## COLLABORATIVE

The **CARMA COLLABORATIVE** is growing a community of CARMA users, prospective users, and other stakeholders working to advance CDA through shared expertise and collaboration. The CARMA Collaborative conducts outreach activities to enhance stakeholder awareness and participation, and facilities strategic partnerships to promote the use of CARMA in CDA research. These outreach activities include: virtual and in-person events, webinars, conferences, meetings, and communications materials (e.g., social media, multimedia, publications). Through these efforts, the CARMA collaborative aims to develop a community of organizations focused on CDA that are using CARMA.

CARMA℠

## ENGAGEMENT

The CARMA ecosystem engages various stakeholder groups to accelerate advancements and encourage collaboration in CDA research, development, and testing.

## SUPPORT

**CARMA SUPPORT SERVICES** provide stakeholders with knowledge and technical support on the CARMA product/tool suite to accelerate CDA research. Staff from the Saxton Transportation Operations Laboratory provide the tools and expertise to CARMA implementers. Support services hopes to accelerate CARMA innovation by providing excellent customer service to users.

**For more information, visit https://highways.dot.gov/research/operations/CARMA or contact the CDA Program at CARMA@dot.gov**

U.S. Department of Transportation
**Federal Highway Administration**

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U.S. Department of Transportation
**Federal Highway Administration**

**Office of Safety and Operations Research and Development**


Source: FHWA.

# Federal Highway Administration's Cooperative Driving Automation Program

*Automated Vehicles Working Together*

Automation is the future of transportation. Research on autonomous driving technology and vehicles is taking place throughout America, and the technology is primed to transform existing and future transportation systems. As the technology for autonomous vehicles continues to develop and eventually becomes ready for real-world testing, cooperative automation can improve the efficiency and safety of these vehicles within the transportation system.

Cooperative driving automation (CDA) supports and enables communication between vehicles with driving automation features, other road users, and transportation infrastructure. Once deployed, CDA has the potential to improve transportation efficiency, facilitate freight movement, increase productivity, and save billions by reducing the need to increase roadway facilities. Most importantly, CDA has the potential to reduce crashes caused by human error and save lives.

## FHWA CDA PROGRAM

The Federal Highway Administration's (FHWA's) CDA program is shaping the future of transportation systems management and operations (TSMO) by strengthening infrastructure and developing platforms for collaborative research and development (R&D) of CDA to advance the safety, efficiency, and sustainability of the entire transportation system. The program fosters the development of the digital infrastructure necessary to support CDA as autonomous vehicles continue to develop and eventually enter the Nation's roadways.

## CARMA[SM] Ecosystem

To advance CDA R&D, the U.S. Department of Transportation developed CARMA, a technology-enabling initiative under the FHWA CDA program. CARMA focuses on improving the transportation system by leveraging emerging automated driving technology and vehicle-to-everything (V2X) technology to enable increased safety, operational efficiency, and sustainability in moving people and goods.

Through collaboration and open-source software (OSS) development, CARMA enables researchers and engineers to research, develop, test, and evaluate CDA features on infrastructure and vehicles equipped with driving automation features. This research will establish the foundation for the adoption of CDA across transportation infrastructure and vehicle make and model.

Under the CARMA ecosystem is a network of products, research tracks, evaluation tools, and engagement strategies that all use CDA to improve transportation safety and performance.

**The CARMA ecosystem has proven to be an innovative set of OSS tools with strong stakeholder support. The ecosystem is poised to move into a new phase of R&D focused on benefit analysis and application testing, building toward large-scale test track and/or on-road pilot testing.**

### CDA RESEARCH TRACKS

The CARMA research tracks leverage strategic partnerships with relevant Federal agencies to accelerate CDA R&D efforts and explore CDA applications to transportation operations scenarios.

#### FREIGHT

**CDA FREIGHT RESEARCH TRACK** Is a joint effort between FHWA, the Federal Motor Carrier Safety Administration (FMCSA), the U.S. Maritime Administration, and the Intelligent Transportation Systems Joint Program Office (ITS/JPO). The effort explores the application of CDA to commercial vehicles, such as buses and trucks, and port operations, with the ultimate goal of accelerating the adoption of CDA technologies in freight vehicles and demonstrating the potential of automated truck movement in ports and warehouses.

#### TRAFFIC

**CDA TRAFFIC RESEARCH TRACK** aims to demonstrate how the introduction of CDA can improve road safety and traffic conditions in partnership with ITS/JPO, the Federal Transit Administration, and FMCSA. The basic travel use case developed on the CARMA Platform tests TSMO strategies to enhance infrastructure and reduce recurring traffic congestion.

#### RELIABILITY

**CDA RELIABILITY RESEARCH TRACK** examines CDA applications to one-time traffic congestion (i.e., hazardous weather, traffic incidents, and work zones) in partnership with ITS/JPO and FMCSA. This track focuses on scenarios for road and weather management, traffic incident management, and work zones. In these scenarios, the vehicle will detect the cause of traffic congestion and adjust its speed and route accordingly, which ultimately will reduce traffic congestion.



Federal Highway Administration's Cooperative Driving Automation Program

### CARMA PRODUCTS

The CARMA product suite consists of four OSS tools that provide the necessary software for conducting CDA research and testing.

#### CLOUD

**CARMA CLOUD[SM]** is a set of cloud-based, OSS services enabling communication and cooperation between cloud services, vehicles, infrastructure, and road users. It will allow the application of TSMO CDA strategies through rules for road users to help manage the flow of traffic.

#### PLATFORM

**CARMA PLATFORM[SM]** is a vehicle-based platform that uses the information from CARMA Cloud to enable automated vehicles to interact and cooperate with road elements, including vehicles, infrastructure, and other vulnerable road users with mobile devices.

#### STREETS

**CARMA STREETS** is an infrastructure-based application for automated vehicles to share information and planned trajectories with one another and infrastructure to enable cooperative actions that improve transportation operations and safety.

#### MESSENGER

**CARMA MESSENGER** is a vehicle-based application for manual, or nonautomated vehicles and it enables communication with other participants to engage in CDA. This new capability will support research with first responders and encourage transit participation in CDA.

### CARMA EVALUATION

enables the assessment of CDA features through simulation environments, 1Tenth vehicles for scaled-down testing, general vehicle testing, and analytics.

#### SIMULATION

**CARMA SIMULATION** focuses on everything-in-the-loop (XiL) capabilities to support CDA in a virtual simulation environment. CARMA XiL will work with CARMA Cloud to design and build tools effectively to advance understanding of CDA's impact on the transportation system.

#### 1 TENTH

**CARMA 1TENTH** is a scaled-down, CARMA platform-equipped vehicle that enables CDA research and testing of CARMA capabilities that are practical, low-cost, efficient, and safe.

#### TESTING

**CARMA TESTING** is conducted at various test sites throughout the United States and aims to educate stakeholders on CARMA, enables users to test their CARMA capabilities, and builds awareness of the benefits of CDA applications to transportation.

#### ANALYTICS

**CARMA ANALYTICS** helps with the transfer, storage and fusion, and analytics of cooperative automated vehicles and traditional transportation data.