



WASHINGTON STATE  
AUTONOMOUS VEHICLE  
WORK GROUP

# Infrastructure and Systems Subcommittee Report

## Activity 3, Action 2 SAE Level 1 and 2 Truck Platooning Report

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December 13, 2019



# SAE Level 1 and 2 Truck Platooning Report

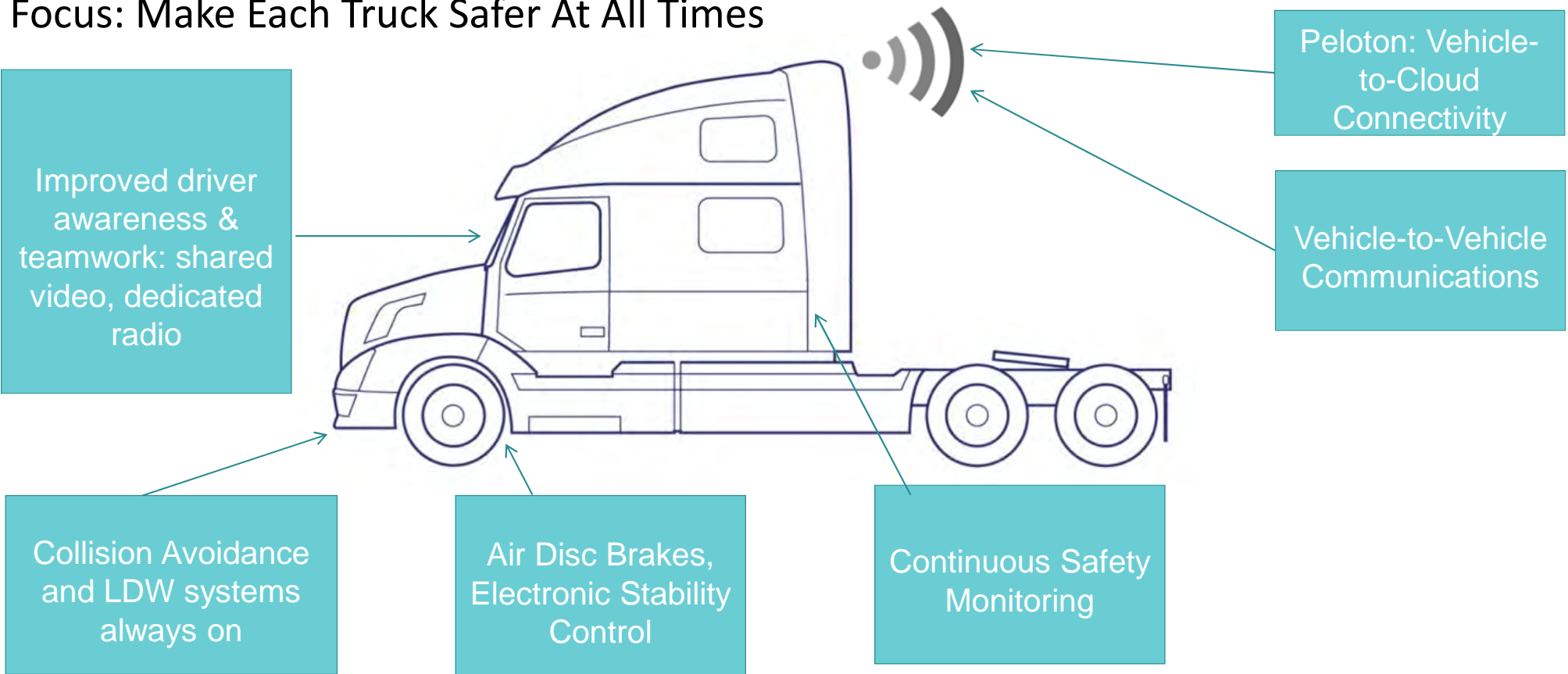


- **Action 2 Task:** Compile a Year-end report on SAE Level 1 and 2 Driver Assistive Truck Platooning Testing and Pilot Deployment Activity in the WA during 2019,
- **Report Overview:**
  - » Scope expanded to include 2019 SAE Level 1 and 2 truck platooning activity (commercial deployment/testing and federal government-funded research) in the U.S. including WA State.
  - » To provide context for the Subcommittee's evaluation of recent local truck platooning activity, the report also covers:
    - Notable international truck platooning activity
    - The regulatory landscape for U.S. truck platooning
    - Highway infrastructure and operations issues related to truck platooning
    - A brief forecast of future automated truck activity including automated platooning

# Platooning Systems Put Best-In-Class Safety on Each Truck



Focus: Make Each Truck Safer At All Times



Improved driver awareness & teamwork: shared video, dedicated radio

Collision Avoidance and LDW systems always on

Air Disc Brakes, Electronic Stability Control

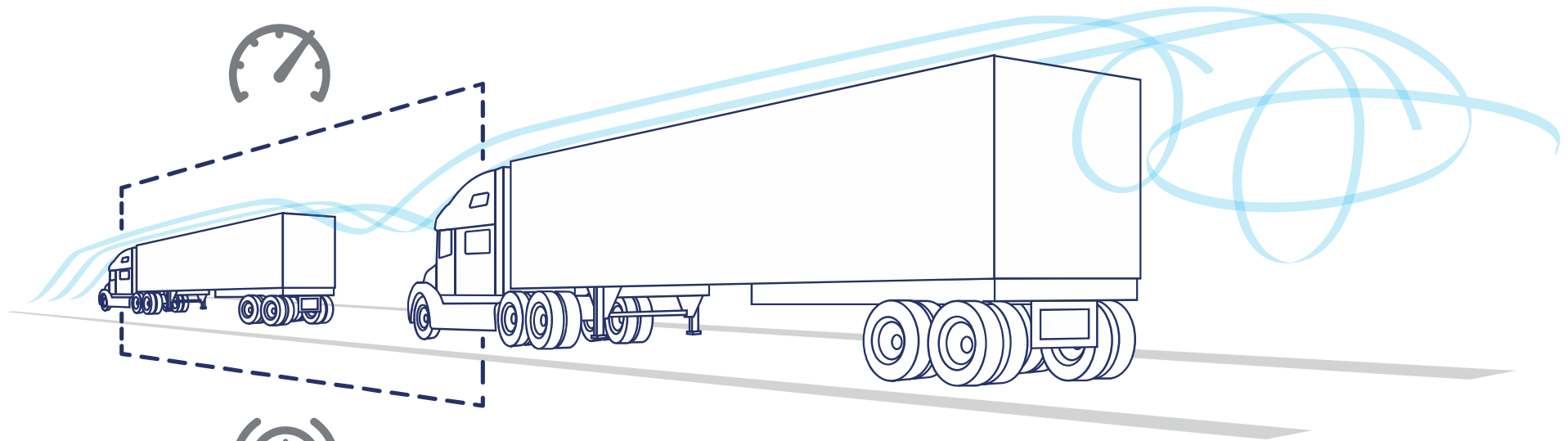
Continuous Safety Monitoring

Peloton: Vehicle-to-Cloud Connectivity

Vehicle-to-Vehicle Communications

# SAE Level 1-2 Platooning

2-3 Trucks, Linked Safety, Enhanced Driver Teamwork and Efficiency



## Front Driver

- **Steering**
- Feet on+ Collision Avoidance
- Eyes/Mind on



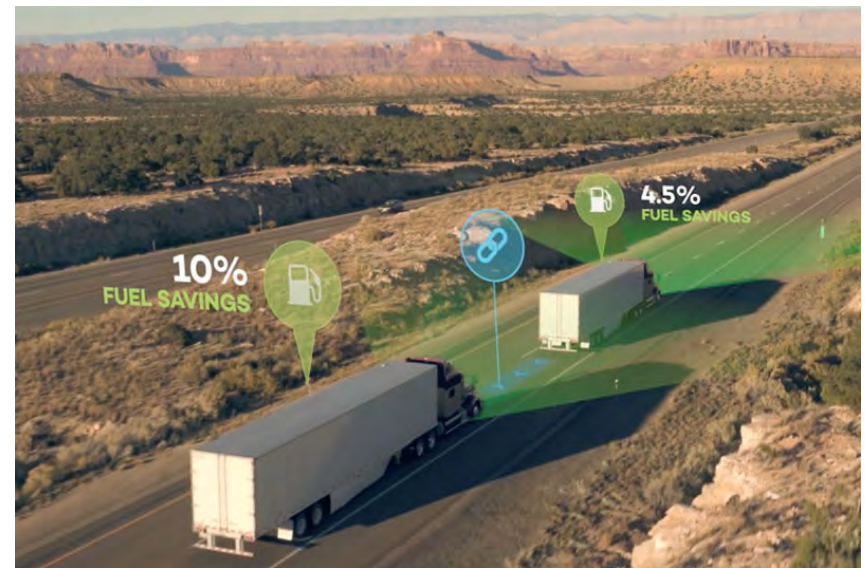
## Rear Driver

- **Actively Steering (Level 1)/ Not Actively Steering (Level 2)**
- **Feet off + Collision Avoidance**
- Eyes/Mind on

# Driver Assistive Truck Platooning: Benefits



- **Safety: Crash reduction and crash congestion-related fuel savings**
  - » NTSB: Widely deployed Collision Avoidance Systems could reduce ~80% of rear-end crashes
  - » NHTSA: Over \$3B annual savings and thousands of saved lives possible with full deployment of even earlier generation truck active safety systems (2015 study)
- **Driver Teamwork:** Enhanced Driver teamwork and awareness.
- **Fuel Economy:** ~7% average fuel savings across the pair of trucks (Peloton)
- **Air Quality:** Corresponding reductions in GHG & Diesel emissions
- **Insight:** High quality data-analytics/telematics for fleets
- **Mobility:** Increased freight efficiency and mobility





# Platooning Engagement & Testing Timeline in Washington State (2017-2019)



Date	Peloton Technology/PACCAR Engagement and Testing Activity Summary
Dec. 2017	Peloton Initiated meetings with WSDOT and WSP regarding possible SAE Level 1 platooning testing opportunities.
Oct. 2018	Peloton began PACCAR driver track training. PACCAR participated in track testing at PACCAR Technical Center related to vehicle integration.
Oct.-Dec. 2018	Peloton held meetings with and presentations to the WSTC, WSDOT, WSP, DOL, and Gov. Inslee's policy team regarding DOL self-certification under E.O. 17
Dec. 2018	Peloton self-certified with DOL and to conduct testing and communicated plans for testing along a short rural segment of I-5.
Dec. 19, 2018	Peloton (in coordination with PACCAR) held a one-day I-5 demo that included a ride-along for 7 WSP officers. Goal of the demo was to show how the system works, PlatoonPro's safety features, and the engagement level of each driver, and the enhanced teamwork between both drivers when operating the DATP system.
Jan. 2019	PACCAR did several days of testing on I-5 using PlatoonPro system that had been previously safety-validated and road tested in Texas and California. Goal of testing was to improve the quality of platooning for a specific PACCAR truck model (Kenworth T-680 trucks). Testing occurred in suitable weather and during non-peak traffic hours.
June-Oct. 2019	Peloton and PACCAR actively participated in multiple WA AV working group subcommittees to advance policy recommendations for AV testing legislation.
Dec. 2019	Peloton is developing an end of year report for the AV Executive Committee on platooning testing and deployment in the U.S including activity in WA to date.



## 12/19/18 I-5 Demo with WSP

- 7 WSP Officers participated in the demo ride
- I-5 Demo Route near PACCAR Technical Center
- **Route:** North of Burlington to Whatcom/Skagit County border and back
- Approximately 20-30 min loop
- 1 Trained PACCAR Driver / 1 Trained Peloton Driver

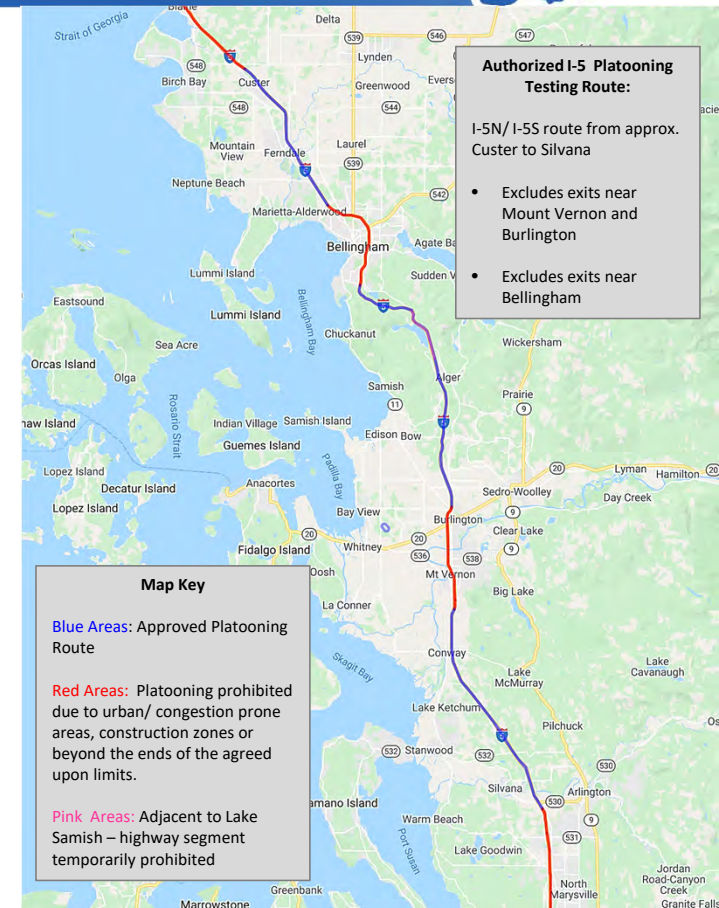
# WA State Driver-Assistive Truck Platooning Testing

## PACCAR/Peloton Activity (January 2019)



Following WSP demo, trained PACCAR test drivers did several days of testing on I-5 using Peloton's PlatoonPro system on a single pair of trucks.

- **Testing Authority:** PACCAR and Peloton self-certified with DOL under Gov. Inslee's E.O. 17.
- **Testing Goal:** Improve the quality of platooning for a specific PACCAR truck model (Kenworth T680 trucks).
- **Testing Conditions:** Testing occurred in non-inclement weather, on appropriate roadways for platooning, and during non-peak traffic hours.
- **System Criteria:** The two Kenworth T680 trucks equipped with the PlatoonPro system had previously been safety-validated and road tested in both Texas and California.



# 2019 SAE Level 1-2 U.S. Platooning Activity (Commercial)



- Peloton PlatoonPro Customer Trials
  - » Six customer fleets, most from *Transport Topics* Top 100 list
  - » Customer routes in TX, LA, and OK
  - » U.S. Interstate Customer Platooning Trials
    - Two trucks, multi-week, hauling customer freight
      - ✓ I-20 E/I-20 W & I-49 N/I-49 S between Wilmer, TX → Alexandria, LA,
      - ✓ I-35N/I-35S between Oklahoma City, OK → Roanoke, TX
- 2019 Commercial on road testing in CA, WA, & TX
- 2018 Commercial on road testing in
  - » Freightliner (Daimler): OR, NV
  - » Volvo/FedEx: NC
- Including activities in 2019, known on-highway truck platooning has occurred in at least 16 states:
  - » AL, AZ, CA, FL, LA, MI, NV, NM, NC, OK, OR, TX, TN, UT, VA, WA





# 2019 SAE Level 1-2 U.S. Platooning Activity (FHWA)



- **FHWA Human Factors Truck Platooning Project**

- » **Objective:** Investigating human factors issues affecting car drivers traveling near a driver-assistive truck platoon including:
  - Freeway entry/exit, visual indicator/other road user recognition of platooning, prior knowledge of platooning by other road users
- » **Approach:** Sign Laboratory Study & driving simulator study
- » Complements European Commission's ENSEMBLE project

- **FHWA Truck Platooning Early Deployment Assessments**

- » **Objective:** 3 project teams assessing technical and operational aspects of DATP truck platoons in commercial service
  - Battelle (using Volvo Group platooning technology)
  - California PATH (using Volvo Group / California PATH platooning technology)
  - CDM Smith (using Robert Bosch platooning technology)
- » Phase 1: \$500K Grants awarded in March 2019
- » Phase 2: 2020 timeframe for on-highway testing of operational concept and testing evaluation plan.



- **FHWA CARMA Platform**

- » Project to promote development by industry, universities and government of cooperative adaptive cruise control (CACC, of which platooning is one form).
- » Includes technologies for cars, trucks and infrastructure based on open-source software.
- » Project started in approximately 2017 and is now entering Phase 3.

# 2019 U.S. Platooning Activity (DOE / Army) (SAE Levels 1-4)



## Department of Energy



- **ARPA-E's (NEXTCAR) Program**

- » Project led by Purdue University with industry partners Cummins, Peloton Technology, Peterbilt Motors and ZF TMW Goal.
- » 3-year, \$5 million project
- » 2 trucks, Uses Peloton's SAE Level 1 Platooning Technology.
- » **Objective:** Improve the fuel efficiency of Class 8 trucks by net 20% by co-optimizing vehicle dynamic controls and powertrain operation, with an incremental vehicle cost increase of under \$3,000.
- » 2019 Track testing: TX; 2020: On Highway Testing with routes TBD.

- **American Center for Mobility**

- » Project partners include Auburn University, University of Michigan-Dearborn, Michigan DOT, DOE's National Renewable Energy Laboratory (NREL) and the U.S. Army's Tank Automotive Research, Development and Engineering Center (TARDEC).
- » **Objective:** By 2020, develop and demonstrate an SAE Level 4 (L4) truck platooning system -- controlling throttle, braking and steering.
- » Study began in late 2018.

## U.S. Army



- **TARDEC's Leader-Follower Evaluation**

- » Partnered with contractors Lockheed-Martin, Oshkosh and Robotic Research.
- » Year-long evaluation.
- » **Objective:** Exploring SAE L1/L4 automated following and other operating modes such as driver warning, driver assist and teleoperation for military applications to allow the Army to compare a platoon of optionally manned vehicles to a platoon of manned systems. Comparison will help determine whether the new capability improves the unit's performance or provides strategic advantage.
- » Combined 60 trucks equipped with platooning technology sent to two truck company units (Fort Polk, LA and Fort Sill, OK) by 2020.

- **Auburn University**

- » Led by Auburn University.
- » Working with IS4S to demonstrate truck platooning with up to six vehicles operating at Level 3-4 and possibly unmanned following with unmanned followers.
- » Funded by the US Army Ground Vehicles Systems Center (GVSC).
- » Work has been underway since approximately 2017.

# Highly Automated Platooning Outlook (SAE 3-5)



## Automated Following Systems (SAE L1/L4)

- » Reliable V2V connects a fully-automated follow truck with a driver-controlled lead truck to platoon.
- » Human-driven lead truck guides the steering, acceleration, and braking of the follow truck.
- » V2V continues to connect active truck safety systems between the trucks with minimal latency.
- » On highway testing of automated platooning with safety drivers expected in 2020.

LOCOMOTION

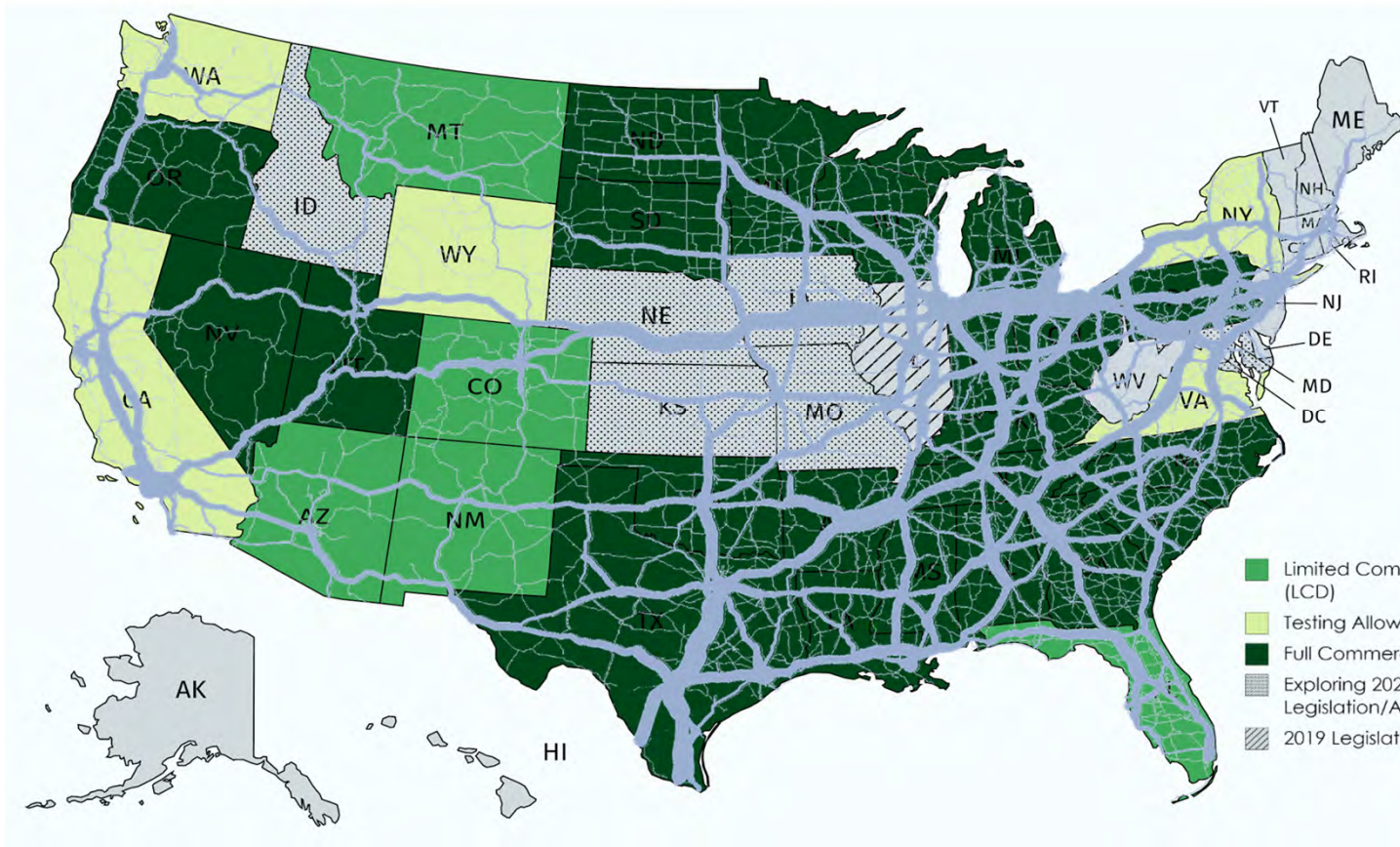


## Fully Automated Platoons (SAE L4)

- » Two solo fully-autonomous vehicles connect through V2V to improve both vehicles fuel economy through “platooning”.
- » Envisioned as an add-on, value-added feature to ongoing development on highly automated, L4 solo trucks.



# Dec. 2019: 32 U.S. States Updated Laws to Allow for SAE Level 1-2 Truck Platooning



- Commercial deployment now allowed in 27 States.
  - » Approved states for commercial deployment now encompass over 80% of Annual US Freight Truck Traffic.
- 5 states including Washington allow DATP testing.
- 5 states allow limited commercial Deployment



## National Context: No Federal Barriers; Govt-Industry Collaboration



- Driver-assistive truck platooning complies with federal law and requires no changes for commercial deployment, as confirmed by federal regulators.
- USDOT, USDOE, and others have participated in demonstrations and funded studies to promote and understand the benefits of the technology.
- USDOT's recent Policy Guidance 3.0 calls on states to remove barriers to truck platooning, stating:

*“States should consider reviewing and potentially modifying traffic laws and regulations that may be barriers to automated vehicles. For example, several States have following distance laws that prohibit trucks from following too closely to each other, effectively prohibiting automated truck platooning applications.” – US DOT Automated Vehicles 3.0, Preparing for the Future of Transportation*

# Growing Global Truck Platooning Activity



## CANADA

### FP Innovations

Two Trucks (non-highway)  
Level 1 2018 – 2019  
Industry



## UNITED KINGDOM

### Helm UK

Two and Three Trucks  
Level 1 2019 – 2020  
(road testing underway)  
Govt Project



## SWEDEN

### Sweden Volvo & Scania

Two Trucks  
Level 1 & 2 2019  
(road testing underway)  
Govt – Industry Project



## SOUTH KOREA

### Hyundai

Two trucks  
Level 1 2019 –  
Govt-Industry



## UNITED STATES

### DOE

ACM, Auburn, others  
Level 4 2018 – 2020  
Govt R&D

### Locomotion

Level 1 & 4 2019 –  
Industry

### FHWA

Two Trucks Platooning FOT  
Level 1 2019 – 2022  
Govt – Industry

### US Army

Auburn University  
Four Truck Platoon  
Level 2 & 4 2019  
Govt R&D

### DOE

Perdue, Peloton, NREL, others  
Two-Truck Platoon  
Level 1 2017 – 2019  
Govt R&D

### Peloton

Two-Truck Platoon  
Level 1 2018 – 2019  
Level 1 & 4 2019 – 2022  
Industry

### US Army

Defense Contractors  
Two and Three Trucks  
Level 1 & 2 2019 – 2020  
Govt R&D



## GERMANY

### Germany MAN

Two Trucks  
Level 1 & 2 2018 – 2019  
(road testing complete)  
Govt – Industry Project



## FINLAND

### Finland Scania

Three Trucks  
Level 1 & 2 2019 +  
(road testing underway)  
Industry – Fleet



## SINGAPORE

### Scania – Singapore LTA

Level 4 operations  
(platooning an option)  
2017 –  
Govt-Industry



## EUROPEAN UNION

### EU ENSEMBLE

(Cross-brand)  
Level 1 & 2 2019 – 2020+  
Govt – Industry Project

### EU CONCORDIA

(Cross-border)  
Level 1 & 2 2019 – 2020+  
Govt – Industry Project



## TURKEY

### Ford Otosan, AVL

Two trucks 2019 –  
Level 1 prototype,  
Level 4 in development  
Industry



## JAPAN

### Japan METI

Three Trucks  
Level 2 2018 – 2019  
(road testing underway)  
Level 4 2019 – 2021  
Govt Project



## AUSTRALIA

### Multiple stakeholders

Two trucks  
Level 1 2018 –  
Industry

# No New Highway or Comms Infrastructure Needed Platooning Works within Existing Infrastructure



## FDOT-FHSMV-University of Florida Study (2018)

- **Communications Infrastructure**

- Direct V2V communications platooning trucks can manage the platooning link.
- Geofencing data, to supervise platooning trucks to prescribed ODD and routes, can be managed using vehicle-to-cloud (V2C) communications transmitted trucks via existing cellular and/or wi-fi networks.

### Highway Infrastructure Effects

- **Bridges:** Less than 1 percent of FL bridges on interstate and turnpike mainlines might be subject to stresses exceeding bridge design specifications with trucks platooning at even a close 30 foot spacing (typical platooning systems operate at over 40 feet spacing).
- **Pavement:** Risk of rutting pavement is naturally mitigated by variation in lateral positioning by drivers.
  - L2+ systems that incorporate automated steering, system developers can implement “intentional wander” features to adjust lateral positioning slightly so that platooning trucks maintain different lateral positioning.

- **Traffic Interactions**

- At high market penetration, studies have shown that platooning would improve flow in heavier traffic, since platooning trucks take up less road space than trucks traveling alone.
- Other modeling found possible negative effects in congested traffic at some types of interchanges – however these are situations in which platoons will dissolve; fuel economy benefits are minimal at lower speeds.

# How Can WA State Do to Better Enable Truck Platooning?



- Formal recognition that connected vehicle solutions can operate under Executive Order 17.
- Separate distinction in AV Working Group regarding recommendations for SAE Levels 1-2 & SAE Levels 3-5.
- Consider updating testing allowance to allow limited commercial freight activity.
- Address existing state laws regarding video screens in vehicles (RCW 46.37.480).
- Flexibility is key for industry.





# Interested in Reading the Subcommittee's Platooning Report?

The Activity 3, Action 2 Truck Platooning Report will be posted publicly on the Washington AV Working Group [Infrastructure and Systems Subcommittee webpage](#) before year end 2019.





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