ENABLING COOPERATIVE DRIVING AUTOMATION

Automated Vehicles Working Together

Automation is transforming mobility. Its integration across our transportation system has the power to enhance the mobility and independence of millions of Americans, especially older Americans and people with disabilities. Cooperative Driving Automation (CDA) supports and enables automated vehicles to cooperate through communication between vehicles, infrastructure devices capable of communication, and road users, such as pedestrians, bicyclists, and scooters. Moreover, once deployed, CDA has the potential to improve transportation efficiency, facilitate freight movement, increase productivity, and save billions in the reduced need to increase roadway facilities. Most importantly, CDA has the potential to reduce crashes caused by human error and save lives.

The U.S. Department of Transportation (USDOT) is committed to facilitating a new era of transportation innovation and safety. CARMA[SM] is part of that USDOT effort advancing research and development to accelerate market readiness and deployment of CDA. Through collaboration and open source software (OSS) development, CARMA[SM] enables researchers and engineers to develop and test their CDA features on properly equipped vehicles —setting the foundation for interoperability across vehicle make and model as well as the safe introduction of the technology on our nation's roads.

Innovation

The Federal Highway Administration (FHWA) developed the unique CARMA Platform[SM] and CARMA Cloud[SM] to support the research and development of CDA features in support of Transportation Systems Management and Operations (TSMO). The CARMA Platform[SM] enables cooperative research functionality to an Automated Driving System (ADS), and CARMA Cloud[SM] enables the roadway to provide information to support and enable safe operation for new TSMO strategies. This technology facilitates cooperation among vehicles and roadway infrastructure through communication. By providing information about what's ahead with CARMA Cloud[SM] (such as work zones, traffic incident, weather, etc.), the CARMA Platform[SM] enables automated vehicles to interact and cooperate with infrastructure and other vehicles, facilitating the safer and more efficient movement of goods and services.

Collaboration

CARMA[SM] was designed to encourage research collaboration among diverse stakeholders on CDA applications. The FHWA has established the CARMA[SM] Collaborative to form a research community of existing and prospective CARMA[SM] users invested in developing intelligent transportation solutions and CDA to improve transportation efficiency and safety. The CARMA[SM] Collaborative provides opportunities to cultivate relationships, share expertise, pilot transportation technologies, implement CDA, and strengthen the transportation industry for public benefit.

CARMA[SM] Collaborative: Stakeholders

The CARMA[SM] Collaborative focuses on bridging gaps among several stakeholder groups, with specific goals for each:

- **Academia:** Advance knowledge and research through a collaborative environment.
- **Government:** Cultivate investments toward public benefits with cooperation among stakeholders.
- **Technical Industry:** Understand cooperative automation to support future product development.
- **Consultant and Association:** Educate participants to advance the deployment of cooperative automation and connected and automated vehicles.

Open Source Mobility

The latest version of CARMA Platform℠ is now live on GitHub and open for collaboration. Created on a robot operating system (ROS), the CARMA Platform℠ is designed for research and development using OSS to enable collaborative testing and evaluation of CDA features (e.g. plug-ins). This unique platform was designed to be vehicle and technology agnostic. It is built on a flexible framework for easier sharing and integration into several vehicle models, including passenger cars and heavy trucks. CARMA℠ is installed on the FHWA fleet of research vehicles, and they currently interface with three different industry developed vehicle controllers, which are DataSpeed, PACmod and NewEagle.

The CARMA Platform℠ has been architected to be extensible and reusable for a wide variety of research purposes on many types of vehicles. Architecture features include:

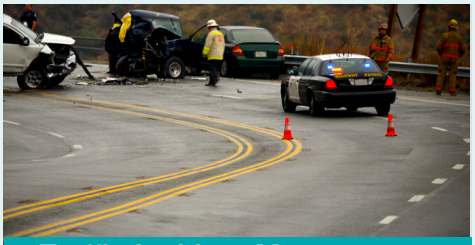
- **Built on Top of ROS:** Encourages modular design so that components can be easily swapped out to experiment with different combinations.
- **Motion Planning Plug-in Application Programming Interface (API):** Allows users to install plug-ins (e.g. software applications) for either strategic planning or tactical planning of vehicle behaviors and trajectories to exercise particular algorithms and cooperative interaction.
- **Controller Plug-in API:** Allows users to install new plug-ins for low-level motion planning algorithms.
- **Hardware Driver API:** Allows the platform to be installed on any properly equipped vehicle as long as drivers are installed that connect to the various vehicle sensors and controller equipment.
- **Vehicle-to-Everything (V2X) Communications Messaging:** Has built-in capability to compose/transmit and receive/parse V2X messages in SAE J2735 format, and can work with any radio device.

The CARMA Cloud℠ research capability will be released in fall 2019 and will enable services that provide information to support and enable CDA for implementing the new TSMO use cases.

CARMA℠ is a multimodal effort among the FHWA, Federal Motor Carrier Safety Administration, Intelligent Transportation Systems Joint Program Office, and Volpe National Transportation Systems Center. Together, the agencies are working to facilitate collaboration, research, and testing in cooperative automation as well as advance the future of our nation's transportation system.

COOPERATIVE DRIVING AUTOMATION TSMO USE CASES

Basic Travel



Traffic Incident Management

Weather

Work Zone

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To learn more about CARMA℠, visit: highways.dot.gov/research/research-programs/operations/CARMA
To access the CARMA℠ GitHub page, visit: github.com/usdot-fhwa-stol

CARMA℠

Turner-Fairbank Highway Research Center

U.S. Department of Transportation