VIRGINIA DEPARTMENT OF TRANSPORTATION

Connected and Automated Vehicles Program Update

April 13, 2022

Amanda Hamm,
CAV Program Manager, Office of Strategic Innovations

VDOT

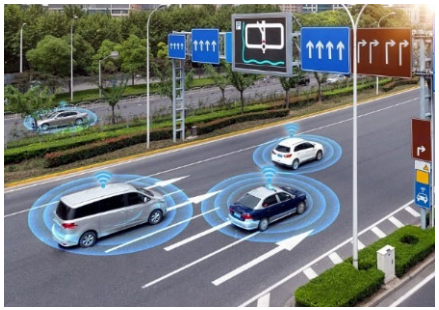
CAVs defined

Automated vehicle (AV) – a vehicle that is capable of conducting some or all of the driving task without needing a human driver.

Technology – sensors, onboard computer

Connected vehicle (CV) – a vehicle that is capable of sharing data to and receiving data from an external source, such as other vehicles, infrastructure, or smart devices.

Technology – onboard units, external devices



Connected and automated vehicle (CAV) – a vehicle that shares and receives data from external sources and is capable of conducting some or all of the driving task.

Technology – all of the above

CAVs on the road today

Vehicles

Tesla AutoPilot/ Full Self-Driving Beta (AV)

Audi Traffic Light Information System (CV)

Sample Features

Adaptive Cruise Control

Adaptive Headlights

Anti-Lock Braking System

Automatic Emergency Braking

Automatic Parallel Parking

Automatic Reverse Braking

Recent CAV news

TuSimple, an autonomous driving technology company, announced it completed 'the world's first fully autonomous semi-truck run on open public roads without a human in the vehicle and without human intervention;' a driverless tractor–trailer completed a nighttime 80-mile trip from a Tucson, Ariz., rail yard to a Phoenix metro area distribution center.

GM's Cruise subsidiary has petitioned NHTSA for permission to put the driverless Cruise Origin into commercial service. Cruise announced the filing of its petition for approval on Friday, saying the car is "a zero-emission, shared, electric vehicle that has been purposefully designed from the ground up to operate without a human driver.

NHTSA, the National Highway Transportation Safety Administration, recently released their final rule for "Occupant Safety in ADS," which changes the crash worthiness Federal Motor Vehicle Safety Standards to account for vehicles with standard seating design, but without manual controls.

Nuro, the autonomous delivery company, announced its third-generation autonomous vehicle with a host of new improvements, including a bizarre-looking external airbag for pedestrians.

VDOT's role in CAVs

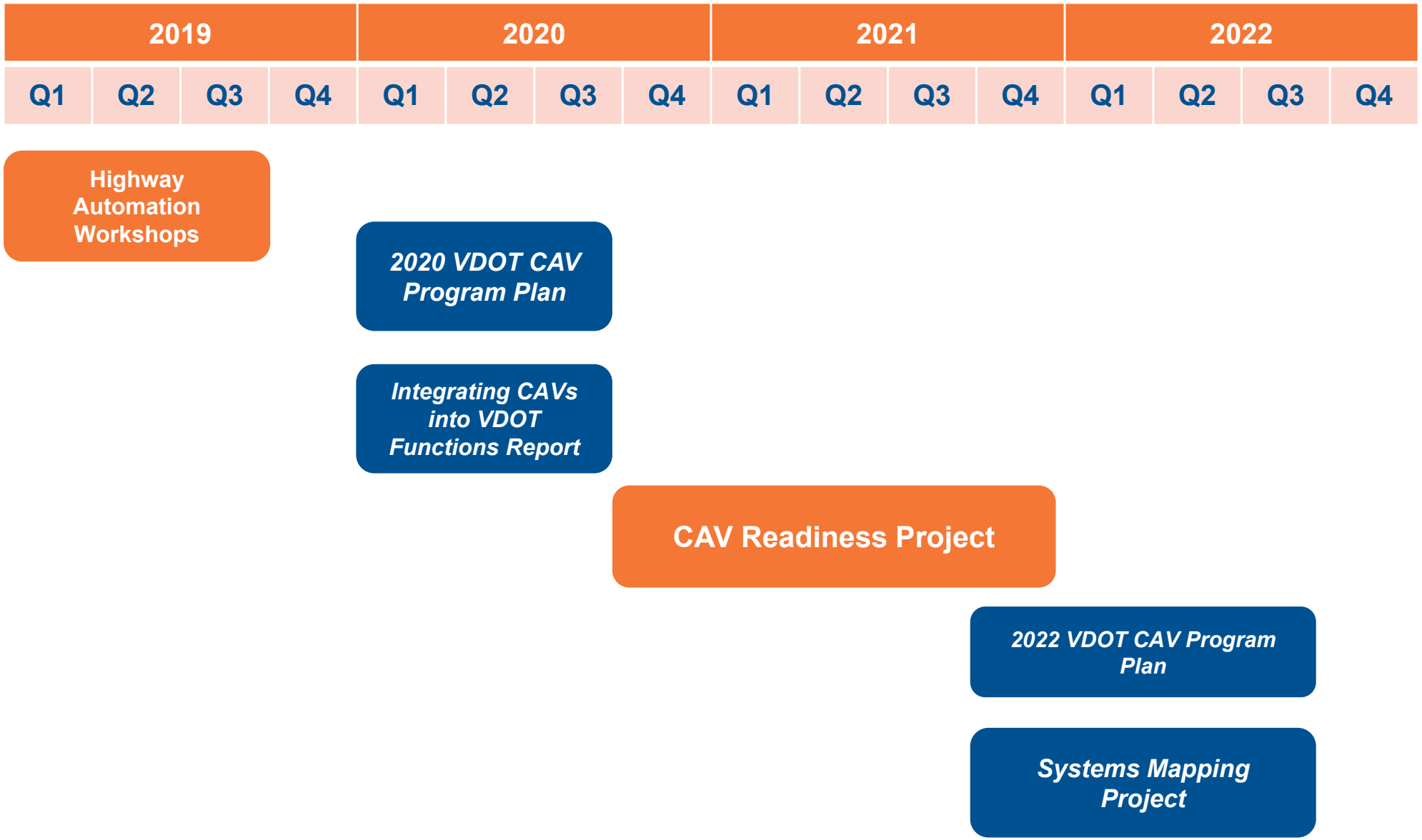
- VDOT is responsible for ensuring the safe, accessible, and efficient movement of people, goods, and services across the Commonwealth.

- CAVs are on our roadways today, and more will be on our roadways tomorrow.

- CAVs could beneficially or adversely impact safe, accessible, and efficient travel in the Commonwealth:
    a. **Possible Beneficial Impact:** A CAV could receive information of a crash five miles ahead and then re-route to avoid it.
    b. **Possible Adverse Impact:** An empty CAV could circle downtown all day while waiting for a pick-up request.

The CAV Program assists VDOT in preparing for and taking advantage of the deployment of CAVs.

VDOT CAV Program Background



CAV Readiness Project Overview

Task 1 – Literature Review, CAV Readiness Assessment

- Reviewed what other CAV stakeholders were doing to prepare for the rollout of CAVs
- Developed the CAV readiness assessment framework
- **Outcome:** An understanding of the state of readiness

Task 2 – Use Case Identification and Review, Investment Roadmap

- Reviewed which CAV Use Cases were available and made sense for VDOT to explore further
- Developed a roadmap of investments
- **Outcome:** An understanding of milestones and success gates

Task 3 – Education Strategy

- Produced an education strategy to ensure that VDOT's workforce is ready for CAVs
- **Outcome:** An increased workforce awareness and professional capacity

Task 4 – Business Strategy

- Developed a business strategy to mainstream CAVs into day-to-day activities of VDOT personnel
- **Outcome:** An understanding of how to test, prepare, and integrate CAV-related technologies

CAV Readiness Assessment: Readiness Factors and Readiness Levels

The project team identified a total of **495 discrete readiness factors,** distributed across the four dimensions (Infrastructure, People, Processes and Technology) that were included in the Readiness Assessment. Factors were drawn from various sources ranging from FHWA to state DOT studies to international studies. Many factors, especially those tailored to VDOT business functions, were based on recent VDOT studies.

An example of the various Readiness levels assigned to each Readiness Factor is provided below:

	VDOT CAV READINESS LEVELS				
	0	1	2	3	4
DESCRIPTION	No activity in this area.	Needs upgrade & maintenance	Meets current best practices	Meets emerging market (1-5 yrs.)	Meets next decade market (10 yrs.)
EXAMPLE READINESS FACTOR	No discussion or research regarding improving communications in the corridor	Limited or no fiber installed in the corridor	Fiber installed along the roadway with access points	DSRC or C-V2X nodes tied into fiber	Small cells deployed along the roadway with 5G coverage

Use Case Selection Process

- 15 use cases were selected from a list of 80 use cases
- Selections were based on
  - Technology maturity
  - CV/AV penetration
  - Input from VDOT
  - Ongoing and required VDOT investments
- CAV Use Case Report
  - Provides details on and an overall assessment (using the Readiness Assessment Scale (RAS)) of each use case
  - Organizes use cases into 8 different categories:

Driver Mobility	Freight Management	Pedestrian	Planning and Unplanned Events
Safety	Traffic Planning	Transit	Weather

CAV Investments Outlined in Investment Roadmap

Infrastructure

- Upgrade Communications Network and Roadside Units — 2022
- Upgrade Signal Infrastructure — 2022
- Develop CAV Testing Capability — 2025
- Upgrade Signing and Pavement — 2025

Process

- Develop CAV Procurement Policies — 2022
- Develop CAV Investment Guidance on Construction Standards — 2022
- Develop Equity Policy for Technology and Investments — 2022
- Establish Cybersecurity Policy — 2022
- Establish Data Format, Accuracy, Accessibility, and Transfer Standards — 2022
- Establish Data Security and Privacy Policies — 2022
- Establish Third-Party Coordination Policies — 2024
- Develop Performance Measures for CAV Data — 2025
- Develop RSU Standards — 2025
- Upgrade Signing and Pavement Markings Specifications — 2025
- Develop Local and Virginia Agency CAV Guidance — 2026

People

- Implement CAV Integration/Business Strategy — 2022
- Increase CAV Education Opportunities — 2022
- Increase CAV Industry Outreach and CAV Public Relations — 2022

Technology

- Upgrade Data Lake for CAVs — 2022
- Upgrade for CAV Cybersecurity — 2022
- Integrate ATMS/Signal with Data Lake — 2023
- Upgrade Data Portal for CAVs — 2023
- Enhance Data Analytics for CAVs — 2025
- Implement Security Credential Management System — 2026

CAV Systems Mapping Project

- **Objective:** To identify internal and external CAV data needs
  - What CAV data is available for VDOT to consume?
  - What systems within VDOT should consume CAV data?
  - Are the systems capable of ingesting, analyzing, and sharing CAV data?
  - What VDOT data is needed by CAVs?
  - What systems within VDOT can provide data needed by CAVs?

- **Status:** Vendor selected

- **Next Steps:** Issue PO and kick-off

CAV Efforts in VA – Work Zone Safety, Connected Intersections, and Transit

- VDOT has partnered with multiple entities to deploy CAV technologies.

C-V2X Deployment

- Involved VDOT, Audi, Qualcomm, American Towers, and VTTI
- Partnered to test and develop two connected technology use cases: work zone and traffic light information
- Completed two filmed demos: Blacksburg (9/21); NoVA (7/29)
- Built on previous VDOT work – development of Smart Vest and Virginia Connected Corridors
- Involved use of direct CV2X communication from the Smart Vest to an Audi vehicle and cellular communications from VTTI network to an Audi vehicle for work zone use case
- Involved CV2X communications from RSUs to Audi vehicle for Traffic Light Information use case

Fairfax County Automated Shuttle Deployment

- Developed through a partnership between Fairfax County, Dominion, and Dept. Rail and Public Transportation with support from VDOT, DMV, and others
- Performs a transit service by circulating between Dunn Loring Metrorail Station & the Mosaic District
- Involves a 100% electric, autonomous shuttle
- Approved to carry passengers since October 2020
- Providing data to VTTI from multiple cameras and on-board sensors for in-depth review of shuttle actions

CAV Efforts in VA – Work Zone Safety

Work Zone Builder App

Problem – Need for accurate digital map of work zones to enable improved sharing of work zone information within agency and to third parties

Solution – Develop an application that allows for efficient, easy input of work zone design details that can be uploaded and shared

Current Status – Developed and field tested work zone builder application

Next Steps – Broaden pilot testing; expand security and user administration, integrate into work zone data exchange

Connected Smart Vest

Problem – Need for improved real-time communications within the work zone and between work zone and traffic

Solution – Develop a connected "Smart" vest that can broadcast messages to connected vehicles (oncoming traffic and connected work zone equipment), and that can receive information in order to alert worker of potential safety risks

Current Status – Developed and demonstrated 1 prototype connected smart vest

Next Steps – Develop 10 connected smart vests along with base station; Conduct 2 pilot demonstrations in live work zones

CAV Efforts in VA – Work Zone Safety

Automated Truck Mounted Attenuator (ATMA) Program Overview

Problem – Safety risk when TMAs are involved in incidents, which have been increasing in recent years

Solution – Develop an ATMA such that a worker drives a lead vehicle and the ATMA follows, acting as a buffer between work zone personnel and oncoming traffic

Program Details –

- Consortia formed in 2018 (VDOT, VTTI, Transurban, DBI Services, and SAFE-D)
- Local design goals: Freeway operations, HMI, robust safety features
- Multi-phase program

CAV Efforts in VA – Understanding Automation

CARMA Testing

- FHWA's CARMA effort focuses on testing automated vehicle features and cooperative automated vehicle features, and conducts on-road testing in Virginia, Maryland, and Washington, D.C.

Daimler Testing

- Testing automated trucks on I-81

Potential Routes: West Coast to East Coast

ADS Trucking Fleet Concept of Operations (CONOPS) for Managing Mixed Fleets

- This USDOT-granted funded project led by VTTI, with VDOT as a partner, will provide the trucking industry with clear information on how to safely implement and benefit from trucks equipped with an Automated Driving System (ADS)
- This project is focusing on the port truck queuing demo, which will take place in California, with a cross-country demo to follow

Safely Operating ADS in Challenging Dynamic Scenarios: An Optimized Automated Driving Corridor Demonstration

- This USDOT granted-funded project led by VTTI with VDOT as a partner will demonstrate how SAE L4 ADS-equipped vehicles can interact safely in challenging dynamic scenarios (e.g., encounters with public safety providers, public services)
- This project is currently identifying a series of scenarios with live demos anticipated later this year

Questions?

Amanda Hamm, Esq.
Connected and Automated Vehicle Program Manager
Office of Strategic Innovation

Email: amanda.hamm@vdot.virginia.gov
Phone: 804-317-1537