminals.
- Alerting vehicles to changing conditions at the port, improving vehicle response.

EVALUATION OF THE CONCEPT

FHWA, in conjunction with the Intelligent Transportation Systems Joint Programs Office and the Maritime Administration, investigated the presented benefits of CDA.[1] The research focused on demonstrating the application of connectivity and automation for trucks transporting containers between a mock port area and a mock staging area (where containers can be temporarily stored before they are moved to warehouses) using a short-haul drayage scenario (figure 2). In this scenario, shipping containers were unloaded from and loaded onto a CDA-enabled truck. After loading, the truck stopped at an inspection point where, if the truck passed inspection, the truck would continue through the port gate before looping around to the original loading and unloading area.



Source: FHWA.

Figure 2. Images. Port drayage scenario.

RESULTS

The research team used the CARMA℠[2] ecosystem of tools, including CARMA Platform℠[3] and Vehicle-to-Everything Hub[4], to test the port drayage system. Independent evaluators from the U.S. Department of Transportation Volpe National Transportation Systems Center tested the port drayage system using the following criteria:

- The system could perform the port drayage operational tasks.
- The route execution, following, and communication performance was within expectations.
- The fail-safe operation of the system worked as expected.
- The system used was ready for operation.

While the system met the criteria, the project team provided suggestions for enhancement, which included:

- Improving object detection and tracking in the vehicle's path.
- Improving truck-stopping behavior and truck-motion control.
- Adding driver-vehicle notifications to inform the driver about system disengagement and reengagement.

CONCLUSIONS

Maritime supply professionals can apply CDA in the port drayage scenario to guide automated trucks through the drayage process from start to finish. CDA enables the automated trucks and the port infrastructure to successfully communicate with each other. Future research for this scenario includes:

- An enhanced demonstration using a miniature port at a one-tenth scale, to enable CDA to be developed at a lower cost and in a more accessible manner.
- An enhanced demonstration within the premises of a port to assess CDA in a real-world environment.

1 Leslie, E., O. A. Osman, S. Nallamothu, P. Bourelly, J. Smet, K. Garvis, H. Park, and K. Clausse. 2022. *Cooperative Driving Automation: Research into Automated Port Operations and Automated Commercial Motor Vehicle Operations- Final Report: Proof-of-Concept Port Drayage Use Case.* Report No. FHWA-JPO-22-933. Washington, DC: Federal Highway Administration.

2 USDOT. n.d. "CARMA" (web page). https://its.dot.gov/cda, last accessed November 22, 2023.

3 FHWA. n.d. "carma-platform" (software and configuration files in GitHub repository). https://github.com/usdot-fhwa-stol/carma-platform, last accessed April 12, 2023.

4 FHWA. 2023. "V2X-Hub" (software and configuration files in GitHub repository). https://github.com/usdot-fhwa-OPS/V2X-Hub, last accessed April 13, 2023.

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