

An aerial photograph of a city intersection. Several vehicles, including a red car, a dark SUV, and a large red and white bus, are visible. Yellow concentric circles radiate from each vehicle, representing sensor waves or communication ranges. The background shows a street with crosswalks, traffic lights, and buildings.

# CONNECTED AND AUTONOMOUS VEHICLES (CAVs) WHITE PAPER

## Planning Considerations for the National Capital Region Transportation Planning Board

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Systems Performance Planning Director

Systems Performance, Operations, and Technology Subcommittee  
August 6, 2020

Connected Intersection ([USDOT/Getty Images](#))



National Capital Region  
Transportation Planning Board

# Agenda

- **Introductions**
- **Objectives**
- **CAV Technical White Paper Overview**
  - Technology and Nomenclature in Brief
  - Potential Impacts of CAVs on Metropolitan Transportation Planning
  - Potential Impacts of CAVs and Corresponding Agency Roles
  - The Role for TPB in CAVs
  - Development of Regional CAV Principles
  - CAV Outlook
- **Q&A**



Bicyclist in front of the Capitol Building (Sandy Torchon/[Pexels](#))

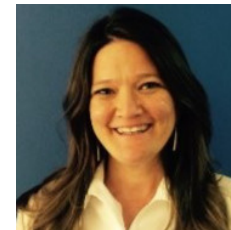
# Introduction: Core Project Team

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## TPB



**Andrew Meese:** Systems  
Performance Planning Director



**Stacy Cook:**  
Principal Planner

## ICF



**Les Brown:**  
Project Manager



**Michael Grant:**  
Subject Matter  
Expert



**Hannah Twaddell:**  
Subject Matter  
Expert



# CAV Technical White Paper: Objectives

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Initiate regional conversations on CAVs and TPB's role related to this topic by examining:

- CAV technologies and nomenclature in brief.
- Areas where TPB goals, policies, and activities may substantially interact with future CAV activities.
- Impacts of CAV deployment and corresponding agency roles.
- Steps TPB can take to influence outcomes and advance the region's goals.
- Processes for developing regional CAV principles and integrating CAV considerations within TPB's planning products and activities.





# Brief Overview of Technologies: CVs

- **Connected vehicles (CVs):** technologies that allow vehicles to communicate with other connected devices in their environment, enabling applications such as:
  - In-vehicle warnings to drivers.
  - Transit priority at signalized intersections.
  - Dynamic signal crossings for pedestrians and bicyclists.

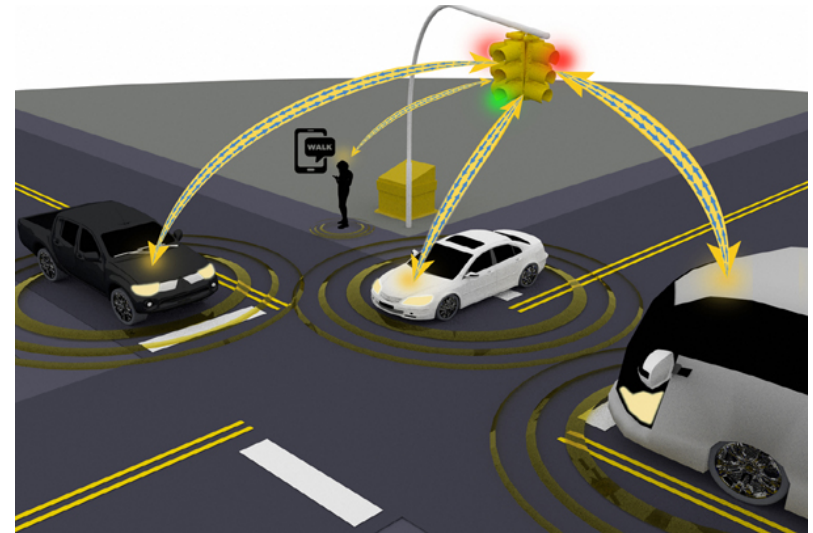


Illustration of "vehicle-to-everything" communications ([USDOT/Getty Images](#))



# Brief Overview of Technologies: AVs

- **Autonomous Vehicles (AVs):** are enabled by sensors, cameras, satellite-based navigation systems, and communications technologies that allow vehicles to dynamically perform steering, braking, and acceleration functions without a human driver or with limited human interaction.

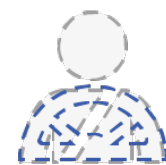


Illustration of AV performing safety-critical driving functions without human driver input (USDOT/Getty Images)

# Brief Overview of Technologies: AVs

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS

Full Automation



0

## No Automation

Zero autonomy; the driver performs all driving tasks.

1

## Driver Assistance

Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.

2

## Partial Automation

Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.

3

## Conditional Automation

Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.

4

## High Automation

The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.

5

## Full Automation

The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

SAE J3016 Standard: "Levels of Driving Automation" ([NHTSA](#))



# Potential Impacts of CAVs on Metropolitan Transportation Planning

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The White Paper identifies 18 types of CAV impacts that relate to the goals, policies, and activities of TPB and those of transportation agencies generally.

These impacts are grouped broadly into the following three categories:

- **Travel:** includes impacts that directly relate to the mobility of the traveling public, motor carriers, and other road users.
- **Societal:** includes impacts of broad societal concern.
- **Organizational:** includes impacts directly related to the activities and responsibilities of infrastructure owner/operators and transportation planning agencies.



# Potential Impacts of CAVs: Travel Impacts

Travel Impacts	Example Linkage to TPB Goals/Objectives
Access	<ul style="list-style-type: none"> <li>• Fair access/mobility for persons with accessibility needs.</li> <li>• Interconnected multimodal transportation system that provides convenient access with reduced automobile reliance.</li> <li>• Comprehensive range of choices for regional travelers.</li> <li>• Accurate and user-friendly real-time transportation system info available to all regardless of traveler's mode or language.</li> </ul>
Active Transportation	<ul style="list-style-type: none"> <li>• Convenient bicycle and pedestrian access.</li> <li>• Reduced auto reliance in the regional core/activity centers.</li> </ul>
Public Transportation	<ul style="list-style-type: none"> <li>• Reduced auto reliance in the regional core/activity centers.</li> </ul>
Goods Movement	<ul style="list-style-type: none"> <li>• The Washington region will be among the most accessible in the nation for international and inter-regional goods movements.</li> </ul>
Safety	<ul style="list-style-type: none"> <li>• Enhanced safety through effective enforcement of traffic/motor carrier laws, and appropriate safety features in facility design.</li> </ul>
Travel Behavior	<ul style="list-style-type: none"> <li>• Reduction of VMT and increased non-auto mode share.</li> <li>• Convenient bicycle and pedestrian access.</li> <li>• Comprehensive range of choices for regional travelers.</li> </ul>



# Potential Impacts of CAVs: Societal Impacts

Societal Impacts	Example Linkage to TPB Goals/Objectives
Equity	<ul style="list-style-type: none"> <li>• Reasonable access/cost for all in the region.</li> <li>• Accurate and user-friendly real-time transportation system info available to all regardless of traveler’s mode or language.</li> <li>• Users of all modes pay an equitable share of costs.</li> </ul>
Employment / Economic Development	<ul style="list-style-type: none"> <li>• Economically strong regional core and activity centers.</li> </ul>
Environment	<ul style="list-style-type: none"> <li>• Meet federal clean air/water and energy conservation mandates.</li> <li>• Protect sensitive locations from adverse traffic/development impacts.</li> <li>• Reduction of VMT and increased non-auto mode share.</li> <li>• Serve as a model for the protection and enhancement of natural, cultural, and historical resources.</li> </ul>
Land Use / Urban Form	<ul style="list-style-type: none"> <li>• Regional coordination of land use and transportation planning</li> <li>• Economically strong regional activity centers with a mix of jobs, housing, services, and recreation in a walkable environment.</li> </ul>

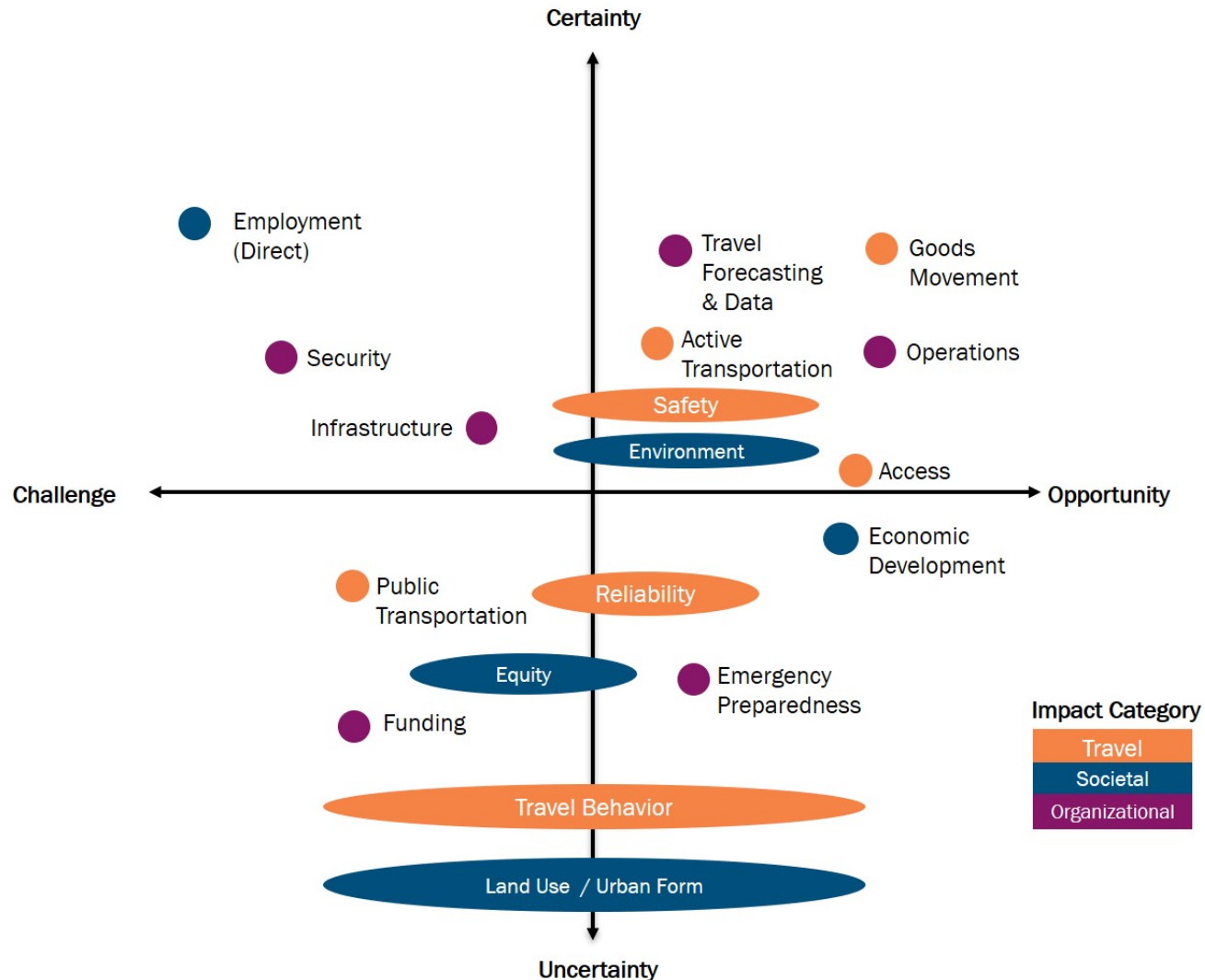


# Potential Impacts of CAVs: Organizational Impacts

Organizational Impacts	Example Linkage to TPB Goals/Objectives
Data Coordination	<ul style="list-style-type: none"> <li>• Full use of future advancements in transportation technology.</li> </ul>
Emergency Preparedness	<ul style="list-style-type: none"> <li>• Improved management of weather emergencies/major incidents.</li> </ul>
Funding	<ul style="list-style-type: none"> <li>• A fiscally sustainable transportation system.</li> <li>• Establish an enhanced funding mechanism for the region's growing mobility and accessibility needs.</li> </ul>
Infrastructure	<ul style="list-style-type: none"> <li>• Adequate management of existing infrastructure assets.</li> </ul>
Operations	<ul style="list-style-type: none"> <li>• Reduction in congestion and congestion-related incidents.</li> <li>• Improved reliability/predictability of operating conditions.</li> <li>• Full use of future advancements in transportation technology.</li> <li>• A user-friendly, seamless system with on-demand, timely travel information to users, and a simplified method of payment.</li> </ul>
Reliability	<ul style="list-style-type: none"> <li>• Improved reliability and predictability of operating conditions.</li> </ul>
Security/Privacy	<ul style="list-style-type: none"> <li>• Full use of future advancements in transportation technology.</li> </ul>
Travel Forecasting	<ul style="list-style-type: none"> <li>• Full use of future advancements in transportation technology.</li> </ul>



# Potential Impacts of CAVs: Certainty & Risk



# CAV Impacts and Corresponding Agency Roles

Each of the 18 CAV impact areas were analyzed to determine:

- The nature of the issue and its associated challenges and opportunities.
- Roles for governments/agencies across jurisdictional levels
- Roles for private sector entities (automotive industry, tech companies, etc.).
- Coordination opportunities between these stakeholders.

Impacts			Governmental Roles				Nongovernmental Roles
Issues	Challenges	Opportunities	Federal	State	MPO	Local	Private Sector
<b>Active Transportation: Mobility</b>	Fragmentation and disruption of bicycle/pedestrian networks (e.g., increased curbside pick-ups/drop-offs, unsafe crossing with platooned and free-flowing traffic)	Repurpose public right-of-way for active travel	Secondary: technical assistance/guidance on complete street design	Primary: design standards for state-owned roadways	Collaborative: regional bike/pedestrian planning, promotion of complete street policies	Primary: design standards and engineering of locally owned street networks	Secondary





# Addressing CAV Impacts: Federal Role

The federal government regulates, maintains, and invests in the nation's transportation system and infrastructure. Federal roles for addressing CAV impacts include:

- **Vehicle safety**
- **Cybersecurity**
- **National Standards**
- **Grant Funding**
- **Research**



U.S. Capitol (Pexels)

# Addressing CAV Impacts: State Role

State transportation agencies are tasked with planning, funding, designing, building, maintaining, operating, and improving the National Highway System (NHS) and other highway and multimodal networks under their jurisdiction. Roles for states in addressing CAV impacts include:

- **Policymaking**
- **Infrastructure and traffic operations**
- **State-level guidance**
- **Planning, research, development, and testing**

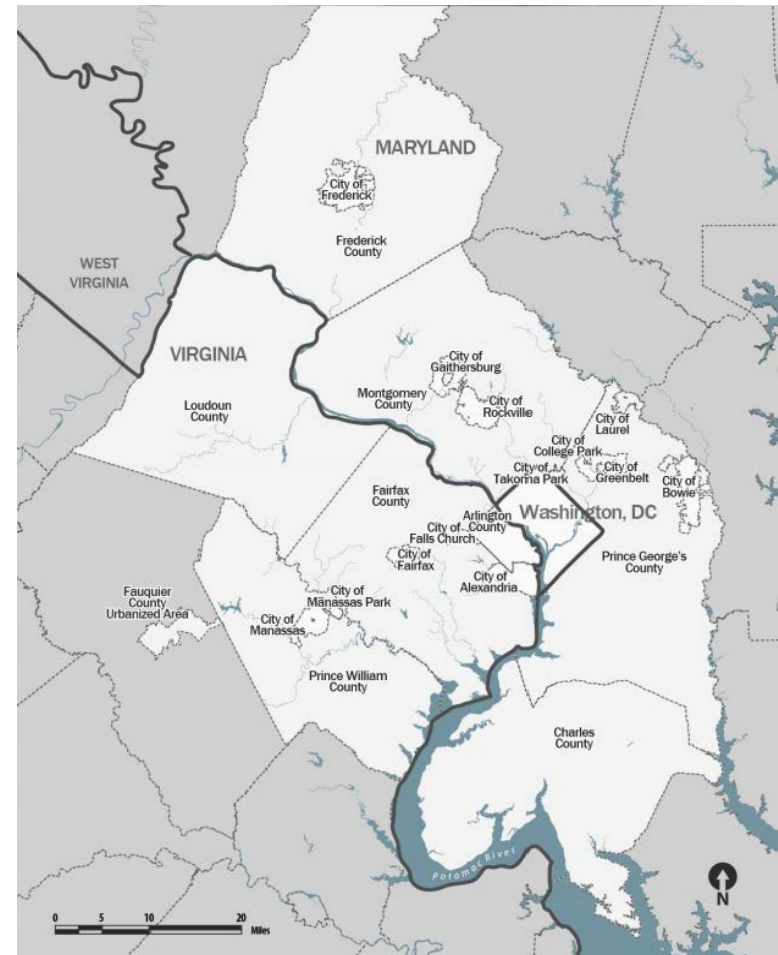


District of Columbia, Maryland, and Virginia flags ([Wikimedia Commons](#))

# Addressing CAV Impacts: MPO Role

MPOs have a strong influence over several of the aspects of transportation system performance that could be affected by CAV deployment, such as:

- **Transportation plans**
- **Travel forecasting & modeling**
- **Multimodal transportation:**
  - **Public transportation/transit**
  - **Bicycle/pedestrian**
  - **Freight**
  - **Safety**
  - **Transportation demand management (TDM)**

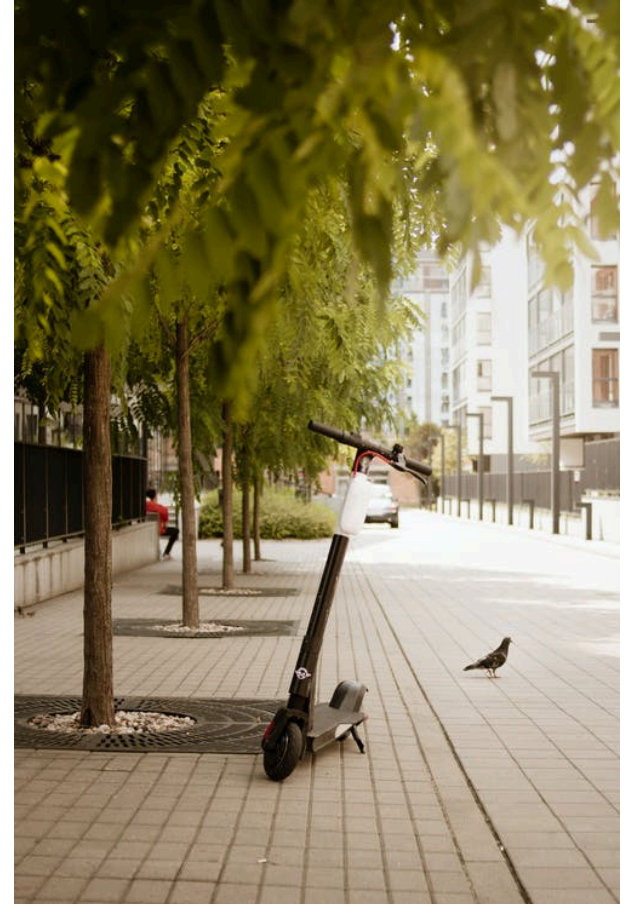


TPB Jurisdictions ([MWCOC](#))

# Addressing CAV Impacts: Local Role

Local agencies also play a key role in various aspects of CAV and issues potentially associated with CAV deployments and impacts, including:

- **Curbside management**
- **Land use planning and urban design**
- **Local transportation project and infrastructure planning, design, operations, and maintenance**
- **Interjurisdictional collaboration on infrastructure projects**
- **Local policies**



Shared E-Scooter (Dominika Roseclay/[Pexels](#))

# Potential CAV Role for TPB

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## Information Sharing, Engagement, and Coordination:

- Increase policymakers' and technical staff's understanding of potential CAV impacts.
- Understand public perceptions of CAVs and communicate potential impacts.
- Provide TPB members with a better understanding of current CAV activities across the region and advise on the coordination of activities.
- Identify and share information on federal and other funding opportunities for CAV deployment and testing.



# Potential CAV Role for TPB (cont.)

## Regional Policy Development and Collaboration:

- Develop a regional framework for coordination to influence CAV deployment in ways that support regional goals, ensure appropriate outcomes, and minimize potential adverse impacts.



Meeting (Christina Morillo/[Pexels](#))



# Potential CAV Role for TPB (cont.)

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## Integrating CAV Considerations into Planning and Programs:

- Conduct scenario planning as part of the long-range planning process to develop and explore possible future regional scenarios for CAV deployment.
- Integrate future CAV considerations into travel modeling and analyses.
- Integrate CAV considerations into existing programs.
- Ensure that CAV applications are fully integrated into Intelligent Transportation Systems (ITS) architecture.

## Potential Approach to the Development of Principles

Engage members through the TPB committee structure to support the development of regional CAV principles.

Develop a simple statement of purpose for the principles.

Collaboratively develop a technical summary that highlights key issues and themes as the basis for establishing principles.

Conduct workshops with TPB members and the board to further discuss and develop draft principles.

TPB staff and the board collaborate to refine the principle language and develop a draft resolution.

TPB Board vote on the adoption of the resolution.



# Examples of CAV Principles

## Universal/Affordable Access

- Promoting universal, affordable access to shared mobility services that use web-based tools for scheduling and fare payment.

## Equitable Investments

- Ensuring equitable distribution of upgrades to transportation and utility infrastructure required to support electrification of AVs.

## Safer Travel, Safer Communities

- Promote strategies that increase safety in the region and avoid adverse safety impacts.



# CAV Outlook

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TPB has a robust committee structure and supporting staff positioned to address and strengthen CAV in metropolitan transportation planning. Activities TPB could undertake may include:

- Strategic planning to develop a coordinated approach to CAV and to build technical, institutional, and policy capacity.
- Developing supportive goals, objectives, performance measures, research, and engagement activities through various TPB plans, programs, and initiatives.
- Collaborating with member agencies and organizations.
- Providing a forum of information exchange that supports public-private partnerships and the advancement of regional goals/priorities.







# Questions?

Washington, DC (Anna Lowe/Pexels)

