U.S. Department of Transportation

# Connected and Automated Vehicle Activities in the United States

## SIP-adus Workshop on Connected and Automated Driving Systems

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# Preparing for the Future of Transportation: *Automated Vehicles 3.0*


https://www.transportation.gov/av/3

# *Automated Vehicles 3.0*: Principles

U.S. DOT has established a clear and consistent Federal approach to shaping policy for automated vehicles, based on the following six principles.

1. We will prioritize safety.

2. We will remain technology neutral.

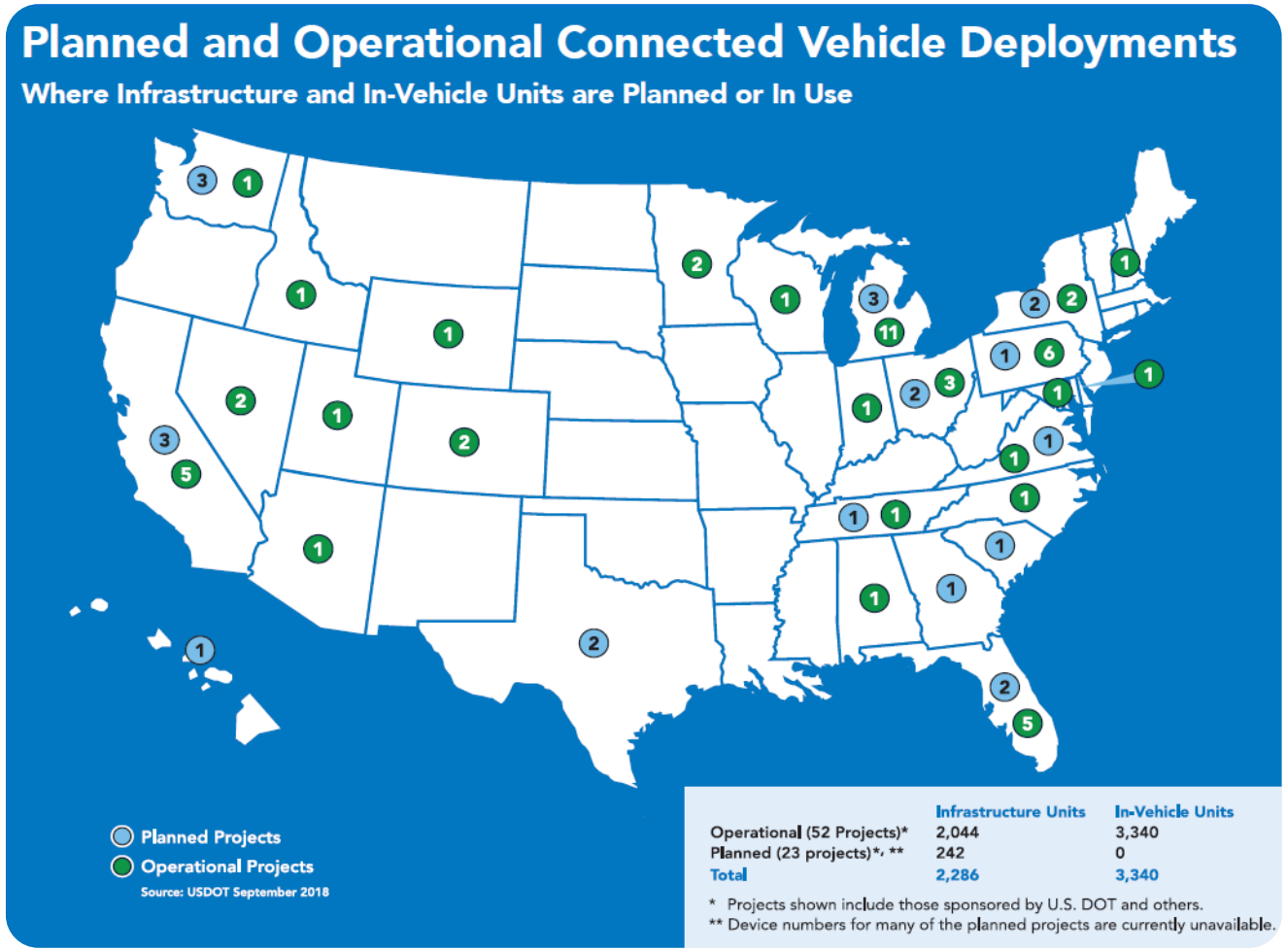
3. We will modernize regulations.

4. We will encourage a consistent regulatory and operational environment.

5. We will prepare proactively for automation.

6. We will protect and enhance the freedoms enjoyed by Americans.

# *AV 3.0*: Cooperative Automation and Connectivity




- More than 70 active deployments of V2X communications utilizing the 5.9 GHz band.
- During the past 20 years, the U.S. DOT has invested over $700 million in research and development of V2X through partnerships with industry and state/local governments.
- U.S. DOT is continuing its work to preserve the ability for transportation safety applications to function in the 5.9 GHz spectrum.

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# Consolidated Appropriations Act, 2018

- Signed into law on March 23, 2018
- Funds highly automated vehicle research and development
- Reallocates a total of $100 million for automation activities, including:
  - Up to $38 million for direct research
  - Up to $60 million for demonstration grants
  - Up to $1.5 million for analysis of impacts on drivers and operators of commercial motor vehicles, in consultation with Department of Labor
- Additional funding for NHTSA and OST
- https://www.congress.gov/bill/115th-congress/house-bill/1625

# Connected Vehicle Pilots Update

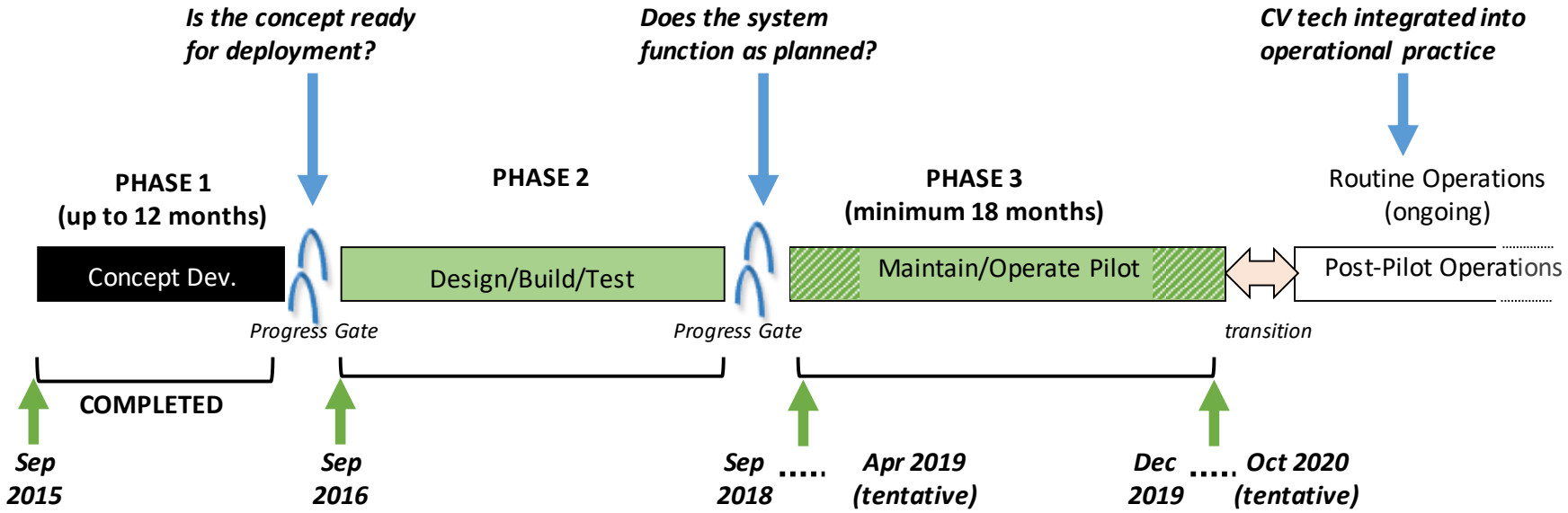
# The Three Pilot Sites


- Reduce the number and severity of adverse weather–related incidents in the I–80 Corridor in order to improve safety and reduce incident–related delays.
- Focused on the needs of commercial vehicle operators in the State of Wyoming.


- Improve safety and mobility of travelers in New York City through connected vehicle technologies.
- Vehicle to vehicle (V2V) technology installed in up to 8,000 vehicles in Midtown Manhattan, and vehicle to infrastructure (V2I) technology installed along high–accident rate arterials in Manhattan and Central Brooklyn.


- Alleviate congestion and improve safety during morning commuting hours.
- Deploy a variety of connected vehicle technologies on and in the vicinity of reversible express lanes and three major arterials in downtown Tampa to solve the transportation challenges.

# CV Pilot Deployment Schedule




- **Phase 1: Concept Development** (COMPLETE)
  - Creates the foundational plan to enable further design and deployment.
- **Phase 2: Design/Deploy/Test**
  - Detailed design and deployment followed by testing to ensure deployment functions as intended (both technically and institutionally).
- **Phase 3: Maintain/Operate**
  - Focus is on assessing the performance of the deployed system.
- Post Pilot Operations (CV tech integrated into operational practice).

***Last updated: August 2, 2018***

# CV Device Deployment Status (As of October 2018)

| WYDOT – Devices | Target | Complete |
|---|---|---|
| Roadside Unit (RSU) | 75 | 47 |
| WYDOT Maintenance Fleet Subsystem On-Board Unit (OBU) | 90 | N/A |
| Integrated Commercial Truck Subsystem OBU | 25 | N/A |
| Retrofit Vehicle Subsystem OBU | 255 | N/A |
| WYDOT Highway Patrol | 35 | N/A |
| Total Equipped Vehicles | 405 | 25 |

| Tampa (THEA) – Devices | Target | Complete |
|---|---|---|
| Roadside Unit (RSU) at Intersection | 44 | 44 |
| Vehicle Equipped with On-Board Unit (OBU) | 1,580 | 861 |
| HART Transit Bus Equipped with OBU | 10 | 10 |
| TECO Line Street Car Equipped with OBU | 10 | 10 |
| Total Equipped Vehicles | 1,600 | 881 |

| NYCDOT – Devices | Target | Complete |
|---|---|---|
| Roadside Unit (RSU) at Manhattan and Brooklyn Intersections and FDR Drive | 353 | 7 |
| Taxi Equipped with Aftermarket Safety Device (ASD)* | 2,500 - 5,850 | 10 |
| MTA Fleet Equipped with ASD* | 700 | 2 |
| UPS Truck Equipped with ASD* | 400 | 0 |
| NYCDOT Fleet Equipped with ASD* | 2,500 - 5,850 | 57 |
| DSNY Fleet Equipped with ASD* | 250 | 1 |
| Vulnerable Road User (Pedestrians/Bicyclists) Device | 100 | 0 |
| PED Detection System | 10 + 1 spare | 0 |
| Total Equipped Vehicles | 8,000 | 70 |

*MTA: Metropolitan Transportation Authority; DSNY: City of New York Department of Sanitation*

# Cooperative Automation Research

# Cooperative Automation Research Mobility Applications (CARMA)

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

**RESEARCH FOCUSED ON ARTERIAL AND FREEWAYS**

Source: FHWA.

**Reduce fuel consumption at intersections by 20 percent.**

Source: FHWA.

**Fuel savings of 10 percent.**

Source: FHWA.

**Double capacity of existing lanes.**

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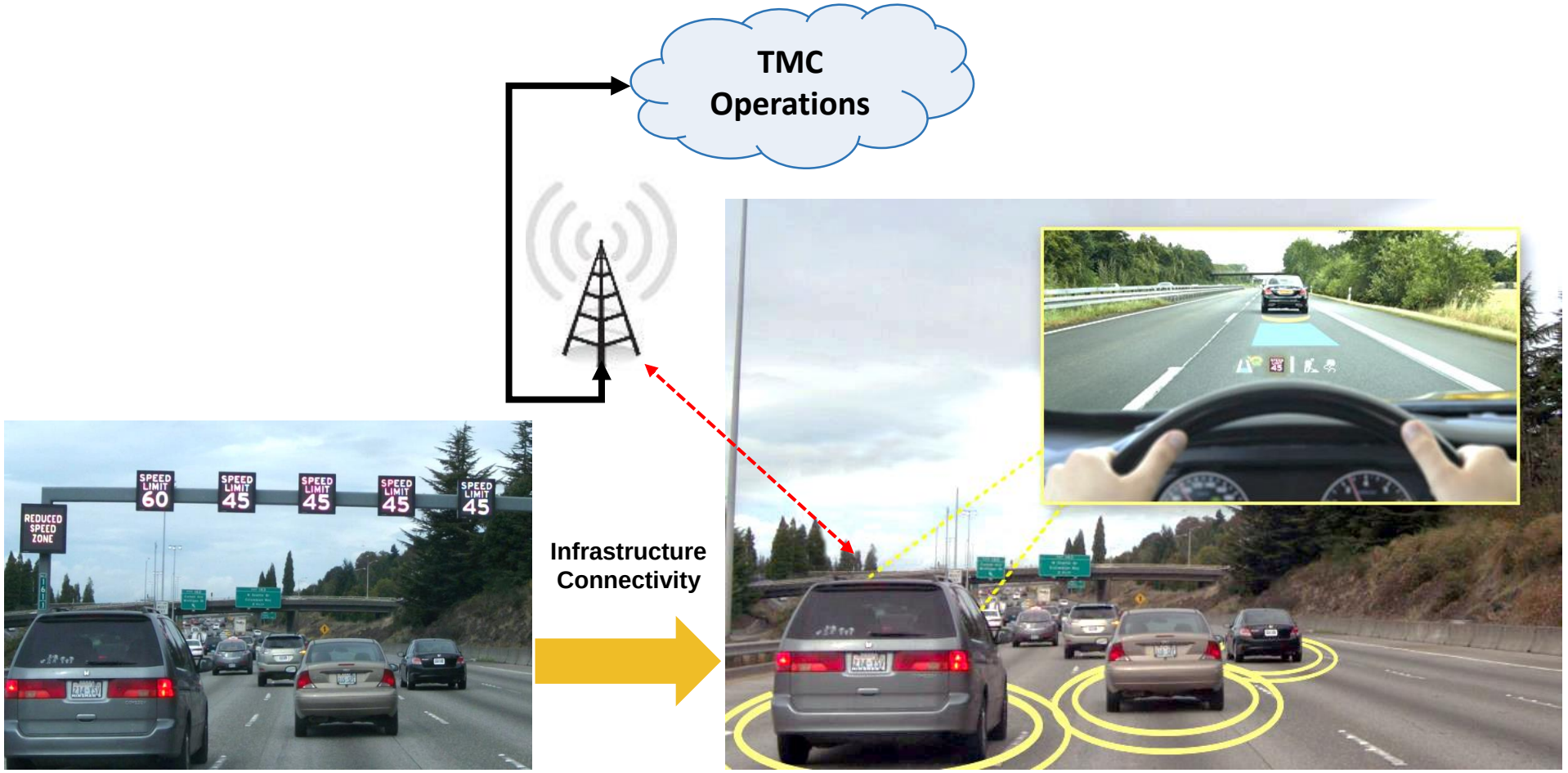
**Federal Highway Administration**

# Connectivity

## Important for Managing Our Transportation System

- Introduction to Cooperative Automated Driving Systems (CADS).
- New Uses Cases for Transportation Systems Management and Operations (TSMO).




Source: FHWA.

**Today – Expensive Infrastructure**

Source: FHWA.

**Tomorrow – Connectivity**

TMC: Traffic Management Center.

# EVOLUTION

## Cooperative Automation Research Mobility Applications (CARMA)

### CARMA1 (2014-2016)

- Initial proof of concept.
- Collection of individual applications.
- Simulink/dSpace running on MicroAutobox.
- Demonstrated several applications:
  - Developed platooning algorithm.
  - Modified eco-approach and departure (EAD) algorithm.
  - Modified speed harmonization algorithm.
  - Modified lane change and merge algorithm.

### CARMA2 (2016-2018)

- Society of Automotive Engineers (SAE) level 1 automation (speed control) and level 2 capable.
- Built on top of Robot Operating System (ROS).
- Flexible – can be installed on several types/modes of vehicles.
- Accepts third-party plugins for research applications (guidance algorithms).
- Includes simple applications:
  - Cruising with adaptive cruise control (ACC).
  - Cooperative lane change.
  - Mixed platoons.
  - Signalized intersections.
  - Speed harmonization.

### CARMA3 (2018-2020)

- SAE level 2 automation (speed and steering control) and level 3 capable.
- More sophisticated vocabulary of cooperation, vehicle-to-vehicle (V2V).
- Leveraging Autoware platform.
- Enhanced lane change and merge/weave.
- Enhanced platooning (cars and trucks).
- Emphasis on infrastructure interactions for TSMO.
  - Work zones, traffic incident management, weather events, etc.
- Emergency vehicle applications and interactions.

# For More Information on CARMA

https://github.com/usdot-fhwa-stol

https://usdot-carma.atlassian.net/wiki

https://highways.dot.gov/research/research-programs/operations/CARMA/

# Truck Platooning Early Deployment Assessment

- Broad Agency Announcement on August 30, 2018
  - Phase 1 for up to 3 awards for concept development. Proposals received November 6, 2018
  - Phase 2: Test, deploy, and evaluate on public roads 2019–2020

- Objectives
  - Safety best practices for operators and State agencies
  - Behavior of other road users
  - Benefits measured in real conditions

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