U.S. Department of Transportation

U.S. DOT Cooperative Driving Automation Research

SIP-adus Workshop 2020
Connected Vehicles Session

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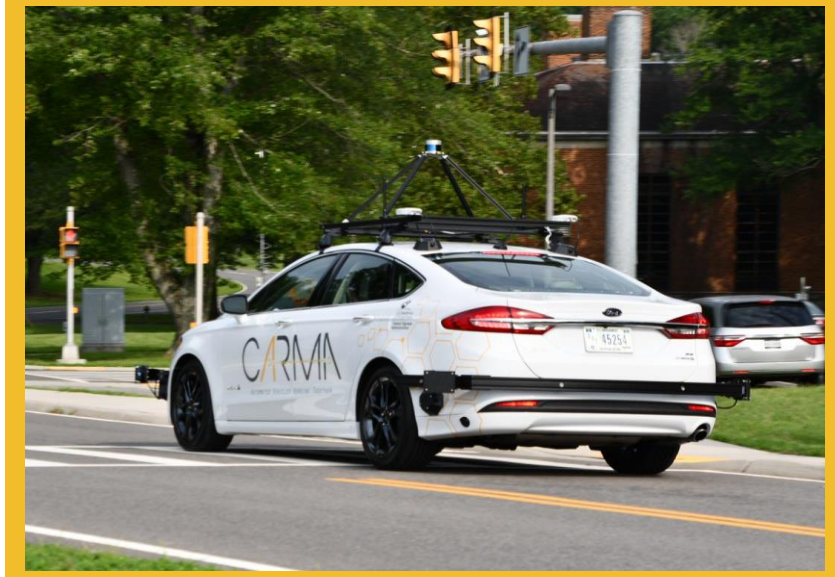
Overview

- **Cooperative Driving Automation (CDA)**: Automation that uses machine-to-machine communication to enable cooperation among two or more entities with capable communications technology and is intended to facilitate the safer, more efficient movement of road users.
- **This presentation**:
  - Spectrum and standards for CDA
  - USDOT CDA field test projects

Benefits of Cooperative Driving Automation

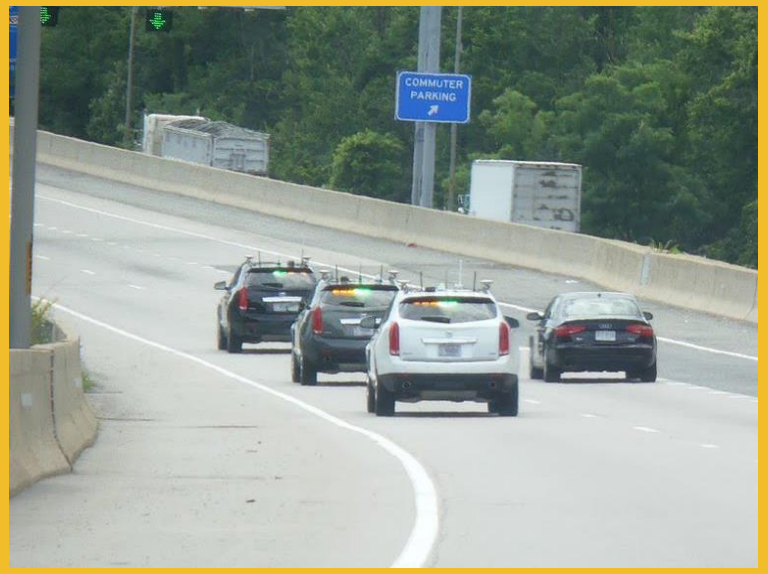
Icon source: FHWA.

RESEARCH FOCUSES ON **AUTOMATED VEHICLES WORKING TOGETHER AND WITH ROADWAY INFRASTRUCTURE** TO INCREASE SAFETY AND IMPROVE OPERATIONAL EFFICENCY.



Source: FHWA.

Reduce fuel consumption at intersections by 20 percent



Source: FHWA.

Double capacity of existing lanes

Source: FHWA.

Fuel savings of 10 percent

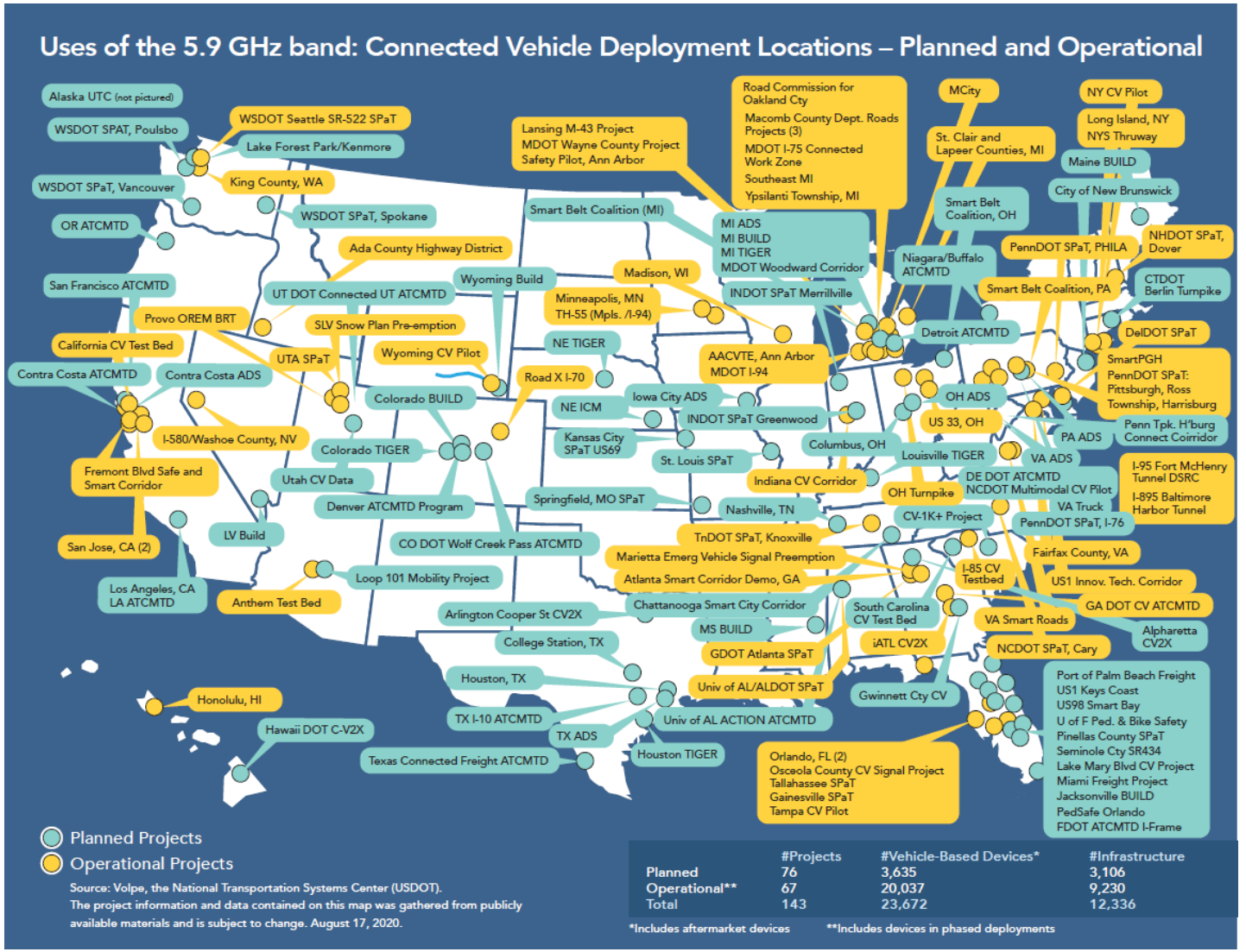
Spectrum (5.9 GHz Safety Band)

143 Projects
(67 operational, 76 planned)

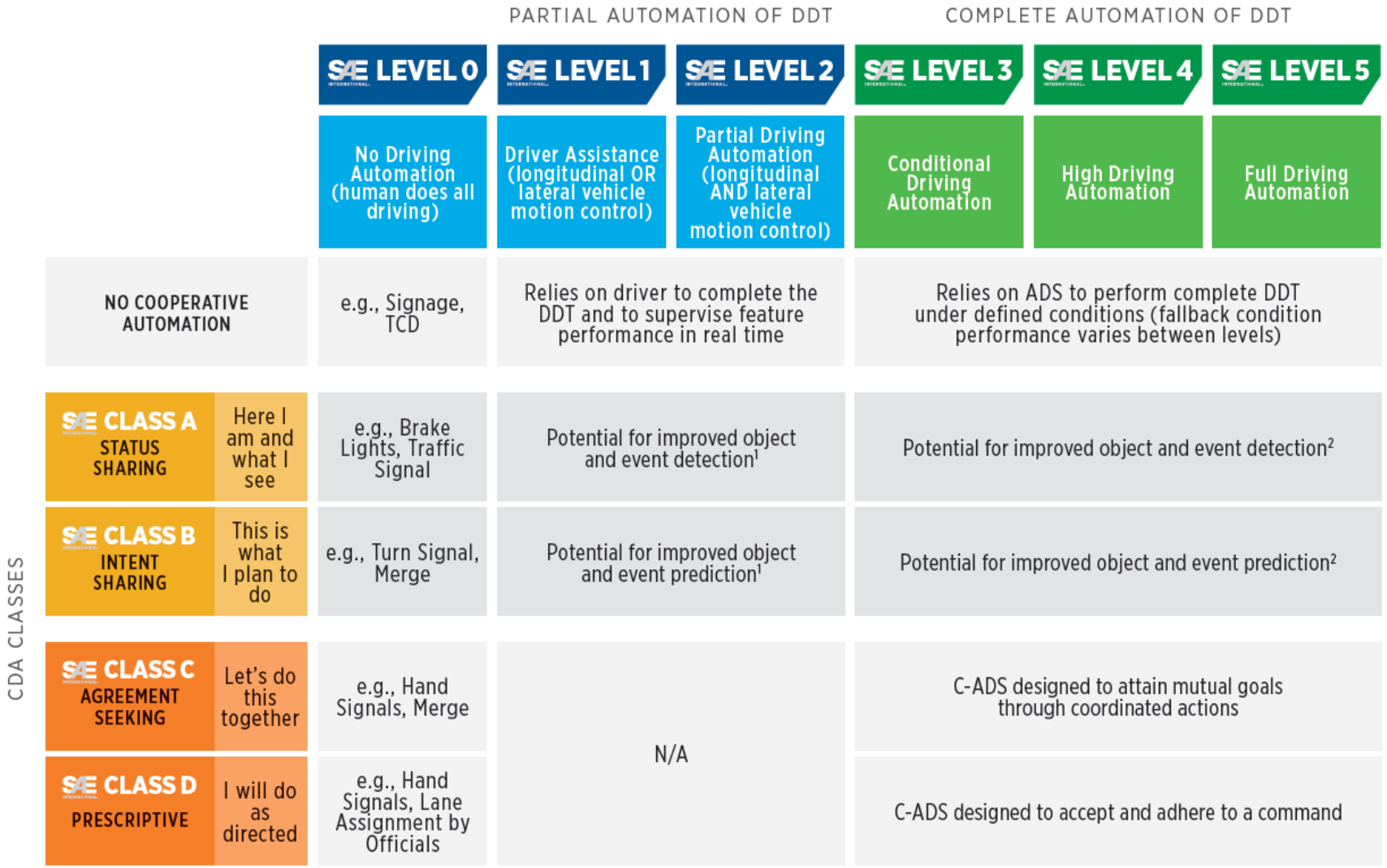
23,672 OBUs
(20,037 operational, 3,635 planned)

12,336 RSUs
(9,230 operational 3,106 planned)

For more information, visit:
https://www.transportation.gov/content/safety-band



RELATIONSHIP BETWEEN CLASSES OF COOPERATIVE DRIVING AUTOMATION (CDA) J3216 AND LEVELS OF AUTOMATION J3016



		PARTIAL AUTOMATION OF DDT			COMPLETE AUTOMATION OF DDT		
		SAE LEVEL 0	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
		No Driving Automation (human does all driving)	Driver Assistance (longitudinal OR lateral vehicle motion control)	Partial Driving Automation (longitudinal AND lateral vehicle motion control)	Conditional Driving Automation	High Driving Automation	Full Driving Automation
NO COOPERATIVE AUTOMATION		e.g., Signage, TCD	Relies on driver to complete the DDT and to supervise feature performance in real time		Relies on ADS to perform complete DDT under defined conditions (fallback condition performance varies between levels)		
CDA CLASSES	SAE CLASS A STATUS SHARING	Here I am and what I see	e.g., Brake Lights, Traffic Signal	Potential for improved object and event detection[1]		Potential for improved object and event detection[2]	
	SAE CLASS B INTENT SHARING	This is what I plan to do	e.g., Turn Signal, Merge	Potential for improved object and event prediction[1]		Potential for improved object and event prediction[2]	
	SAE CLASS C AGREEMENT SEEKING	Let's do this together	e.g., Hand Signals, Merge	N/A		C-ADS designed to attain mutual goals through coordinated actions	
	SAE CLASS D PRESCRIPTIVE	I will do as directed	e.g., Hand Signals, Lane Assignment by Officials			C-ADS designed to accept and adhere to a command	

1 Improved object and event detection and prediction through CDA Class A and B status and intent sharing may not always be realized, given that Level 1 and 2 driving automation features may be overridden by the driver at any time, and otherwise have limited sensing capabilities compared to Level 3, 4 and 5 ADS-operated vehicles.

2 Class A and B communications are one of many inputs to an ADS's object and event detection and prediction capability, which may not be improved by the CDA message.

P20542738

- J3216 established **4 Cooperation Classes** for Machine-to-Machine sharing information of road users in the Transportation System
- SAE J3216 is now available at SAE.org for free

Ongoing U.S. DOT CDA Pilot Projects

- CARMA
- Truck Platooning Early Deployment Assessment
- Traffic Optimization for Signalized Corridors (TOSCo)

What is the CARMA Program?

The USDOT's initiative focused on improving the transportation system by leveraging emerging automated driving technology and vehicle-to-everything (V2X) technology to enable increased safety and operational performance in moving people and goods.

Source: FHWA

CARMA Research Vehicle Fleet

Source: FHWA

CARMA Use Cases

TRAFFIC

Recurring traffic congestion use cases on freeways and arterials.

- Congestion
- Transit
- Traffic Signals

USDOT Partners:
FHWA | HRDSO | HOTM | RC
ITSJPO | **FTA** | **FMCSA**

RELIABILITY

Nonrecurring traffic congestion use cases on freeways and arterials.

- Work Zones
- Weather
- Traffic Incident Management (TIM)

USDOT Partners:
FHWA | HRDSO | HOTO | RC
ITSJPO | **FMCSA**

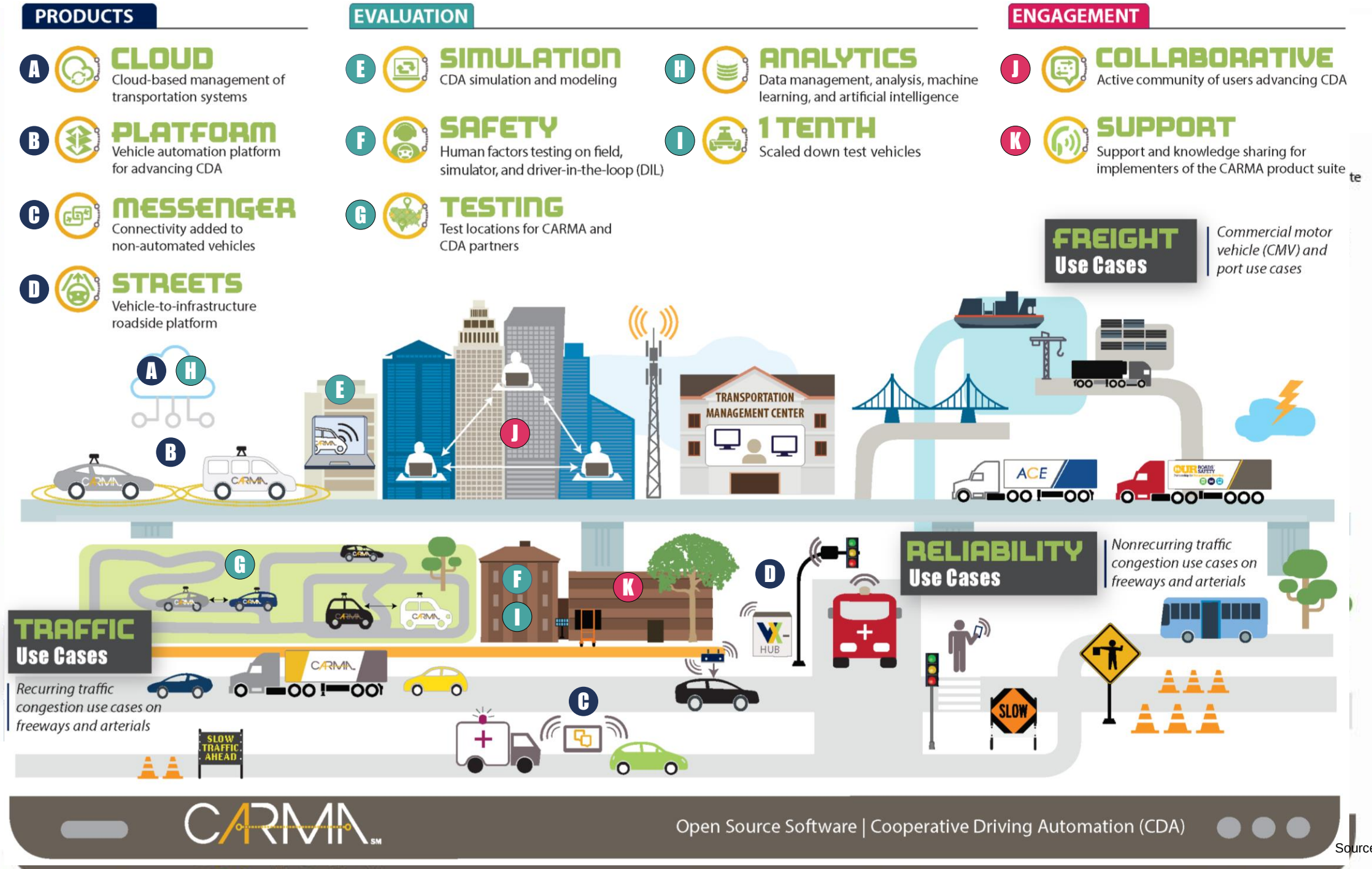
FREIGHT

Commercial Motor Vehicle (CMV) and port use cases.

- Port Drayage
- Commercial Motor Vehicles (CMV)
- Truck Platooning

USDOT Partners:
FHWA | HRSDO | HOFM | RC
ITSJPO | **FMCSA** | **MARAD**

CARMA℠ Ecosystem



Source: FHWA.

Truck Platooning Early Deployment Assessment

What is Level 1 Truck Platooning?

- Employs longitudinal control only (throttle and brakes), driver steers the truck.
- Builds on production adaptive cruise control (ACC).
- Uses vehicle-to-vehicle (V2V) communication to deploy cooperative adaptive cruise control (CACC).

Source: FHWA

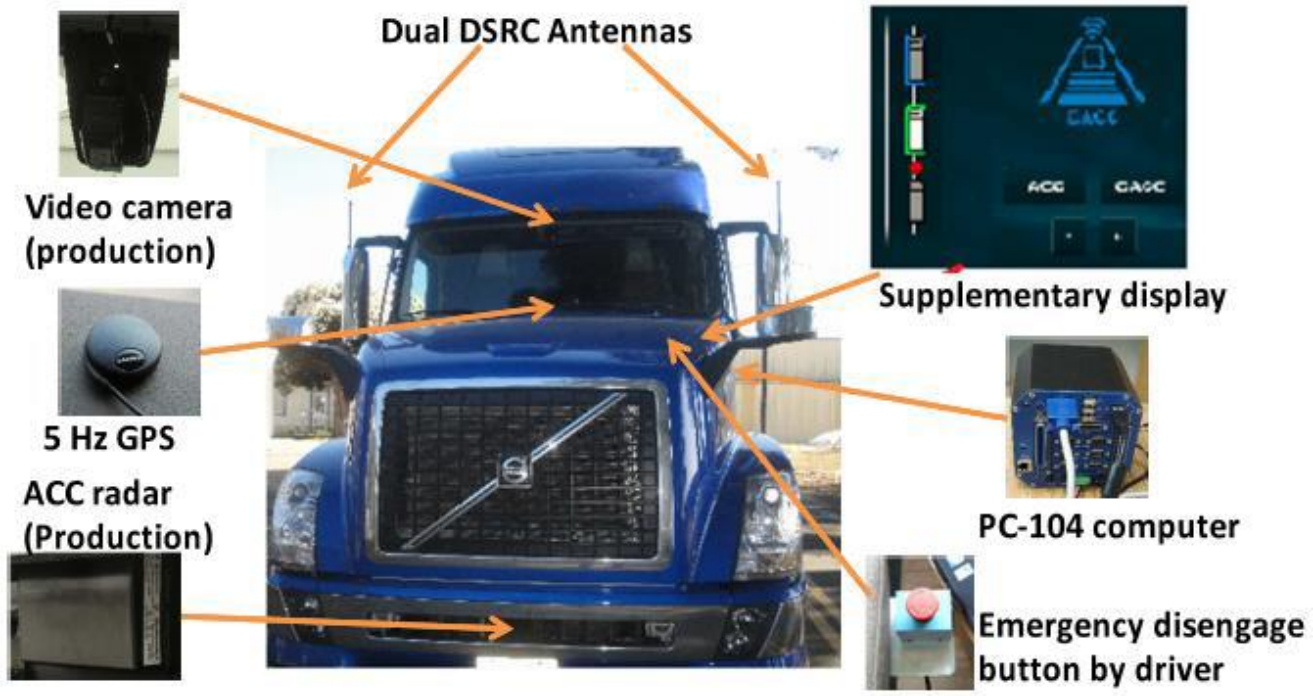
Truck Platooning Early Deployment Assessment
Goals and Background

- Goals:
  - Understand how truck platoons will behave in a regular operational environment.
  - Inform State and local stakeholders making decisions related to truck platooning regulations.
- Phased approach to manage risks and uncertainties in dynamic environment:
  - Phase 1 (March 2019 – December 2019): Pilot concept and proposal development.
  - Phase 2 (September 2020 – December 2022): Field Operational Test (FOT).

Source: FHWA

Truck Platooning Early Deployment Assessment
Phase 2 Field Operation Test Overview

- Project team:
  - California PATH (team lead and technology supplier)
  - Roly's Trucking (fleet operator)
  - Westat (human factors) and Cambridge Systematics (partnership)
  - Noblis (independent evaluator)
- Truck platooning system:
  - Implement PATH-CACC capability on 4 new trucks
  - 3 trucks for CACC/platooning field test and the 4th truck used as a "control truck" as baseline.

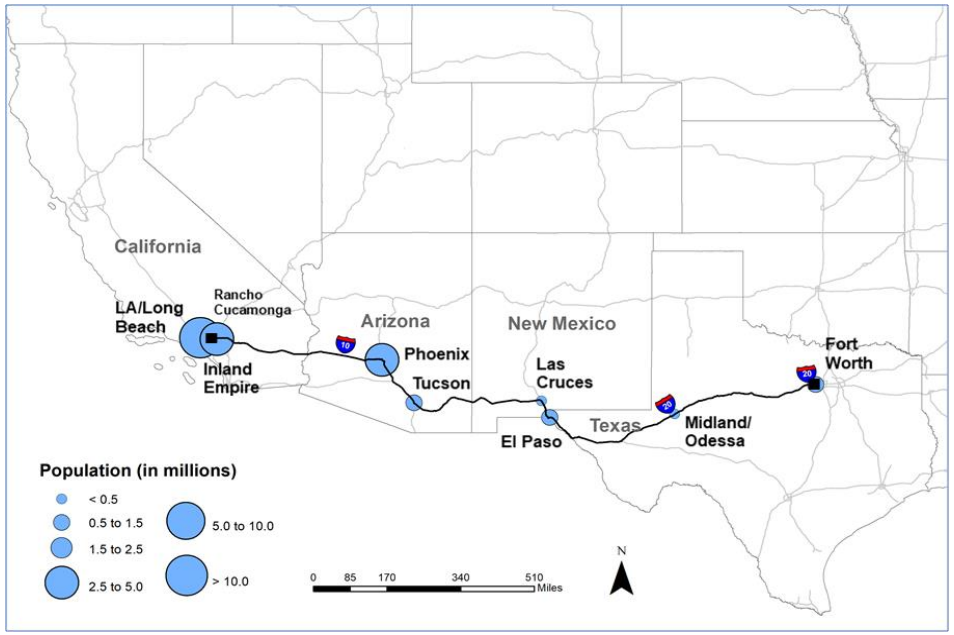


Source: California PATH

Truck Platooning Early Deployment Assessment

Phase 2 Field Operation Test Overview

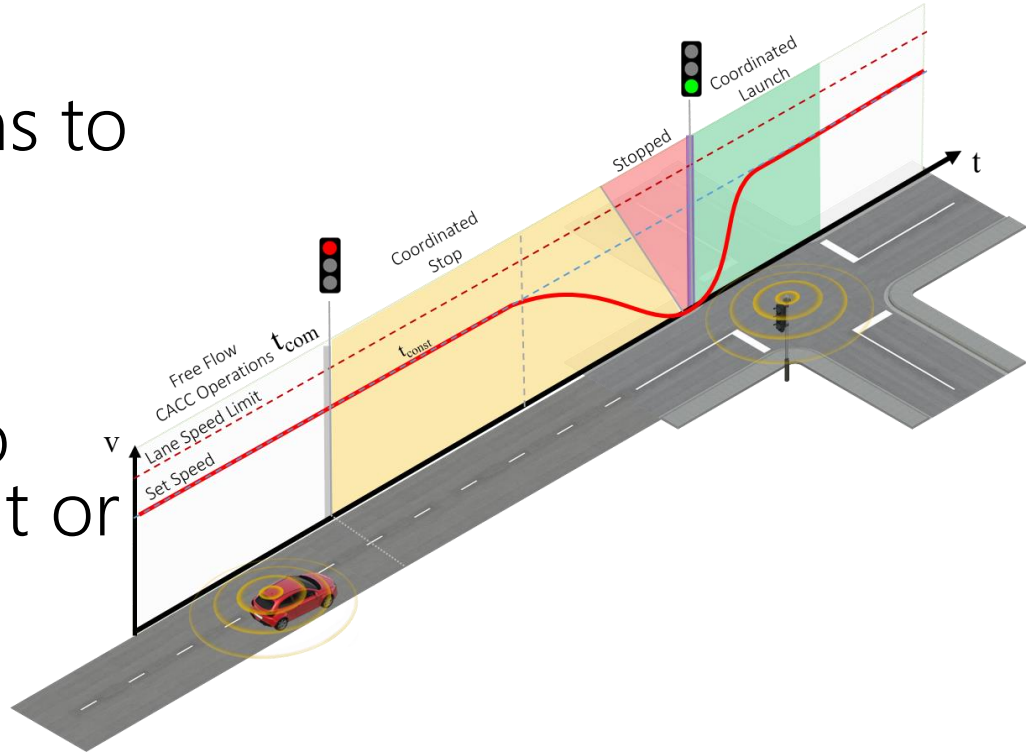
- Proposed route and experimental design:
  - California to Texas – 1,400 miles of I-10
  - California, Arizona, New Mexico, Texas
  - Four trucks and 20 drivers.
  - One round trip per week for one year.
- Data to be collected.
  - Engineering data:
    onboard sensors, J-1939 Bus, and DSRC
  - Extra sensors for surrounding traffic collection:
    fixed beam lidars and video cameras
  - Wireless modem connection with trucks for monitoring:
    CACC system operation and data logging health



Source: California PATH

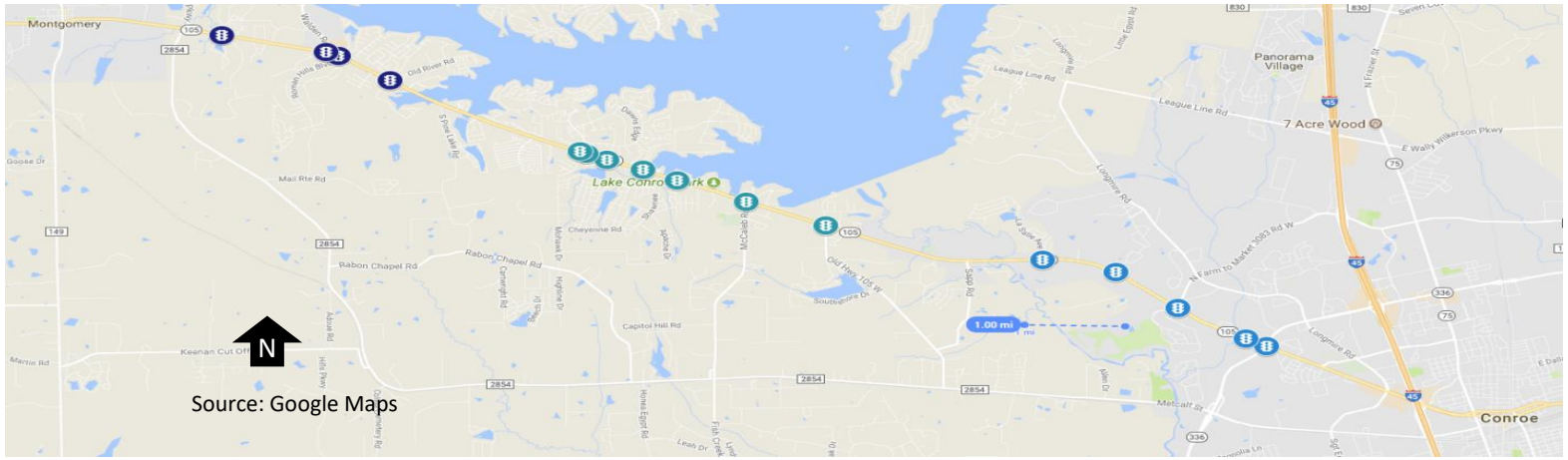
Traffic Optimization for Signalized Corridors (TOSCo)

- Sponsored by USDOT and the Crash Avoidance Metrics Partners LLC (CAMP) V2I Consortium
- V2X with equipped signalized intersections to optimize mobility, fuel economy and emissions while traveling along urban corridors of.
- Determines the vehicle's optimal speed to pass the next traffic signal on a green light or to decelerate to a stop in an eco-friendly manner.



TOSCo Phase II – Build & Test 2020-2022

- Most research related to connected vehicles occurs on low speed arterial (35-45 mph) range or freeways
- SH 105 - Conroe, TX Corridor Represents a high speed facility
  - 15 intersections between Montgomery, TX and Conroe, TX covering about 12 miles
  - Posted speed limit range: 45 mph (east end) to 55 mph (west end)



Source: Google Maps

Thank you!

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https://www.its.dot.gov/