Saxton Transportation Operations Laboratory Cooperative Driving Automation (CDA) Tools to Improve Road User Safety

Road users encompass anyone utilizing and traveling roads, including pedestrians, bicyclists, and vehicle operators, among others. The tools provided by the U.S. Department of Transportation enable road users to navigate and interact with roads more safely and efficiently. The suite of tools includes CARMA Platform[SM,1] CARMA Messenger[SM,2] and CARMA[SM], 1Tenth,[3] which aid in conducting research and testing of CDA technology.[4] Two of the tools within the suite, CARMA Platform and CARMA 1Tenth, are open-source software platforms, enabling public access that allows for software customization to meet users' requirements.

CARMA Platform[1] software is designed to facilitate the development and testing of CDA features in vehicles equipped with automated driving systems (ADS). This software allows automated vehicles to interact seamlessly with other vehicles, infrastructure, and other road users. The primary objective of CARMA Platform is to establish a foundation for interoperable connectivity across different vehicle makes and models, laying the groundwork for safe introduction of these tools on our Nation's roads. This software also provides tools for cooperative research functionalities of ADS.

Key benefits include:

- Facilitating the continuous advancement of CDA technology, leading to safety and efficiency improvements in vehicle automation.
- Increasing accessibility for a broader range of users, allowing a diverse community of experts to contribute to its ongoing development.
- Reducing the costs associated with conducting research and development.

CARMA Messenger[2] software is designed for nonautomated vehicles and facilitates communication with other transportation system users to enable them to engage in CDA interactions. This software leverages infrastructure to share data with other users, broadening access to the usage and benefits of the technology. CARMA Messenger supports research involving first responders and encourages transit participation in CDA.

Key benefits include:

- Supporting research that involves first responders, which contributes to increased safety from alert messages and data.
- Increasing communication between other vehicles, other road users, and infrastructure.
- Encouraging public transit involvement in CDA, potentially resulting in more efficient public transportation systems and reducing travel times.
- Enabling a broad range of vehicles, including nonautomated vehicles, to actively participate in the CDA network.

Figure 1 shows how vehicles communicate with CARMA products.[5]
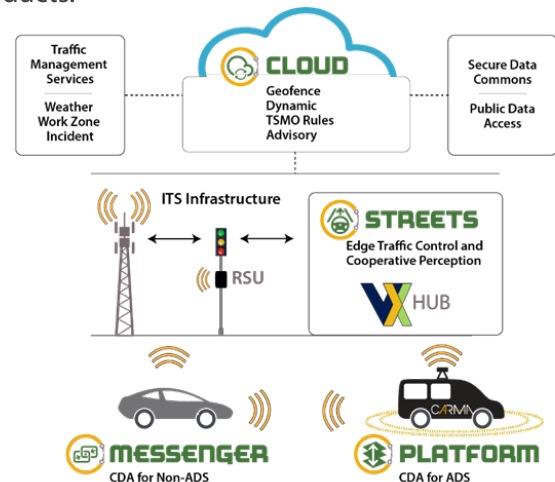
Source: Federal Highway Administration (FHWA).[6]
TSMO = transportation system management and operations; RSU = roadside unit; ITS = intelligent transportation systems.

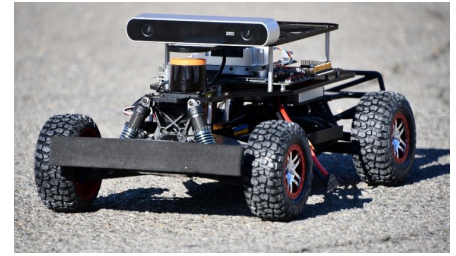**Figure 1. Illustration. CARMA products.**[1,2,7,8,9]

The CARMA 1Tenth[3] research initiative integrates the CARMA Platform[1] onto smaller, simplified versions of full-scale vehicles known as 1Tenth vehicles (figure 2). These vehicles use a modified version of CARMA Platform, enabling researchers to conduct CDA research with a larger number of vehicles than full-scale connected ADS allow. This feature maintains the hands-on and demo-friendly nature of nonsimulated vehicles.

Source: FHWA.
Figure 2. Photo. CARMA 1Tenth.[3]

Key benefits include:

- Providing a safer environment for the initial development and testing by offering more control over the experimental conditions.
- Improving testing processes by allowing researchers to experiment on smaller vehicles without compromising CDA functionality, ensuring features work correctly before implementation in full-scale vehicles.
- Reducing reliance on test tracks, which can lower costs and allow for more extensive and varied testing scenarios.
- Accelerating research by engaging a larger community.
- Facilitating the testing of scenarios with large vehicle fleets, enabling the study of large-fleet CDA testing and performance.
- Creating a more equitable and affordable platform for researchers who do not have access to full-size, CDA-enabled vehicles.

GETTING STARTED

These previously mentioned tools can be accessed on GitHub,[1,2,3] allowing for collaboration and contribution among researchers. This collaboration will lead to a better understanding of CDA technologies, which helps accelerate market readiness of CDA.

GitHub provides a platform for users to collaborate, gain experience with CDA, and customize the software for their specific needs.

For technical support, please contact the CARMA Support Services Help Desk at CARMASupport@dot.gov. Each GitHub page also contains a section of frequently asked questions with solutions to common issues.

References

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

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For more information, please contact the CDA Program at CDA@dot.gov