All photos source: FHWA.

OFFICE OF RESEARCH, DEVELOPMENT, AND TECHNOLOGY

Maryland CAV Working Group

VOICES Overview

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U.S. Department of Transportation
Federal Highway Administration

Voices Virtual Open Innovation Collaborative Environment for Safety

TURNER-FAIRBANK Highway Research Center

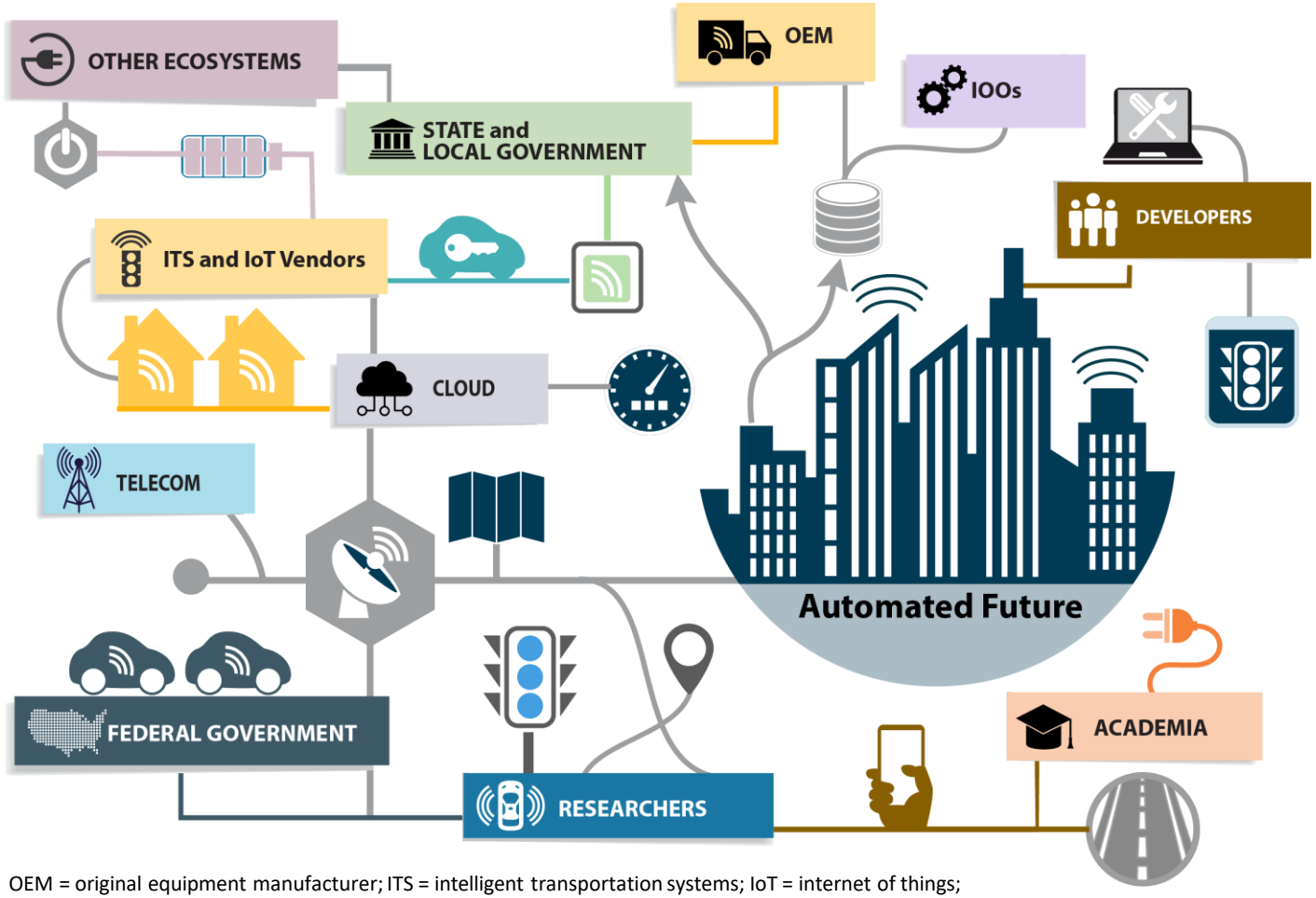
THE TRANSPORTATION SYSTEM OF THE FUTURE

An integrated, ubiquitously connected, and intelligent system of systems.

Source: USDOT.

THE CHALLENGE OF COLLABORATION

- Lack of a simple, effective, and efficient mechanism to perform collaborative research and testing.
- Multiplicity of stakeholders.
- Natural silos.
- Trust deficit.
- Intellectual property and competitive pressures.
- Cost and resource barriers.
- Lack of interoperable test tools and environment.

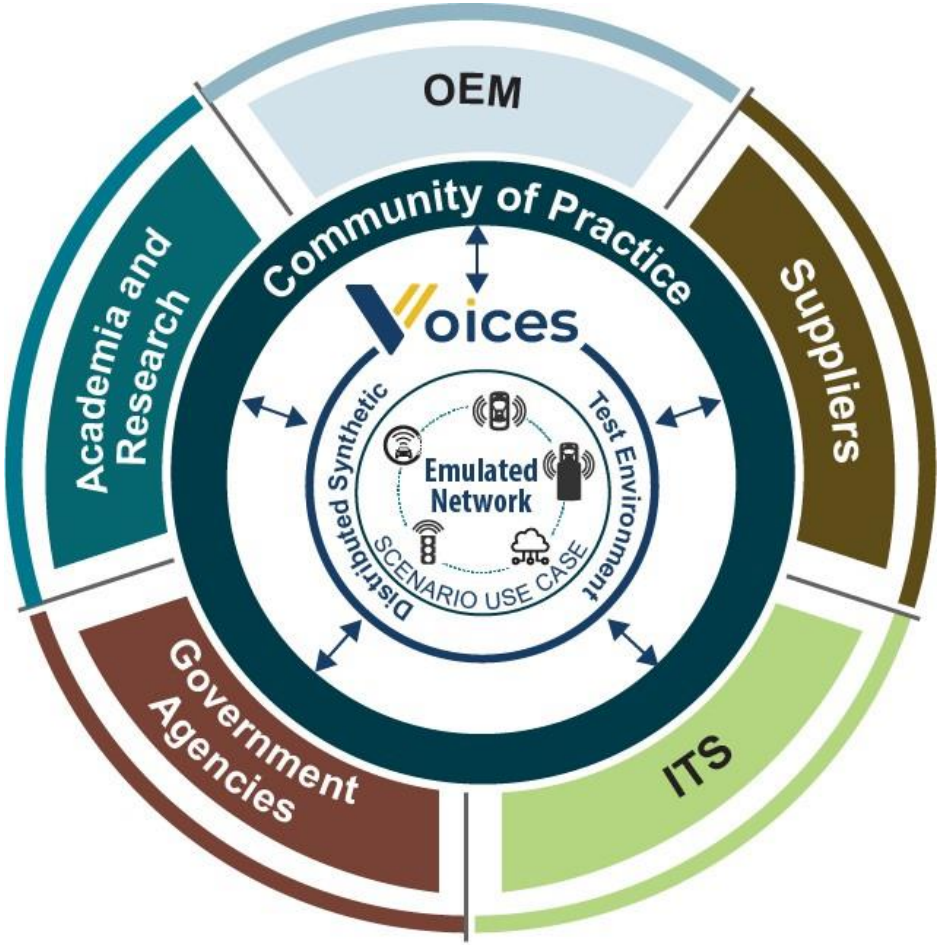


OEM = original equipment manufacturer; ITS = intelligent transportation systems; IoT = internet of things; IOO = infrastructure owner operator.

Source: USDOT.

WHAT VOICES IS

- Distributed virtual platform that enables stakeholder virtual collaboration for research and interoperability testing of cooperative driving automation (CDA) applications.
- Intellectual property-protected environment.
- Collaboration tool for participating entities.
  - Public sector.
  - Private sector.
  - Academic institutions.



Source: USDOT.*

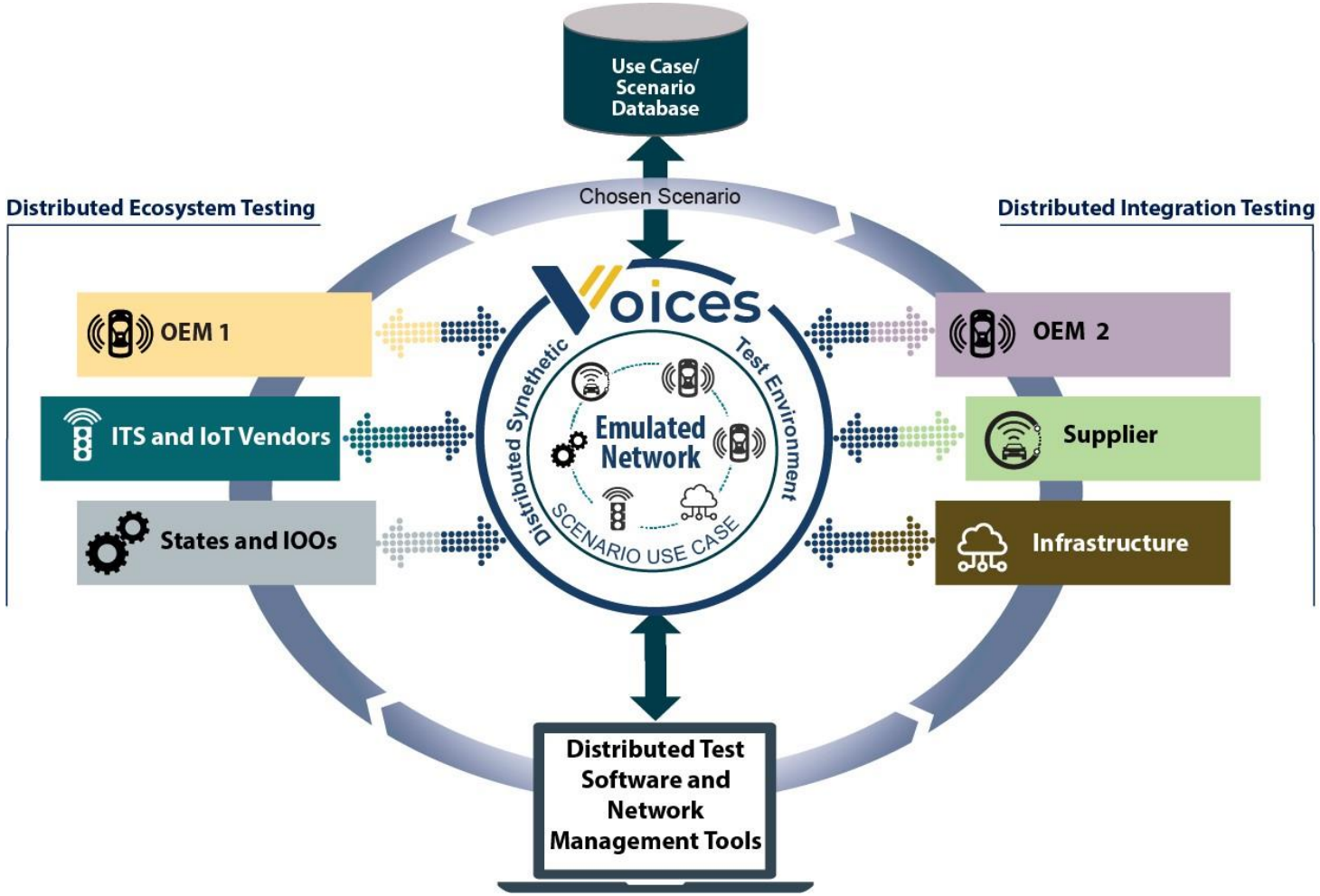
ITS = intelligent transportation systems, OEM = original equipment manufacturer

*VOICES. 2021. "Voices Overview" (webpage). https://usdot-voices.atlassian.net/wiki/spaces/VP/overview, last accessed October 6, 2021.

HOW VOICES WORKS

Safe

Secure



Efficient

Realistic

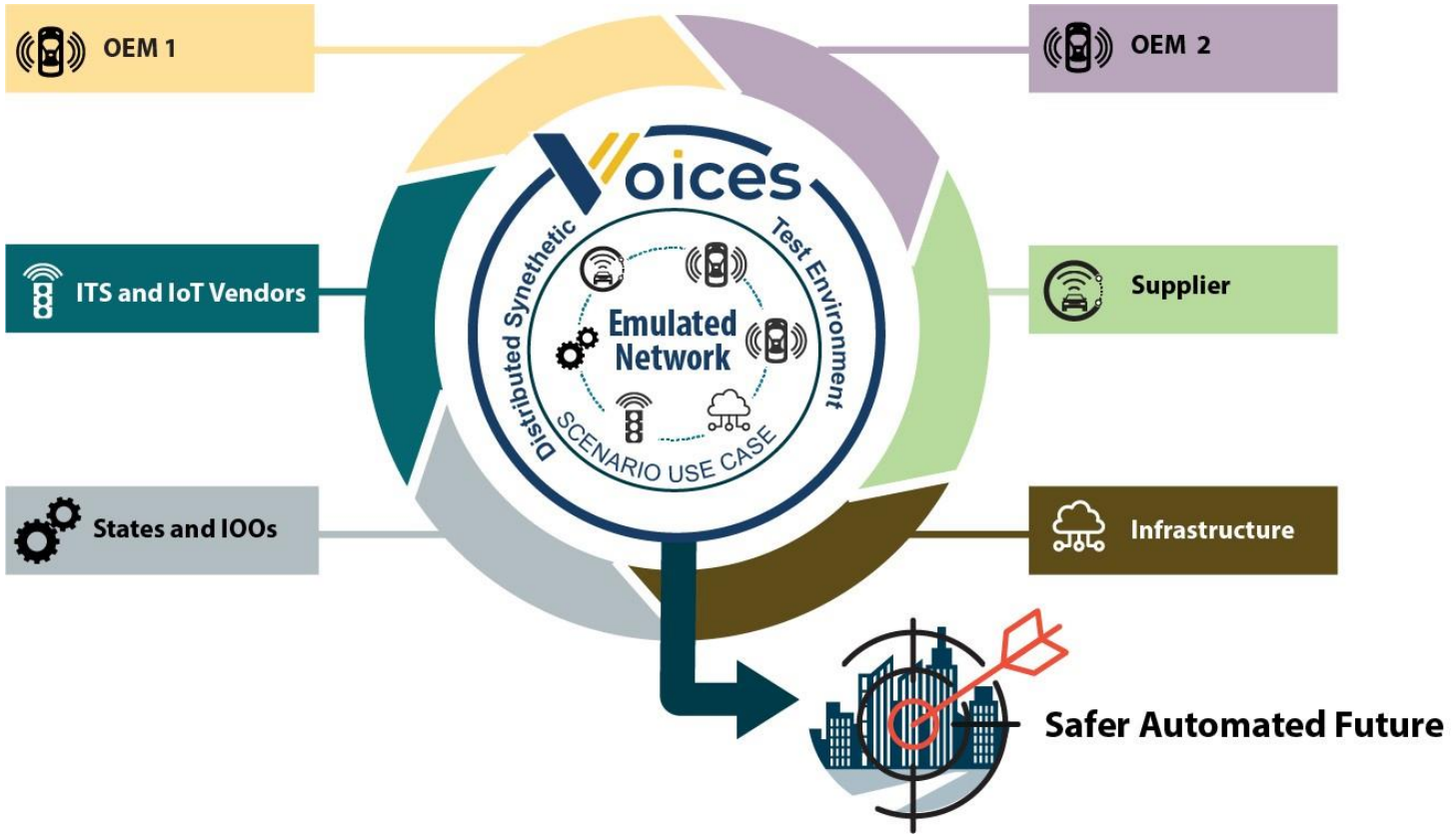
Source: USDOT.

VALUE AND IMPACT

The United States Department of Transportation (USDOT) leadership is advancing progress toward its vision of an integrated, seamless, efficient, clean, and equitable transportation system of the future.

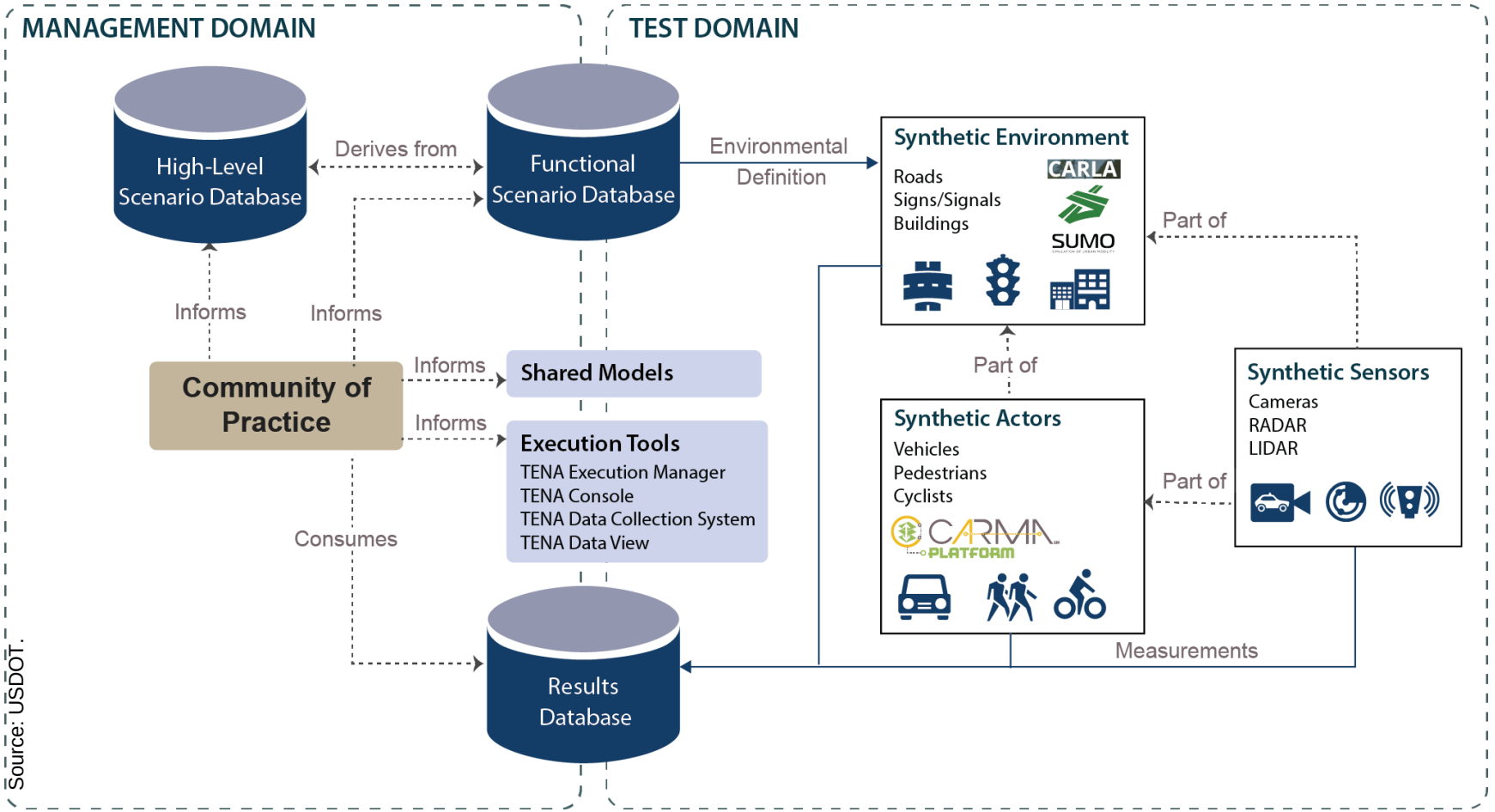
VOICES is:

- A pathway to prepare for the transportation system of the future.
- An opportunity to advance equity, innovation, climate, and safety priorities.
- A way to harness convening power of government to enable collaboration.
- A platform to test for today and explore for tomorrow.



Source: USDOT.

HIGH-LEVEL ARCHITECTURE



TENA = test and training enabling architecture; CARLA = cars learning to act; SUMO = simulation of urban mobility;
CARMA = cooperative automation research mobility applications; RADAR = radio detection and ranging;
LIDAR = light detection and ranging.

Figure created using Microsoft Visio. CARMA℠ is a registered trademark of the Federal Highway Administration. SUMO is an open-source traffic simulation package developed by German Aerospace Center (DLR) and licensed under EPL 2.0. SUMO logo used with permission from DLR. CARLA® logo used with permissions from the Computer Vision Center (CVC). CARLA is an open-source simulator developed by CVC and trademarked by the CARLA Team 2021.

SAMPLE USE CASE: PLATOONING

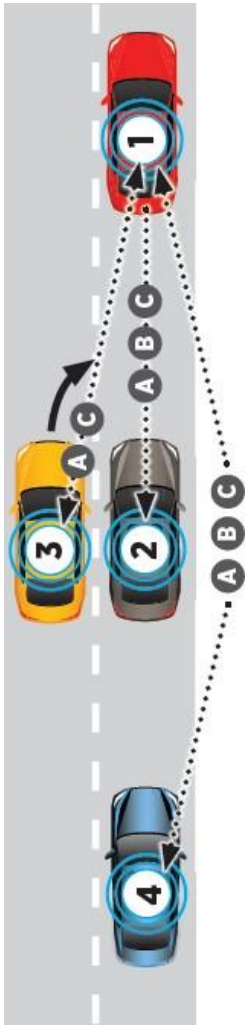
FEATURE	CLASS OF CDA	CDA DEVICE TRANSMISSION MODE AND DIRECTIONALITY	INFORMATION EXCHANGED	LEVEL OF FUNCTIONALITY
Platooning Awareness and CACC* vehicle control**	SAE CLASS A STATUS SHARING	Two-way: CDA Vehicle 1 <--> CDA Vehicle 2, 4 CDA Vehicles 1 --> CDA Vehicle 3	Platooning/CACC activation status; speed, trajectory, and location of vehicles in platoon	**Supporting:** Follower vehicles in platoon can follow more closely and stably than they could otherwise
				Supporting: CDA Vehicle 3 has additional awareness that CDA Vehicle 1 is platooning with other vehicles
Advance notice of braking maneuver	SAE CLASS B INTENT SHARING	One-way: C-ADS 1 --> C-ADS 2, 4	Planned speed reduction	**Supporting:** C-ADS 1 detects forward hazard that may require deceleration of platoon, enabling smoother deceleration of all vehicles
Platoon Joining	SAE CLASS C AGREEMENT SEEKING	One-/Two-way: C-ADS 1 --> C-ADS 2,4 C-ADS 3 <--> C-ADS 1	Seeking to join platoon; allow to join platoon in the middle; inform other platooners	**Enabling:** C-ADS 3 can join the platoon in the middle (otherwise it would have had to join at the end)

*CACC: Cooperative Adaptive Cruise Control.

**Note example A has been defined using CDA vehicles (i.e., SAE Levels 1 to 5 automation), and the B and C examples have been defined for C-ADS (i.e., SAE Levels 3 to 5 automation).

NOTE: In practice, one-way transmission will typically send the message to multiple CDA devices in the vicinity.

C-ADS = cooperative–automated driving system.



SAE International. 2020. *Taxonomy and Definitions for Terms Related to Cooperative Driving Automation for On-Road Motor Vehicles.* J3216_202005, United States. https://www.sae.org/standards/content/j3216_202005/, last accessed August 31, 2021.

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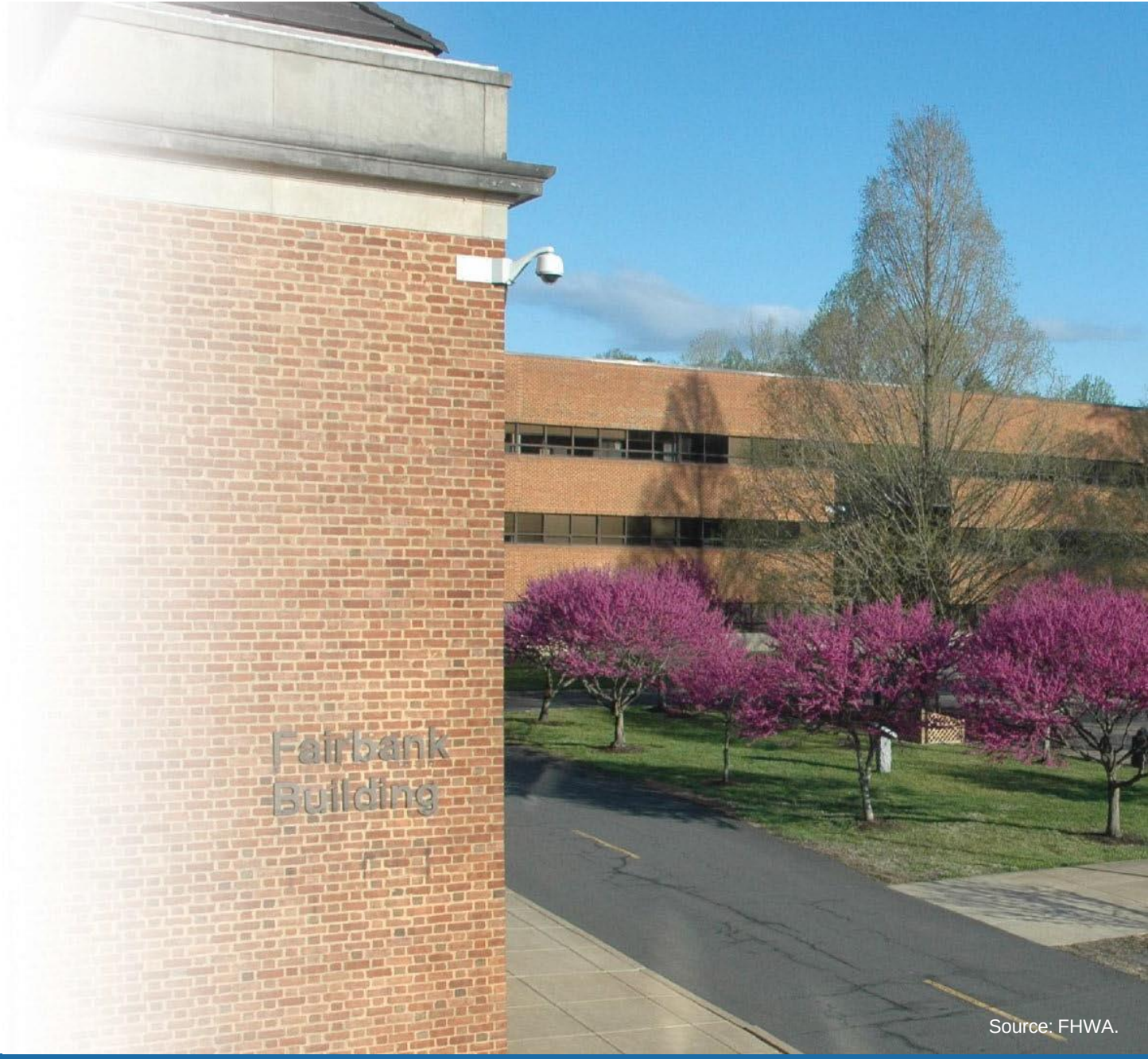

Source: FHWA.