Maryland Transportation Authority

Strategic Plan for Connected and Automated Vehicles (CAV Plan)

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Introduction

Maryland is eager to realize the benefits of connected and automated vehicle (CAV) technology, while ensuring the safety of all who travel Maryland roadways. The Maryland Department of Transportation (MDOT) recognizes the numerous safety and mobility benefits that this transformative technology represents and may offer to the citizens of the State. The Maryland Transportation Authority (MDTA) is likewise committed to embracing CAV technology and welcomes the opportunity to collaborate with entities that are interested in researching, testing, and supporting the deployment of CAV technology in Maryland. The MDTA is uniquely situated to facilitate the CAV revolution in Maryland with well-maintained facilities that can serve as incubators for testing and experimentation.

In preparation for the advent of CAVs, the MDTA has developed this plan, which is focused on near-term actions appropriate in the five-year period from 2019-2024, while setting the stage for future CAV-based advances in transportation.

CAV State of the Industry

CAV Ecosystem

Connected Vehicle (CV) technologies enable all types of vehicles, roadways, and mobile devices to communicate and share vital transportation information. Several mediums will provide connectivity, including satellite radio, commercially available cellular, and dedicated short-range communications (DSRC). Many existing vehicle models are already "connected" through cellular technology, such as GM's OnStar, Chrysler's UConnect, and other commercially available services. Future CV applications may enable more advanced safety-related actions, depending on the communication mediums to provide fast, secure, reliable connections that are not vulnerable to interference. Figure 1 shows a graphic representation of CVs communicating.

Figure 1: Graphic Representation of Connected Vehicles
Source: WSP USA

Automated Vehicles (AV) detect their surroundings using a variety of on-board sensors such as radar, lidar, and cameras. Working in concert with other technologies such as GPS, the advanced control systems on a vehicle interpret the data to identify

appropriate navigation paths; detect, avoid, and navigate around obstacles; and interpret traffic-control devices such as signs and pavement markings.

Advanced Driving System (ADS) components such as lane keeping, parking assist, emergency braking and adaptive cruise control are being introduced on new vehicles each model year. Highly Automated Vehicles (HAVs) have multiple ADS components and on-board sensors which, working in concert, can analyze sensory data to distinguish between different vehicles on the road as well as the presence of bikes, pedestrians, obstacles - and autonomously operate a vehicle on varying levels of roadway networks (e.g., urban, rural, freeway, arterial, etc).

To standardize the discussion of vehicle capabilities, the National Highway Traffic Safety Administration (NHTSA) has adopted a six-level classification system of vehicle automation capabilities based on a system developed by the Society of Automotive Engineers (SAE) – See Figure 2. Depending on the level of automation, the interaction of a human driver can vary from "be ready to take over" to "no action needed."

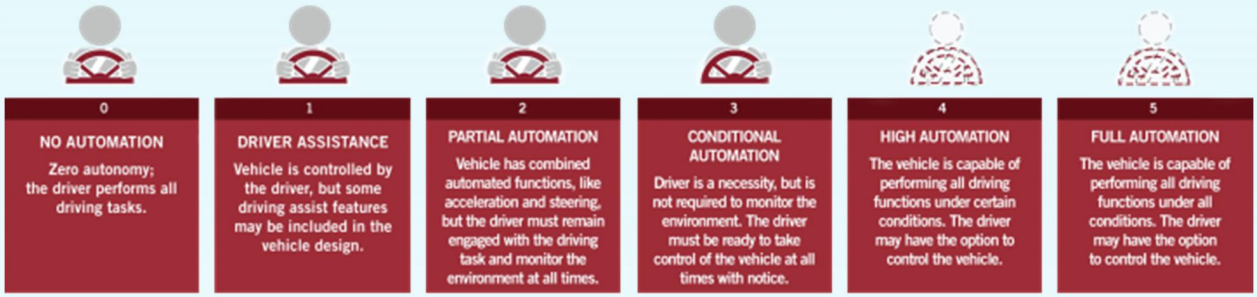


Figure 2: Levels of Automation from SAE
Source: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

The umbrella term connected and automated vehicles (CAV) is often used to indicate varying levels of connectivity and automation – recognizing that the technologies are being integrated to provide safety, mobility, and environmental benefits.

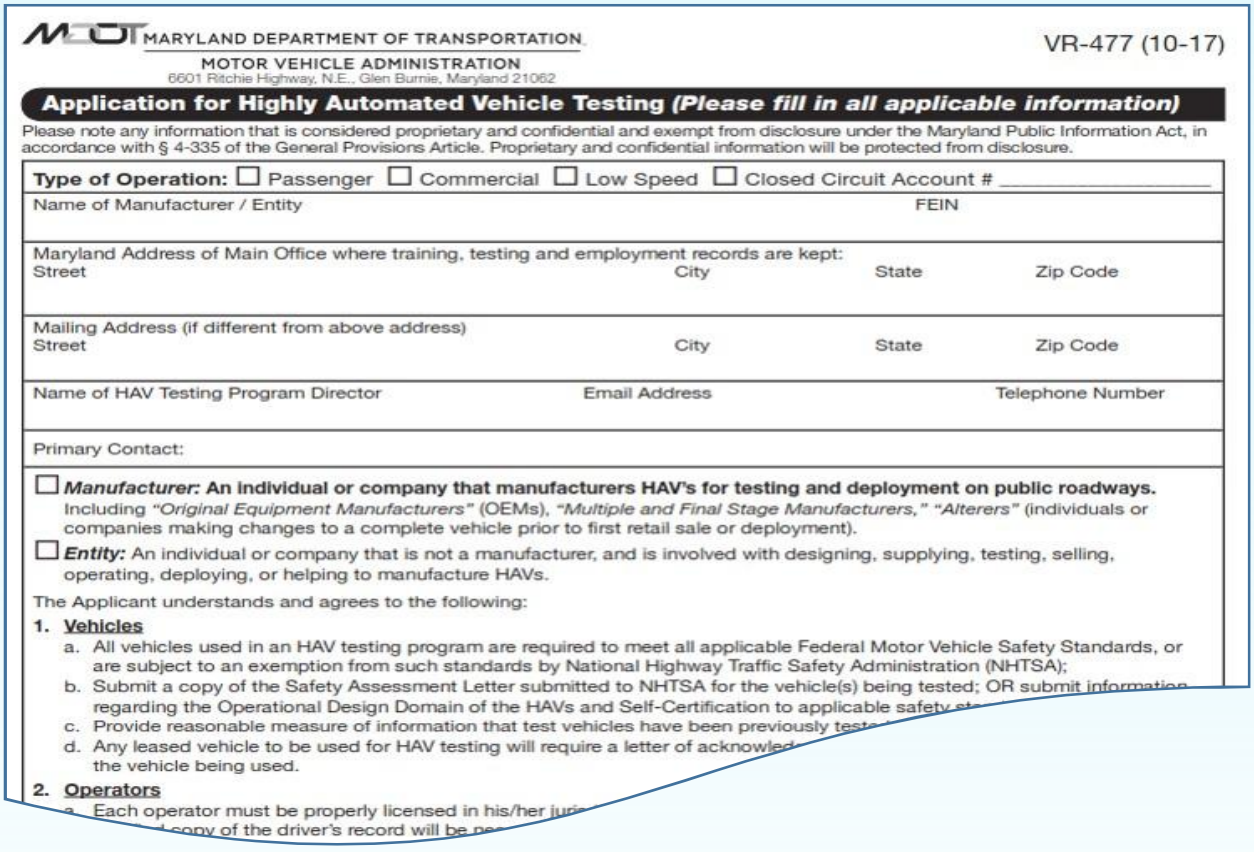
The advent of CAVs, along with the supporting technology, and the ability to leverage new and expanding data about transportation use, is expected to dramatically impact the roles and responsibilities of transportation agencies, many of which are working to find ways to improve the economies, efficiencies, and safety of their transportation facilities and services. CAV technologies represent a significant opportunity for Maryland to address transportation safety, mobility, and environmental challenges faced by travelers and transportation systems managers alike in new and innovative ways.

Testing and Research

As the MDTA prepares for CAVs, it is crucial to understand and remain up-to-date regarding the state of CAV infrastructure, vehicle technologies, legislation, policies, testing, and research. Make no mistake - this is an evolving transformation of the overall transportation network. While fully-automated or self-driving vehicles may not be available commercially or widespread for several years, testing is underway today on closed courses, campus settings, and even on public roadways.

Many states, including Maryland, have instituted a "permitting" process to encourage dialogue between entities wishing to test vehicles on public roads and the agencies that own and operate those roads. Figure 3 provides an example portion of MDOT's blank form for HAV testing. Given the wide variance of test parameters – ADS component testing all the way up to vehicle platooning and full automation – a continuous dialogue is critical to allow public agencies to keep their focus on maintaining transportation operations and public safety, while allowing the vehicle development entities to present what steps they have taken to meet that same objective.

Testing on public roads is valuable because it puts the vehicle and accompanying technology components through "real-world" scenarios difficult to replicate in a laboratory or even on a closed-course. While closed-course testing is almost always a first-step, exposure to different real-world road configurations and situations is critical to expanding the scenarios where a vehicle's artificial intelligence can adequately interpret the environment and recommend safe interactions by the vehicle.



MARYLAND DEPARTMENT OF TRANSPORTATION
MOTOR VEHICLE ADMINISTRATION
6601 Ritchie Highway, N.E., Glen Burnie, Maryland 21062

VR-477 (10-17)

Application for Highly Automated Vehicle Testing *(Please fill in all applicable information)*

Please note any information that is considered proprietary and confidential and exempt from disclosure under the Maryland Public Information Act, in accordance with § 4-335 of the General Provisions Article. Proprietary and confidential information will be protected from disclosure.

Type of Operation: ☐ Passenger ☐ Commercial ☐ Low Speed ☐ Closed Circuit Account # _____

Name of Manufacturer / Entity — FEIN

Maryland Address of Main Office where training, testing and employment records are kept:
Street — City — State — Zip Code

Mailing Address (if different from above address)
Street — City — State — Zip Code

Name of HAV Testing Program Director — Email Address — Telephone Number

Primary Contact:

☐ ***Manufacturer:*** **An individual or company that manufacturers HAV's for testing and deployment on public roadways.** Including *"Original Equipment Manufacturers"* (OEMs), *"Multiple and Final Stage Manufacturers," "Alterers"* (individuals or companies making changes to a complete vehicle prior to first retail sale or deployment).

☐ ***Entity:*** An individual or company that is not a manufacturer, and is involved with designing, supplying, testing, selling, operating, deploying, or helping to manufacture HAVs.

The Applicant understands and agrees to the following:

1. **Vehicles**
   a. All vehicles used in an HAV testing program are required to meet all applicable Federal Motor Vehicle Safety Standards, or are subject to an exemption from such standards by National Highway Traffic Safety Administration (NHTSA);
   b. Submit a copy of the Safety Assessment Letter submitted to NHTSA for the vehicle(s) being tested; OR submit information regarding the Operational Design Domain of the HAVs and Self-Certification to applicable safety st
   c. Provide reasonable measure of information that test vehicles have been previously teste
   d. Any leased vehicle to be used for HAV testing will require a letter of acknowled the vehicle being used.
2. **Operators**
   a. Each operator must be properly licensed in his/her juri copy of the driver's record will be re

Figure 3: Sample Portion of Blank Application for HAV Testing in Maryland
Source: MDOT Motor Vehicle Administration

Roads and other transportation facilities typically conform to accepted design standards and guidance, such as the Policy on Geometric Design of Highways and Streets ("Green Book"), published by the American Association of State Highway and Transportation Officials (AASHTO) and the Manual on Uniform Traffic Control Devices (MUTCD), which is published by the Federal Highway Administration (FHWA). However, adaptations to fit real-world conditions have created a seemingly infinite number of

design variations and exceptions which create an added level of complexity to designing CAVs to operate safely in almost any situation. This necessitates continued real-world testing for the foreseeable future.

Several research studies are underway nationally and internationally, attempting to better understand many of these challenges. The National Cooperative Highway Research Program (NCHRP), run by the Transportation Research Board of the National Academies (TRB), is sponsored by the member departments (i.e. individual state DOTs) of AASHTO, in cooperation with FHWA. More than two dozen research projects related to CAVs are planned or underway, identifying critical issues associated with CAVs that state and local transportation agencies will face, conducting research to address those issues, and conducting related technology transfer and information-exchange activities.

Benefits of CAVs

If CAVs are still an evolving science, why is there such an emphasis on preparing for adoption now? The answer lies in the unprecedented potential expected from CAV introduction and the rapid evolution of new technology moving faster than ever before.

In the transportation sector, where the probable cause of more than 90 percent of serious roadway crashes involves human behavior[1], CAV technologies possess the potential to save thousands of lives, as well as reduce congestion, enhance mobility, and improve productivity. The United States Department of Transportation (US DOT) estimates that more than 80 percent of non-impaired incidents could be mitigated with the implementation of CV technology. NHTSA statistics show that 37,461 lives were lost on US roads in 2016, an increase of 5.6 percent from calendar year 2015. While data for 2017 is not yet finalized, estimates from the National Safety Council project the possibility of more than 40,000 fatalities.

As shown in Figure 4, widespread deployment of CAV technology will provide numerous additional benefits beyond safety. Vehicle-to-vehicle communication will enable cooperative adaptive cruise control and vehicle platooning, which according to the US DOT can "smooth out traffic perturbations" and thus increase roadway throughput, reducing congestion, and ultimately reducing fuel consumption and lowering emissions[2].

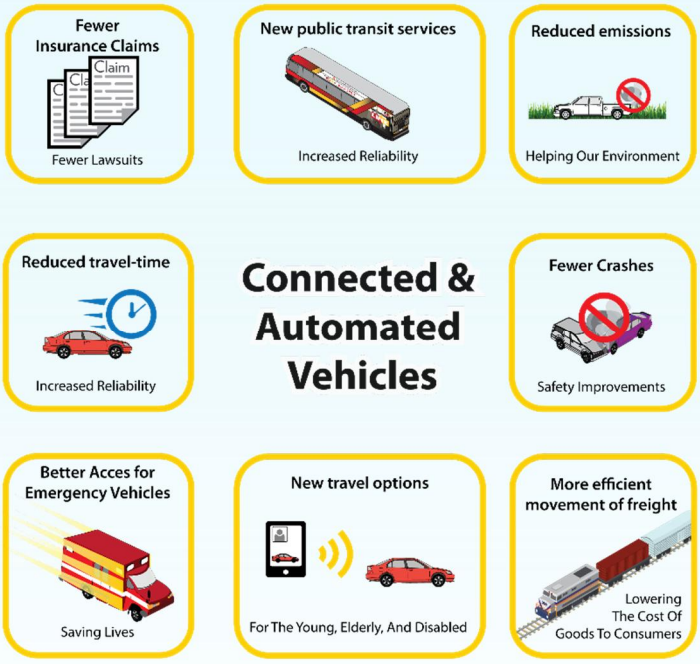


Figure 4: Graphic Representation of CAV Benefits
Source: WSP USA

[1] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115
[2] https://www.fhwa.dot.gov/publications/research/safety/13045/003.cfm

Vehicle performance data such as excessive braking or skid control or windshield wiper activation could provide additional road weather information for transportation management centers, allowing for advanced warnings and more efficient deployment of road crews.

The deployment of CAVs also could produce abundant economic and societal impacts. NHTSA estimates approximately $242 billion in economic costs resulted from motor vehicle crashes in 2010, which incorporates lost productivity, medical costs, legal and court costs, emergency medical services costs (EMS), insurance administration costs, congestion costs, property damage, and workplace losses. The development of CAVs would also create a demand for relevant goods and services, fostering the expansion of the transportation technology industry that would supply the specialized equipment to enable public deployments. Secondary impacts could be felt by the insurance industry in the form of transformed policies and premiums based on improved road safety.

Impacts to Transportation Planning

In June 2016, the FHWA published Connected Vehicle Impacts on Transportation Planning (FHWA-JPO-16-420). This report comprehensively assesses how CVs should be considered across the range of transportation planning processes and products developed by states, metropolitan planning organizations (MPOs), and local agencies throughout the country.

While it focuses on CV technology, the report notes that to incorporate the full range of planning products and activities, AV should be considered as well; thus, the subject of this effort was broadened to include CAV in many instances.

The project conducted four distinct types of analysis to comprehensively assess the impact of CAV technology on transportation planning:

1. Identify how CAV technology should be considered in transportation planning processes and products under a variety of circumstances.
2. Develop illustrative scenarios of CAV planning, based on real-world planning environments that highlight the various ways that CAV's can be addressed in planning processes and products.
3. Identify new or enhanced tools, techniques, and data to support various CAV planning activities and approaches for how to develop them.
4. Identify the roles and responsibilities of stakeholders and organizational and workforce skills, expertise, and capabilities needed to carry out CAV planning.

This publication supports the discussions and action items that make up the foundation of MDTA's CAV Plan and further emphasizes MDTA's validity in direction and process.

Planning for CAV at MDTA

MD CAV Working Group

In late 2015, MDOT Secretary Pete Rahn established the Autonomous and Connected Vehicle Working Group as the central point to develop and deploy emerging CAV technologies in Maryland. It was later renamed the Maryland Connected & Automated Vehicle Working Group (CAV Working Group) and now

features multiple sub-working groups. The MDTA is actively involved in Working Group activities – from both a policy and technical perspective.

The group includes a diverse membership of transportation stakeholders, including elected officials, state and local agency representatives, highway safety organizations, and representatives from the private sector and the automotive industry. The group evaluates the latest research, tracks federal and state laws, policies and programs, and coordinates with other agencies, organizations and businesses to set the course for the future of CAVs in Maryland.

The MDOT Secretary's Office is assembling an over-arching CAV strategic plan for MDOT, and incorporating input from the MDOT transportation business units (TBUs) and the MD CAV Working Group to formulate a direction for the future.

The MD CAV Working Group, as shown in Figure 5, represents a great opportunity for the MDTA to garner feedback from other sectors of the industry and connect with other TBUs to effectively communicate MDOT's vision for CAV.

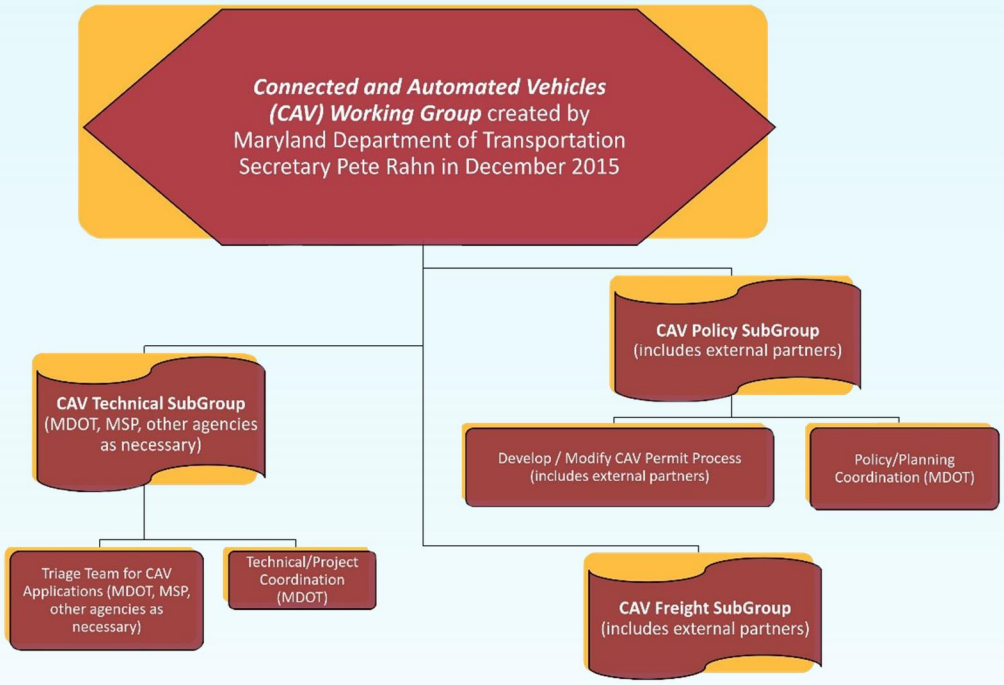


Figure 5: MD CAV Working Group Organizational Chart Source: MDOT, Motor Vehicle Administration http:// www.mva.maryland.gov/safety/MarylandCAV/index.htm

MDTA Strategic Plan

The MDTA's Strategic Plan will help its leaders and employees more effectively focus limited time, money, and resources on a consistent set of actions. For many years, the MDTA has seen itself, first and foremost, as a toll agency. However, today, the MDTA understands that its core mission goes beyond

collecting funds and strives to provide its customers with an improved quality of life by delivering premium transportation facilities that provide safer and more reliable trips.

Forward-looking accommodation of CAVs is one of four major initiatives on the MDTA's horizon. These major initiatives will greatly influence how the MDTA will operate in the future and may affect how the MDTA does business today. With regard to CAVs, the MDTA Strategic Plan states: "In partnership with manufacturers and other industry partners, the MDTA will support the development of CAV policy and infrastructure, so that owners of CAVs can take full advantage of their vehicles' features when traveling on MDTA facilities."

Opportunities to accommodate CAVs are available at every level of the MDTA Strategic Plan.

- MDTA's Vision calls for revolutionizing customer service, delivering premium transportation alternatives, and providing a safer, faster, and more reliable driving experience.
- The MDTA's Purpose includes direction that the MDTA should advance the future of transportation.
- The MDTA's Values include innovation, and becoming a national leader in applying state-of-the-art technology to revolutionize transportation operations.

Accommodating CAVs is reflected in the actions proposed in the Strategic Plan which include:

- Build and maintain strategic partnerships
- Develop and conduct CAV pilot projects
- Determine infrastructure-related design standards for CAV
- Explore the revenue-generating potential of CAV technology use on MDTA facilities

The CAV Plan provides additional detail on how the MDTA can achieve its CAV goals, and the recommendations made in the CAV Plan support the outcomes desired by the MDTA Strategic Plan.

MDTA ITS Strategic Plan

While the MDTA Strategic Plan is currently in draft form, in 2017 an MDTA Intelligent Transportation Systems (ITS) Strategic Plan was developed and published. It laid the groundwork for development of the CAV Plan.

The ITS Strategic Plan was clear in its prediction that "agencies can simultaneously leverage existing ITS capabilities to improve operations with connectivity and take a scalable approach to prepare for future technology." As such, the ITS Strategic Plan established several short-term actions that set the stage for this effort including:

- Establishing an internal working group (in the ITS Strategic Plan it was named an "Advanced Technology Committee") that would be tasked with framing a program that addresses the introduction of CAVs
- Equipping MDTA maintenance and operations vehicles with CV technology to jumpstart market penetration and coverage of DSRC on toll facilities
- Reviewing existing and planned projects to identify opportunities for advanced technologies
- Conducting pilot and field evaluations of advanced technologies

MDTA CAV Plan Vision and Goals

Agencies around the world are developing plans to address CAV technologies. For more than a year, MDTA staff and leaders have been assembling under the auspices of an "MDTA CAV Working Group" to foster dialogue, lessons learned, and explore future paths. The MDTA CAV Working Group held a series of strategic planning conversations, and a key outcome was the development of a vision statement, several goal statements, and accompanying "considerations" that address the question: over the next five (5) years, what does the MDTA need to do to be ready for CAV?

MDTA's CAV Plan Vision:

"The MDTA will support a framework for CAV transformative technologies to improve customer experience and provide access to safe and reliable transportation solutions."

To achieve this vision, five goal statements were created. The CAV Plan goals closely align with the MDTA Strategic Plan pillars and strategies, and emphasize the core values of the organization.

MDTA's CAV goals are:

1. Maximizing customer experience with the latest vehicle technology.
2. Improving safety and travel time reliability.
3. Seeking opportunities to partner with technology providers and automakers.
4. Preparing the MDTA workforce for the technology of the future.
5. Communicating with customers on use of CAV technologies on MDTA facilities.

The CAV Plan five-year goals are important in helping provide not just a target to collectively aim towards, but also measure the MDTA's efforts in reaching them.

A strategic plan should have goals that are measurable. Even if some of the measures may be subjective, they provide management with a tool to assess whether (a) the original goals are being achieved, (b) the original goals need adjustment based on results of the measurement, and/or (c) the original goals need to be adjusted based on a changing environment.

An ongoing responsibility of the MDTA internal CAV Working Group can include establishment of measures and execution of the measurement for these five goals.

MDTA Readiness for CAV – Considerations

While goals set high-level targets to aim towards, a series of considerations pave the road toward achieving those goals. Through the MDTA CAV Working Group meetings, more than 75 potential actions (considerations) were initially identified, and then later prioritized and explored in greater detail.

A total of 30 considerations were selected as the highest priority and are discussed in this document. However, the full list will be maintained as a living document and periodically revisited by the MDTA CAV Working Group. The MDTA CAV plan – like this topic – will evolve in real-time. And in many instances, individual actions might involve exploration of the impacts to policy, engineering, operations, finance, and enforcement before being fully implemented or even pilot tested.

GOAL: Maximizing Customer Experience with the Latest Vehicle Technology

- Explore enhanced sign and pavement marking visibility for human and machine vehicle operators
- Explore the potential of dedicated lane scenarios for CAVs
- Prepare for the latest technologies by including accommodations for CAV such as duct work, conduit, and fiber in all new projects
- Enhance real-time traffic data sharing efforts
- Enhance training and workforce development to address maintenance, operations, enforcement and incident management needs in a CAV environment
- Explore next-generation vehicle communications and mobile alerts and develop system management and operation applications considering multiple technology options
- Define implications of transition from current toll collection methods to All-Electronic Tolling (AET) or Open Road Tolling (ORT) in a CAV environment

GOAL: Improving Safety and Travel Time Reliability

- Continue deployment and enhancements for existing tools – Dynamic Message Signs (DMS), 511, BAYSPAN hotline, web-based traffic information – including broadcast of travel times
- Explore future information technology needs, including data management
- Continue cooperative collaboration efforts to deploy CAV infrastructure devices and solutions that have the potential to reduce crash risk and improve travel time reliability
- Continue cooperative collaboration efforts to support pilot and demonstration testing of CAVs, and explore federal grant funding when applicable
- Explore current and future vehicle technology to expand knowledge base and capabilities, such as depicted in Figure 6
- Explore policies to utilize Connected Vehicle technology for toll collection activities

GOAL: Seeking Opportunities to Partner with Tech Providers and Automotive Manufacturers

- Support signing and pavement marking enhancements evaluation testing through the Maryland Product Evaluation List(MPEL) process
- Enhance real-time weather and traffic information sharing
- Explore data sharing opportunities to facilitate commercial vehicle movements
- Define needs to support future multiprotocol devices in vehicles

- Explore legislative needs or barriers to CAV testing such as following distance restrictions on vehicle platooning
- Explore implications of permitting CAV pilot or deployment testing on the I-95 Express Toll Lanes (ETL) or Intercounty Connector (ICC)/MD 200

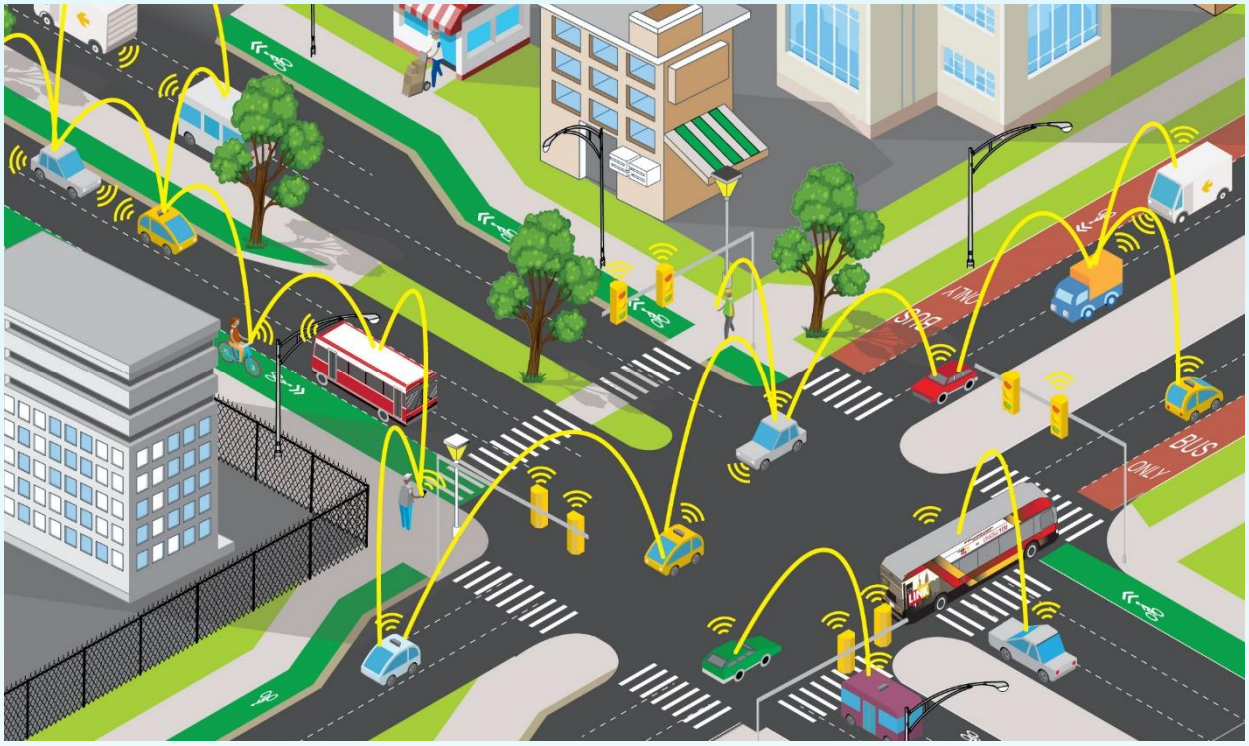


Figure 6: Graphic Representation of CAV Wireless Interaction
Source: WSP USA

GOAL: Preparing the MDTA Workforce for Future Technologies

- Develop plans to facilitate employee CAV knowledge, skill sets, and abilities
- Insert CAVs into future planning activities
- Engage in training related to CAVs for all levels of the MDTA workforce
- Define data management and governance needs and how it impacts future staffing roles
- Explore legislative, regulatory, liability, or legal changes that might occur because of CAVs
- Explore alternate sources of funding for CAV readiness investments

GOAL: Communicating to Customers – CAV Technology on MDTA Facilities

- Explore CAV public education and outreach needs
- Develop internal and external communication plans with consistent messaging
- Define and respond to potential changes in commercial vehicle information needs
- Explore needs related to distracted driving education
- Explore future changes in toll rates and congestion pricing, incentives, and discounts for CAV

MDTA CAV Communications Plan

A key outcome of the strategic planning conversations within the MDTA CAV Working Group was the need to address varying levels of education, outreach, and communication – within the MDTA, across the MDOT TBUs, with policymakers, and with the general public. Several of the 30 actions/ considerations directly suggest outreach while others might include an outreach or education component. As a result, this Plan expands on the concept one step further.

Internal MDTA Awareness

Given the incredible speed with which CAV transformations are occurring, it is nearly impossible for even those charged with tracking it to stay current. But given the interest of MDTA's CAV Working Group, the circle of stakeholders engaged in CAV must include a broad range of MDTA officials and employees to raise awareness throughout the entire organization and to leverage the experience and facility knowledge of the MDTA workforce.

As the MDTA advances the proposed action statements included in this Plan, frequent internal communication, cooperation, and coordination are needed to successfully leverage the collective talents and ownership of various CAV project components. In addition to MDTA CAV Working Group meetings, where initiatives are discussed and explored, a broader MDTA-wide campaign to educate staff and engage them in the pursuit of future solutions could provide long-term benefits. An example of this campaign is depicted in Figure 7, a fact sheet that was produced by the working group.

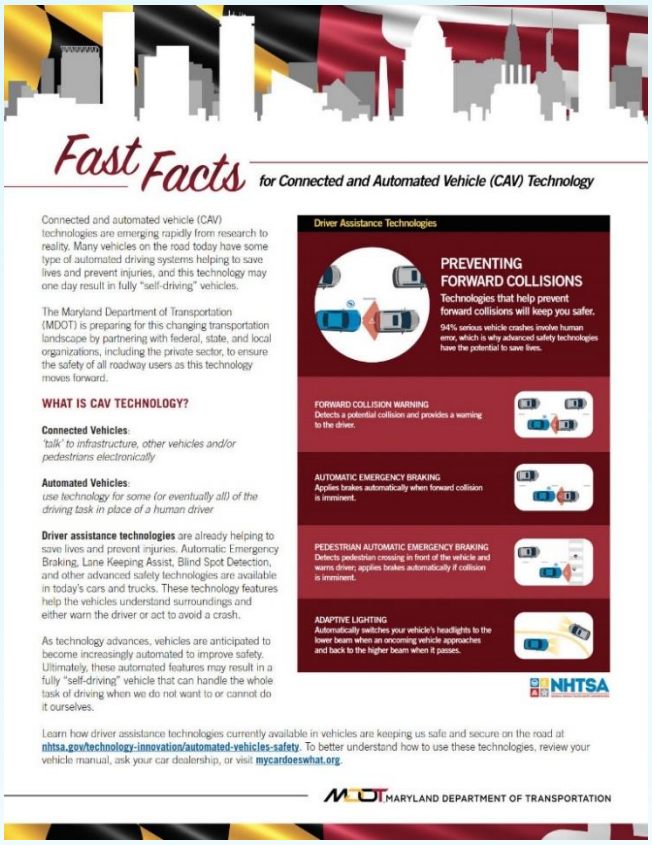


Figure 7: CAV Fact Sheet from MDOT
Source: MDOT, Motor Vehicle Administration
http://www.mva.maryland.gov/safety/MarylandCAV/index.htm

A general awareness campaign is needed to cover the basic concepts of CAV, and in a broader sense the anticipated transformation of the transportation system that may result from the deployment of CAV technologies. Using existing outreach tools such as internal newsletters, lunch-and-learn sessions, or email blasts could provide CAV information to a significant portion of the MDTA staff. For those who want to learn more, a series of more detailed sessions could be offered via webinar, lunch-and-learn, or staff meeting sessions to engage employee interest and knowledge sharing.

As initiatives and projects get underway, ensuring that a broad coalition of internal staff is engaged will be critical to aligning with the core pillars of MDTA's broader strategic plan.

Internal MDOT Awareness

Just as the MDTA is growing in its knowledge and engagement in the CAV arena, so too are other TBUs within MDOT, as well as The Secretary's Office (TSO). Sharing lessons about evolving technology and collaborating on deployment integration and procurement is a natural outgrowth of this effort. Coordinating the anticipated data volume, storage, analysis, and management issues together allows the shared effort to leverage skills and expertise, and share the risks and challenges amongst a broader coalition of stakeholders.

The MD CAV Working Group will continue to be the overall voice for CAV issues in Maryland. As CAV testing and deployment expand, the TBUs will become primary stakeholders in individual projects and will begin to interface more directly with entities in this rapidly evolving CAV space.

The MDTA should continue to share knowledge and strategies with others through the MD CAV Working Group so as to warrant reciprocal treatment and learn from sister agencies. Considering the ongoing pilot testing of CAV technologies along State-owned roads, regular meetings with the MDOT State Highway Administration (SHA) should continue to be scheduled to provide opportunities to share lessons learned and to identify future shared testing opportunities.

Media and Public Engagement

The MD CAV Working Group has also been the external voice introducing CAV to the public in Maryland. The first set of public brochures has been produced with the involvement of all the TBUs, and printed by the Motor Vehicle Administration (MVA). MDTA staff supported that effort by coordinating the original drafts of the brochures and playing a pivotal role in their development.

When HAV and CAV technology testing occurs on MDTA facilities, it will be MDTA staff and the partnering CAV technology developer that will manage public outreach concerning such activities. Advance planning of outreach activities and messages will facilitate customer response efforts when the need arises.

The MDTA has regular outreach with its customers through routine financial transactions (tolling) and also through email and public advertising campaigns – establishing the MDTA as a good candidate for future public education in terms of CAV awareness.

The MDTA regularly conducts customer satisfaction surveys for *E-ZPass* holders, which also provides an opportunity to begin measuring public awareness in terms of CAV developments. TBU partnering and sharing of outreach data may allow MDTA to develop a statewide knowledge-base of CAV technology awareness and use by its customers.

Program Development and Schedule

The goals and considerations serve as a foundation to consider the MDTA's future path. They answer the question "What are the key issues and topics the MDTA must consider to be ready for CAVs during the next five years?"

There is an opportunity with this CAV Plan to go one step further and convert those considerations and topics into concrete action steps and projects, as discussed in the following sections. Many of the activities will be strengthened through partnership with other TBUs, but more importantly through internal multi-disciplinary involvement and ownership.

Prioritization of Pilot Projects

As new technology and strategies begin to form around CAVs, it is important for the MDTA to gain experience and anticipate (as much as can be done) future needs. Pilot programs are an excellent opportunity to build experience with next-generation technology, new partners, and future operational scenarios.

Among the 30 action statements listed in this plan, several make direct reference to pilot programs, while others would benefit from incorporating a pilot test as part of the efforts:

- Enhance real-time traffic data sharing efforts
- Explore next-generation vehicle communications & mobile alerts
- Enhance real-time information sharing with outside parties developing transportation safety applications
- Explore enhanced data sharing with commercial vehicles
- Collaborate with industry partners to explore infrastructure needs to support future multi-protocol in-vehicle readers

A subset of the MDTA CAV Working Group is already meeting to discuss possible pilot projects. They are identifying facilities that could be used by CAV technology developers, possible technical or policy issues that can be explored, and the steps that might be needed to advance the efforts beyond concept. These meetings have also included MDOT SHA, an important ally in sharing facilities, resources, lessons learned, procurement, technology, and operations.

Continued meetings and discussion amongst the stakeholders are important as the MDTA CAV Plan is implemented, as the CAV space evolves, and as other stakeholders (such as the Maryland Transit Administration or Maryland Aviation Administration) consider expanding their pilot projects and incorporating MDTA's facilities.

Impacts to CTP Projects & Schedule

The MDTA CAV Working Group periodically will discuss and recommend CAV-related project needs for exploration. Part of this exploration will include what impacts - if any - the projects might have on the Consolidated Transportation Program (CTP), Maryland's six-year capital budget for transportation projects, and ensure that elements from this CAV Plan are addressed (shown in Figure 8).

The CTP includes capital projects that are generally new, expanded or significantly improved facility or service that may involve planning, environmental studies, design, right-

Figure 8: Cover from 2018 MDOT CTP Source: MDOT http://www.mdot.maryland.gov/newMDOT/Planning/CTP/Index.html

of-way acquisition, construction, or the purchase of essential equipment related to the facility or service.

For example, in reviewing the current CTP – covering FY 2018-2023 – several discussion opportunities exist. The table on the following page presents a sample of possible opportunities as they might relate to the CTP.

Once a project is outlined and recommended by the MDTA CAV Working Group, the Offices of Engineering and Planning will work cooperatively to determine whether incorporation into applicable CTP entries is needed, or if the project can stand alone with no significant impact.

In addition to identifying opportunities where CTP projects could accommodate CAV technologies, additional projects specifically addressing the challenges of CAV deployment should receive high priority in discussion within the Working Group.

Sample Interconnections between 2018-2023 CTP and the MDTA CAV Plan

CTP Entry	CAV Plan Consideration	CAV Opportunity
I-95 Fort McHenry Tunnel - Moravia Road to Tunnel Improvements	Explore next-generation vehicle communications & mobile alerts and develop system management and operation applications Explore signing and pavement marking enhancements evaluation testing	This project includes restriping, and might be a potential opportunity to explore connected work zone devices and enhancing infrastructure to support automated vehicle optical sensor readings.
Update and replace sign structures along the John F. Kennedy Memorial Highway (I-95)	Continue deployment and maintenance of ITS devices and solutions for reduced crash risk and improved travel time reliability	Discuss viability of installing ITS/CV devices (such as detection or DSRC) while updating or replacing sign structures
I-95 Fort McHenry Tunnel - Port Covington I-95 Access Study	Insert CAVs into future planning activities	CAV should be a formal component of the planning process
Rehabilitate Decks on Three Bridges over I-95 in Cecil County	Explore specific data sharing with commercial vehicles	Opportunity to investigate new methods for sharing transportation system condition information with commercial vehicle stakeholders

Impacts to MDTA Operations, Practices, and Procedures

This CAV Plan is and will continue to be a living document. Ongoing project implementation, as well as practices, procedures, and policies, will be impacted on an evolving basis. It is important that updates to this plan capture those changes and continually acknowledge operational impacts.

As planning efforts continue forward for CAV deployment, consideration should be given to maintainability, device standardization, staff expertise, and most importantly operational outcomes. Just because one CAN place a device in a location does not always mean one SHOULD. What are the applicable regulations? What are the operational outcomes desired? What applications can be enabled? Does the application create any potential new areas of liability? What impacts might this have on other

device deployments (e.g., the communication backhaul for DSRC could also enable other ITS device transmissions such as traffic cameras or detection)?

Another important program element is incorporating a basic asset-management system such as the existing MAXIMO asset management system, that includes, at minimum, an inventory of devices along with approximate age, procurement cost, life expectancy, regular maintenance needs, and notes such as frequency and impact of failures. As technology rapidly evolves, configuration management is also a necessity. Keeping track of software and firmware versions, upgrade needs, and firewall/connectivity issues is just as important as the physical characteristics of the devices. Such information is useful not only for managing equipment, but for making a business case for assigning resources for a more robust maintenance program.

The evolution of CAV also brings the need for new staff skills in IT, telecommunications, data management, asset and configuration management, and more. The needs are unclear as to whether it is simply a matter of additional training for existing staff, or if the proliferation of devices and technology will warrant additional staff as well. In general, workforce development is one of the key elements of the plan going forward, because it is important for MDTA to have technical staff who are trained and skilled in the CAV technology that is being deployed, and are able to take advantage of the data and planning changes that might arise as an outcome from new CAV technology. While outsourcing some of the support is certainly feasible, having resident staff who understand the technology and can appropriately supervise the contractors is critical to maintaining the integrity of the system in a fast-evolving environment.

From a performance management perspective, the MDTA already measures key performance metrics of response time and incident duration, along with other operations and maintenance factors such as device availability and mean time to repair. As the MDTA begins to implement elements of the CAV Plan, however, there is a further opportunity to also incorporate measurements of effectiveness to the goals in this plan. This could include something as simple as the number of actions taken, the number of miles of conduit, the number of new pavement markings, or even the number of private partners engaged.

As mentioned in the Outreach section, the MDTA also has an opportunity to begin incorporating CAV into its regular customer satisfaction surveys to gauge their awareness and/or MDTA's success in implementing new approaches to accommodating technology.

Future Planning

Planning in transportation is often focused on traditional models and a dependence on historical data. In this instance, there is no historical comparison for CAV, therefore providing a unique set of challenges in terms of scenario development. Further complicating the planning task is the rapid evolution of technology and society - changes in how people use transportation, changes in views toward vehicle ownership, and even changes in who might be able to manage transportation going forward.

As a result of all this diversity in challenges, the planning task - more than ever before - requires immense flexibility, fast response to changes, and awareness of factors often outside the typical transportation field.

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