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Real-Time Data Analysis and Trust Building with the Connected and Automated Vehicle (CAV) Telematics Tool

FACT SHEET

Across the United States, State and local Departments of Transportation, along with other infrastructure owners and operators (IOOs), are responsible for supporting the development, performance, and operation of CAV systems. These systems contain complex interactions between subcomponents, such as sensors and cameras, which are critical for enabling road safety and mobility applications.

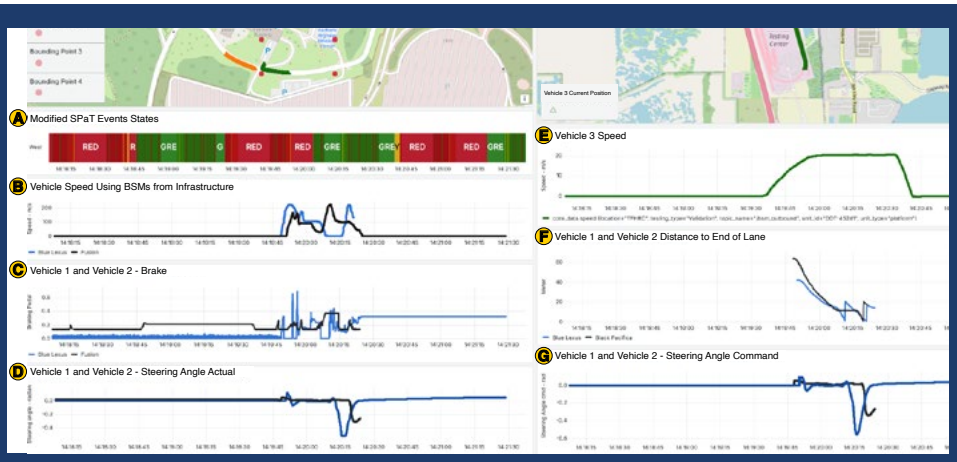
Developing, testing, and deploying CAV use cases and scenarios requires monitoring systems and rapidly analyzing the data these systems generate. To address this challenge, the U.S. Department of Transportation (USDOT) created the CAV Telematics Tool, an open-source data collection system.[1] This tool facilitates the analysis of CAVs, allowing engineers and analysts to track and evaluate information in near realtime, ensuring systems function as intended. Additionally, the tool addresses concerns raised by stakeholders about the trustworthiness of information exchanges between vehicles and infrastructure in vehicle-to-everything (V2X) deployments. Finally, the CAV Telematics Tool enables real-time data monitoring and analysis, helping to build trust among IOOs, original equipment manufacturers, and other stakeholders and ensuring the accuracy and efficiency of shared data.

KEY BENEFITS

- **Real-time alerts and monitoring:** Enhances transportation system safety by providing real-time alerts and monitoring.
- **Improved decisionmaking:** Optimizes traffic flow and reduces congestion by supporting better decisions.
- **Increased efficiency:** Offers timely updates on traffic conditions and road data, helping users make informed decisions.
- **Flexible deployment options:** Can be deployed in the cloud for scalability or locally for low-cost implementation and testing.

HOW IT WORKS

The CAV Telematics Tool can be installed to visualize data on any vehicle or infrastructure element (such as traffic signals) and in work zones, with latency typically between 300 and 400 ms.[2] The tool tracks a variety of data, including current speed; acceleration; distance from the end of the lane (the distance a vehicle can travel before needing to change lanes, turn, or stop); vehicle lane status (providing upcoming lane change alerts); basic safety messages (BSMs); and traffic signal phases.[3]



Source: Federal Highway Administration (FHWA).[1]

Figure 1. Image. CAV Telematics Tool dashboard.

Additionally, the tool visualizes various automated driving system data, such as drive-by-wire input and output, detected object classification, localization status, and system alerts from both physical and simulated vehicles. Users can also analyze past events by visualizing data from previously recorded Robotic Operating System (ROS) message data files.[4]

The tool's user-friendly dashboard provides a visual representation of CAV system data, enabling users to monitor, plot, and analyze system behavior and facilitating monitoring and analysis of system performance (figure 1). Within the dashboard are two maps. One map charts the progress of two test vehicles moving through an intersection marked by geofence boundaries at the FHWA Turner-Fairbank Highway Research Center. The second map shows a vehicle's path on a different test track. Additionally, the dashboard has seven graphs that present key data: signal phase and timing (SPaT) information (graph A), vehicle speed (graphs B and E), speed reductions from braking (graph C), remaining distance to the end of the lane or intersection (graph F), and vehicle steering angle (graphs D and G).

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INTEGRATIONS

The CAV Telematics Tool integrates with automated driving systems and intelligent transportation systems (ITS). The tool provides vehicle telemetry information, such as roadside unit status, pedestrian detection information in physical and simulated infrastructure, and message information exchanged between connected vehicles and infrastructure. This integration allows the tool to work with any application that uses any of the following methods to broadcast or store the data:

- ROS2.[4]
- Apache Kafka.[5]
- Text logs.
- ITS infrastructure data from sources that include infrastructure sensors and devices that include loop detectors, traffic signal controllers, and radios.

Additionally, the tool is integrated with CARMA Cloud℠, a cloud-based service that helps various components of the transportation system work together.[6] This integration allows the tool to visualize work zone information, enabling transportation entities to monitor and address work zone issues.[7] The tool supports the CAV education (CAVe)-in-a-box tool, used for testing connected vehicle equipment and training new ITS technicians.[8]

For simulation testing, the tool integrates with CDASim, which provides anything-in-the-loop capabilities for evaluating CDA algorithms and applications.

THE TOOL IN USE

The CAV Telematics Tool played a pivotal role in the success of the Advanced Traffic Signal Control Optimization in a CDA Environment project.[1,9] This project aimed to reduce traffic delays by developing an algorithm to optimize both signal phases and vehicle trajectories for three CAVs approaching an intersection at different speeds. Researchers used the tool to monitor each vehicle's speed, acceleration, and distance from the intersection with the timing of optimized signal plans in realtime. This capability streamlined the testing process by reducing the need for multiple test runs, enhancing efficiency, and ensuring the algorithm's accuracy.

RESOURCES AND SUPPORT

- To use the CAV Telematics Tool, download and set up an instance via the source code available on GitHub. https://github.com/usdot-fhwa-stol/cda-telematics.[1]
- For technical assistance with the CAV Telematics Tool or to learn more please email cavsupportservices@dot.gov.
- To learn more about CAVe-in-a-box, please refer to FHWA's factsheet, available at https://doi.org/10.21949/1521460.[10]
- To learn more about CDASim, please refer to FHWA's factsheet, available at https://doi.org/10.21949/1521459.[11]

REFERENCES

1. FHWA. n.d. "cda-telematics" (software and configuration files in GitHub repository). https://github.com/usdot-fhwa-stol/cda-telematics, last accessed May 29, 2024.
2. FHWA. 2023. CAV Telematics Tool Overview (video). https://www.youtube.com/watch?v=kZi15fF5TnA, last accessed May 29, 2024.
3. SAE International®. 2020. V2X Communications Message Set Dictionary, J2735_202007™, revised July 23, 2020. Warrendale, PA: SAE International. https://www.sae.org/standards/content/j2735_202007/, last accessed May 30, 2024.
4. Open Robotics. 2021. "ROS—Robot Operating System" (web site). https://www.ros.org/, last accessed May 29, 2024.
5. Apache Software Foundation. n.d. Apache Kafka (software). Version 2.2.3.
6. FHWA. 2023. CARMA Cloud (software). Version 4.3.0.
7. FHWA. 2024. An Open-Source Tool for Interoperable Connectivity. Publication No. FHWA-HRT-24-121. Washington, DC: Federal Highway Administration. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-24-121.pdf, last accessed September 24, 2024.
8. USDOT. n.d. "Connected and Automated Vehicle Education" (web page). https://www.its.dot.gov/pcb/CAVEducation.aspx, last accessed May 30, 2024.
9. FHWA. 2024. Advanced Traffic Signal Control Optimization in a Cooperative Driving Automation (CDA) Environment. Publication No. FHWA-HRT-24-151. Washington, DC: Federal Highway Administration. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-24-151.pdf, last accessed October 28, 2024.
10. FHWA. 2023. Saxton Transportation Operations Laboratory Research Tools To Enhance Connected Automated Vehicle (CAV) Capabilities. Publication No. FHWA-HRT-24-035. Washington, DC: Federal Highway Administration. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-24-035.pdf, last accessed September 24, 2024.
11. FHWA. 2023. Saxton Transportation Operations Laboratory Simulation Tools To Advance Cooperative Driving Automation (CDA) Research. Publication No. FHWA-HRT-24-034. Washington, DC: Federal Highway Administration. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-24-034_0.pdf, last accessed September 24, 2024.

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