



U.S. Department of Transportation  
**Federal Highway Administration**



NATIONAL DIALOGUE ON  
**HIGHWAY AUTOMATION**

# FHWA National Dialogue on Highway Automation

Operations

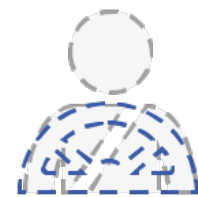
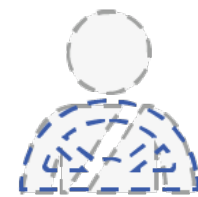
Delta Hotels Phoenix Mesa, Mesa, AZ

October 24-25, 2018

# Levels of Automation

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.



# USDOT Modal Agencies and Roles



Federal Highway Administration (FHWA)



Federal Motor Carrier Safety Administration (FMCSA)



Federal Transit Administration (FTA)



National Highway Traffic Safety Administration (NHTSA)



Maritime Administration (MARAD)



Pipeline and Hazardous Materials Safety Administration (PHMSA)



Federal Railroad Administration (FRA)



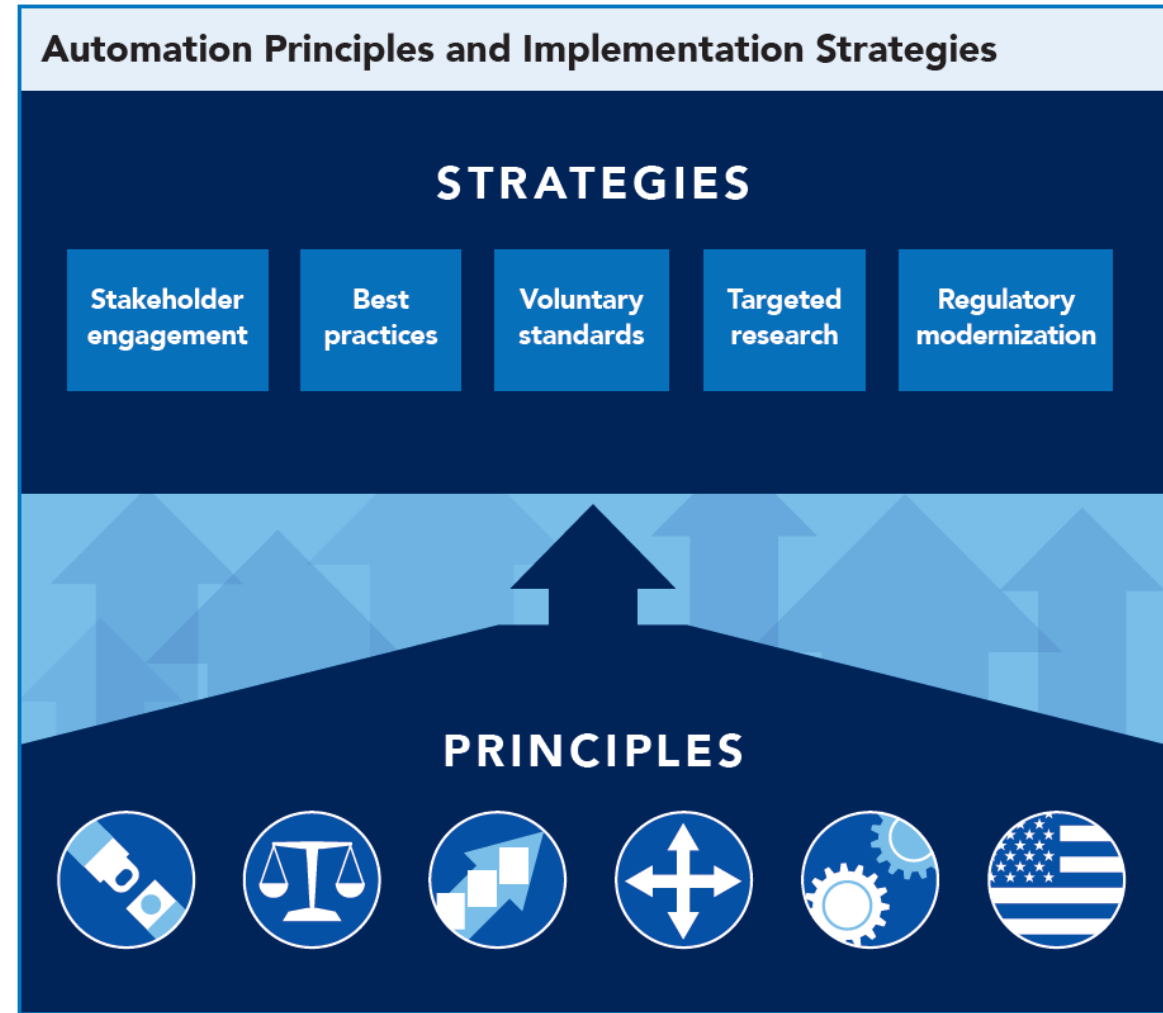
# FHWA Released Request for Information (RFI) in March 2018

## *Select Themes:*

- Greater **Uniformity and Quality** in road markings and traffic control devices would enable automation.
- FHWA should take a **Leadership** role in convening stakeholders to encourage collaboration.
- Certain **Data Elements** about the roadway environment are useful for industry, State, and local DOTs to share and could improve automation operations.
- Conducting **Pilots** and supporting pilot testing are important for facilitating learning and collaboration.
- **Uncertainty** in infrastructure investment and allocation of limited resources are key concerns for State and local agencies.

# AV 3.0 Released in October 2018

- Automated Vehicles 3.0 provides:
  1. New multimodal safety guidance
  2. Clarifies policy and roles
  3. Outlines how to work with U.S. DOT as automation technology evolves
- U.S. DOT will use the automation principles and strategies defined in figure at right



# AV 3.0 --- FHWA's Authorities Over Traffic Control Devices

1. U.S. DOT recognizes that the quality and uniformity of road markings, signage, and other traffic control devices support safe and efficient driving by both human drivers and automated vehicles.
2. The MUTCD is recognized as the national standard for all traffic control devices installed on any street, highway, bikeway, or private road open to public travel.
3. FHWA will pursue an update to the 2009 MUTCD that will take into consideration these new technologies and other needs.

# AV 3.0 --- Considerations for Infrastructure Owners and Operators (IOO)

U.S. DOT provides the following considerations for infrastructure owners and operators, including State DOTs, metropolitan planning organizations (MPOs), and local agencies.

1. Support safe testing and operations of automated vehicles on public roadways.
2. Learn from testing and pilots to support highway system readiness.
3. Build organizational capacity to prepare for automated vehicles in communities.
4. Identify data needs and opportunities to exchange data.
5. Collaborate with stakeholders to review the existing Uniform Vehicle Code (UVC).
6. Support scenario development and transportation planning for automation.

# What Is *Data for AV Integration*?

- Access to data is a limiting factor for AV deployment across all modes.
- Data exchanges can help increase access to data across traditional silos.
- U.S. DOT is using our convening power to understand critical needs for data exchange and the appropriate Federal role to enable them, using a common language.

*For more information, visit <https://www.transportation.gov/AV/Data> and see the draft **Framework for Data for AV Integration**.*



# The National Dialogue on Highway Automation

# What Are Desired Outcomes?

## *FHWA may use inputs to:*

1. Assess national issues and priorities.
2. Develop guidance, best practices, standards.
3. Support necessary research.
4. Adapt programs and policies.
5. Create a national community or coalition.



# Workshop Schedule

Month	Event	Location
June 7	National Dialogue Launch Workshop	Detroit, MI
June 26-27	National Workshop 1: Planning and Policy	Philadelphia, PA
July 12	Automated Vehicle Symposium FMCSA-FHWA Truck Automation Listening Session	San Francisco, CA
August 1-2	National Workshop 2: Digital Infrastructure and Data	Seattle, WA
September 5-6	National Workshop 3: Freight	Chicago, IL
October 24-25	National Workshop 4: Operations	Mesa (Phoenix), AZ
Nov. 14-15	National Workshop 5: Infrastructure Design and Safety	Dallas, Texas

# Themes: Launch Workshop

- FHWA has a clear role as a facilitator.
- A national vision for automation will help clarify goals.
- Clear communication about the technology helps to encourage public acceptance.
- A lack of consistency (i.e., traffic control devices, policies) can hinder adoption.
- Information sharing is important for enabling automated vehicles.
- There will be a transition period of a mixed-vehicle fleet, which will require interoperability.

# Themes: Policy and Planning Workshop

- The transportation planning process may need to evolve to address uncertainty of AV impacts (e.g., congestion, land use).
- Infrastructure investment and funding to raise overall condition enables not only automation, but all road users.
- Clearly defining roles and goals will help policy development.
- State and local agencies need education, resources, and guidance to support organizational readiness.

# Themes: Data/Digital Infrastructure Workshop

- Data exchange can accelerate safe integration of AVs (see next slide).
- Important to achieve data standardization where useful and tangible.
- Lifecycle management and upkeep of data are emerging issues.
- Further clarity needed around digital mapping --- who is building, level of detail needed, Federal role.
- Above activities may necessitate development and linkage of systems and technologies.

# Themes: Freight Workshop

- Safety and efficiency are key priorities for the freight industry and its customers.
- How data can be used to enhance freight operations and in context of specific parts of a trip is important (e.g., last-mile delivery, highways, etc.).
- May be useful to evaluate physical infrastructure design needs that may include designated truck lanes, impacts/changes to interchanges, and space at intermodal facilities for mode transfer (rail to truck).
- Consider research and engineering studies to determine loading patterns of automated (freight) vehicles and their impacts on the road infrastructure.

# Operations



# What Is TSMO?

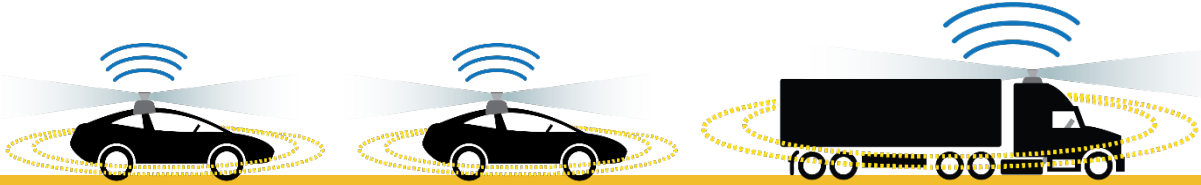
## Transportation Systems Management and Operations

“[A set of] integrated strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects.” (MAP-21, Section 1103, a, 30)

“Integrated strategies” means:

- Regional integration
- Intermodal coordination
- Interagency collaboration
- Technical integration

# COOPERATIVE AUTOMATION Research Program



Safely improve the operational efficiency and maximize capacity of our Nation's urban and rural roadways

RESEARCH FOCUSED ON ARTERIALS AND FREEWAYS



Source: FHWA.

Reduce fuel consumption at intersections by 20%.



Source: FHWA.

Fuel savings of 10%.



Source: FHWA.

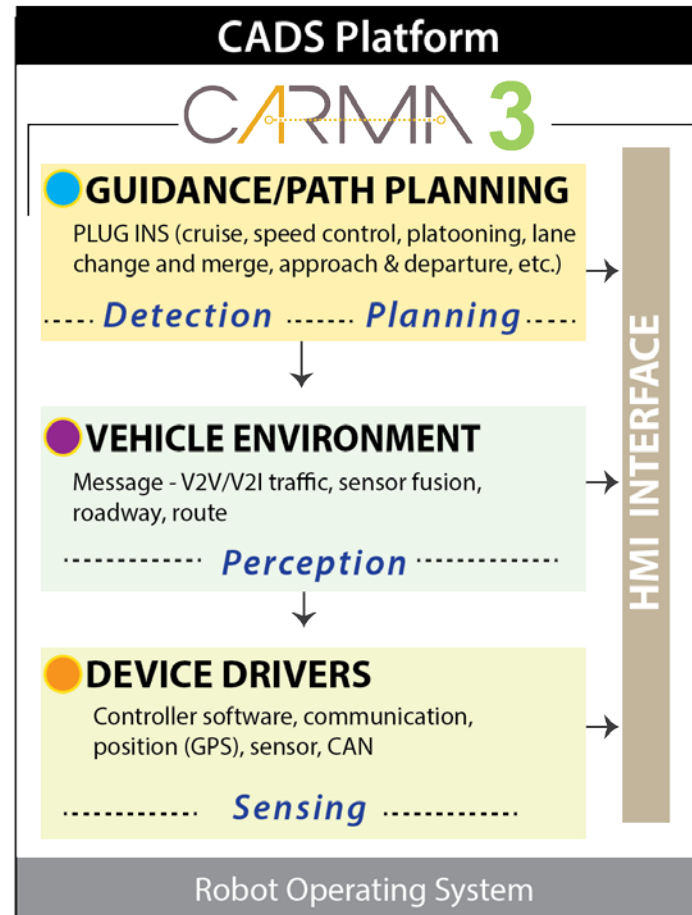
Double capacity of existing lanes.



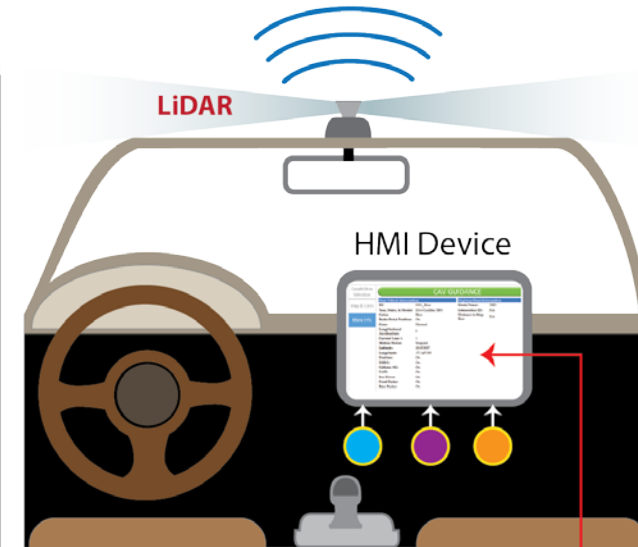
# CARMA 3 Cooperative Automation Research Mobility Applications SOFTWARE ARCHITECTURE

**CARMA FACTS**

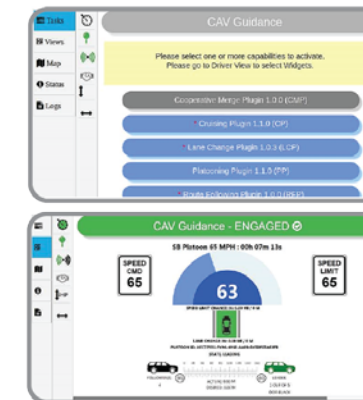
- 3 Week sprint cycles
- 6 Quarterly webinars
- 7 ADS-equipped vehicles
- Unlimited Partnerships



Source: FHWA.



### User Interface Examples



V2V: Vehicle-to-Vehicle.

LiDAR: Laser Imaging, Detection, and Ranging.

CAN: Controller Area Network.

HMI: Human Machine Interface.

V2I: Vehicle-to-Infrastructure.

GPS: Global Positioning System.

CADS: Cooperative Automation Driving Systems.

*A platform developed in the open using agile software development process to collaborate with stakeholder community*

# Cooperative Automation USE CASES

TSMO PROOF OF CONCEPT  
TESTING AND EVALUATION



U.S. Department of Transportation  
Federal Highway Administration

# 1

## Basic Travel



Source: FHWA.

### Example scenarios:

- Engage in a platoon defined by a geofence.
- Leader maintains safe time gap.
- Followers maintain inter-platoon time gap.
- Platoon size 5-car to 2-car for one of the lanes.
- Possible maneuvers with other CADS-equipped vehicles.

# 2

## Work Zones



Source: FHWA.

### Example scenarios:

- Reduced command speed entering work zone.
- Defined by a stationary geofence.
- Lane change assignment prior to entering work zone.
- Maintain safe time gap through the work zone.
- Possible maneuvers with other CADS-equipped vehicles.

# 3

## Weather



Source: FHWA.

### Example scenarios:

- Reduced command speed entering low visibility weather.
- Defined by a dynamic geofence.
- Engage in larger time gap.
- Maintain lane guidance.
- Possible maneuvers with other CADS-equipped vehicles.

# 4

## Traffic Incident Management (TIM)



Source: FHWA.

### Example scenarios:

- Reduced command speed entering traffic incident event.
- Determined by infield geofence.
- Lane change to provide space for first responders.
- Possible maneuvers with other CADS-equipped vehicles.



# Potential Challenges for Discussion

- Priority issues or challenges for traffic operations.
- Identify use cases or operational scenarios involving AVs that need further attention.
- Near-term operations challenges, especially as IOOs are interacting with AV pilots, demonstrations, and deployments.
- Ensuring the safety of emergency responders and others working in the roadway.
- Preparing for managing system efficiency while AVs operate on roadways.
- Information collection/exchange/sharing to support AV operations.
- FHWA roles in supporting IOOs, industry, and the transportation community to support safe and efficient AV operations, as part of the broader transportation network.

**Contact:**  
**HighwayAutomation@dot.gov**

# Glossary of Terms

- **INFRASTRUCTURE OWNER OR OPERATOR (IOO):** Generally refers to entities responsible for the design, build, maintenance and operation of the roadway infrastructure. For example, this would include State and local departments of transportation.
- **OPERATIONAL DESIGN DOMAIN (ODD):** The operating conditions under which a given driving automation system or feature is specifically designed to function, which includes but is not limited to, environmental, geographical, and time-of-day restrictions, and/or the presence or absence of certain traffic or roadway characteristics.
- **ORIGINAL EQUIPMENT MANUFACTURER (OEM):** Refers to the original producer or manufacturer of a vehicle's components. The term is regularly used to describe vehicle or automotive manufacturers.

