Peloton Technology
Teamwork for Freight Safety & Efficiency

Overview on Driver-Assistive Truck Platooning
MAASTO CAV Summit, Madison, October 18, 2019
MAASTO Platooning Snapshot

• Great leadership by MAASTO to advance innovation in freight safety & mobility.
• Encouraging the development, testing, and deployment of CAVs.

Regional Picture on Truck Platooning:
• Of 10 MAASTO states, 6 allow commercial deployment of truck platooning: Indiana, Kentucky, Michigan, Minnesota, Ohio, and Wisconsin.
• Great work has also been done in 4 others, setting stage for 2020: Illinois, Iowa, Kansas, and Missouri.
• MAASTO - excellent forum for sharing best practices.
MAASTO = Regional and National Leadership

- MICHIGAN: Led the way nationally, passing the 1st commercial platooning bill.
  - Peloton’s 1st platooning demo in Winter 2017
- OHIO: Led the way in establishing the first administrative allowance in the U.S.
- INDIANA: Leading in advanced platooning fuel savings research (Purdue-NEXTCAR)
  - Peloton works closely w/ State and Industry leaders including Purdue, Cummins, Wabash, ZF/TRW, NACFE (North American Council on Freight Efficiency)
- MINNESOTA: Leading in pre-approving state highways and infrastructure for platooning corridors
  - Peloton presented to Joint House/Senate Legislative Committee on connected and automated vehicles in Feb. 2019.
Market Overview: Freight Trucking Scale & Major Pain Points

- **US Freight Trucking:** $726 Billion in Revenues
  - Fuel Cost: **$100+ Billion** (nearly 30 billion gallons of fuel)
    - 34%+ Operating Costs
  - Crash Cost: **$93+ Billion**
  - Crash Congestion: 113 million gallons of fuel
  - Typical Fleet Net Profit: 3 – 5% or less

- Preventing Accidents
- Saving Fuel
- Improving Mobility
- Improving Decisions

Enhanced Fleet Economics & Safety
PlatoonPro: Driver-Assistance, Not Self-Driving Trucks

Monitored Driving:
- Level 0: Driver only
- Level 1: Assisted
- Level 2: Partial automation

Non-Monitored Driving:
- Level 3: Conditional automation
- Level 4: High automation
- Level 5: Full automation

Driver is continuously exercising longitudinal AND lateral control.
Driver has to monitor the system at all times.
System has longitudinal AND lateral control in a specific use case.
System can cope with all situations automatically during the entire journey. No driver required.

Peloton
We Must Address the Growing Safety Crisis on our Highways

• Challenge to address growing national safety crisis: 37K+ fatalities, Millions of injuries.
• Vehicles very safe; ADAS, V2X now key opportunities.
• In 2012, over 1.7 million rear-end crashes (NTSB)
  • Almost half of all 2-vehicle truck crashes; 1,705 fatalities and over half a million injuries
• Highway end-of-queue crashes involving commercial vehicles are particularly deadly, ex:
The Wild West: Tailgating Trucks on America’s Roads Today

- **NO** advanced best-in-class safety systems
- **NO** linked safety monitoring the roadway ahead
- **NO** driver communications regarding road conditions or maneuvers
- **NO** look-ahead view of road ahead for rear driver

Brownsburg, IN

Shellsville, PA

I-81 NORTH REST AREA

Traffic closest to camera is traveling North
Active Safety System uptake in US trucking has been slow

New Class-8 Trucks Sold w/ FCAM System

- EU regulations mandated FCAM systems on all heavy trucks starting in 2015, estimated to save 5,000+ lives per year.
- In US, Passenger car OEMs voluntarily pledged to make FCAM standard on all vehicles by 2022.
- No similar agreement on commercial vehicles in US, and years away from possible mandate.
- Systems can cost $2-3k upfront and have hard-to-measure payback for fleets
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, over-the-horizon alerts
- Collision avoidance and LDW systems always on
- Air Disc Brakes, Electronic Stability Control
- Continuous Safety Monitoring
- Vehicle-to-Cloud Connectivity
- Vehicle-to-Vehicle Communications

Focus: Make Each Truck Safer At All Times
PlatoonPro: Linked Active Safety using **V2V Communication**

- Link pairs of trucks on suitable highways
- **V2V using 5.9 GHz DSRC**
- Near instantaneous V2V connection
- ACC/Collision Avoidance looks ahead 100s of meters
- Linked Safety Systems benefit both Drivers
- Intelligent ordering by weight/braking ability
- Enhanced Driver Teamwork
Platooning Trucks Benefit from Linked Active Safety Systems

- Follow truck is benefiting from the FCAM systems (w/ AEB) and ACC of the Lead Truck.
- System instantaneously sends proportionate braking signals to Follow truck to proactively grow the gap between the trucks (or dissolve the platoon) in the event of a potential hazard in the roadway ahead of the front truck.
- Follow truck can break before the lead truck or harder to prevent collision.
PlatoonPro: Pairs of Trucks, Both Drivers Steering At All Times
Linked Safety, Enhanced Driver Teamwork and Efficiency

Front Driver
- Hands on
- Feet on + Collision Avoidance
- Eyes/Mind on

Rear Driver
- Hands on
- Feet off + Collision Avoidance
- Eyes/Mind on
Real-time video forward driver’s view

- Look-ahead view of road ahead for rear driver
- Dedicated push-to-talk radio for drivers to share information.
- Each driver looking out for the other.

Driver Teamwork & Awareness
Drivers are Key

- PlatoonPro enhances Driver Teamwork.
- Veteran Driver-informed System Design & Training Program.
- Trained, CDL-certified drivers fully engaged in each truck.
- Peloton teams with Fleets to provide Training.

“A driver will feel safer behind the wheel because the truck can hit the brakes prior to a human in critical situations…”

Dave Mercer - Peloton Driver (~3 million MTD)
Peloton Hardware in the Smithsonian Design Museum

- Contributed the hardware components of our truck platooning system to Cooper Hewitt Smithsonian Design Museum (NYC)
- Museum placed the Peloton hardware in the appropriate sites on a full-size line drawing of a truck.
- Strong functional technology design, with visual appeal of the industrial design
- Platooning software design that has safety as its dominant design mandate.
- Design of the user interface so that professional truck drivers are empowered to make decisions and can operate the system easily.
- Design of the hardware look and feel to co-exist harmoniously with the driver so OEMs want to incorporate into their vehicles.
Integration & Safety Validation Working with OEMs

Know when to dissolve a platoon

Continuous improvement process

Manage and maintain safe following distance

ISO 26262

Continue to test for edge cases

Exceed automotive grade safety standards

Listen and address our customer's safety concerns
Making Aerodynamic Following Safe: V2V linked Safety

Driver Perception & Reaction Time:
2 sec

< 10\textsuperscript{th} of a sec

Faster than a Driver or Radar/ACC on a single truck
Supervision, Enhanced Safety: Geofencing to Suitable Roads & Conditions

Network Operations Cloud (NOC), System & Fleet Procedures limit platooning to:

- Multi-lane, divided, limited access highways
- Suitable traffic conditions (platoons dissolve automatically below 35 MPH)
- Suitable weather and road conditions
- Appropriate topography (no major up and down grades)
- Excluding construction zones, lower capacity bridges, and other specialized areas
Operational Domain: Multi-lane, Divided, Limited Access Highways
BETTER THAN INDIVIDUAL TRUCK SAFETY SYSTEMS

DRAMATIC REDUCTION AND MITIGATION OF FRONTAL COLLISIONS

INCREASING FLEET & DRIVER PRODUCTIVITY

FOSTERING DRIVER TEAMWORK AND ENHANCED ROADWAY AWARENESS
**National Context: State Following Distance Laws**

**Numeric Minimum Following States**
- A defined numeric minimum following distance in 23 states
- Platooning requires change in law.

**“Reasonable and Prudent” States**
- A flexible, discretionary standard in 27 states
- Platooning can be legal under current law.
Oct. 2019 - U.S. State Allowance for Truck Platooning

Commercial deployment now widely allowed

- Commercial Deployment now allowed in 27 States
- Approved States now Encompass over 80% of Annual US Freight Truck Traffic
FL DOT Study: No New Highway or Comms Infrastructure Needed Platooning Works within Existing Infrastructure

FDOT-FHSMV-University of Florida Study (2018)

- **Highway Issues:**
  - Allow DATP operations on any limited access, multi-lane, divided highway.
  - Allow DATP operations on any lane currently allowable for trucks.

- **Infrastructure Effects**
  - FDOT analysis found that well less than one percent of 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).
  - The State can notify system providers and fleets regarding any locations/areas where platooning should be restricted, due to specific infrastructure elements or other factors.

- **Traffic Interactions**
  - At high market penetration, simulation 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.
  - Traffic interactions during the recent Florida Platooning Pilot operational demonstration, which included interchanges, bridges, Service Plazas, etc. showed smooth dynamics and did not raise concerns.
Initial Major Use Case: Same-Fleet, Hub-to-Hub Routes

Example Strong Customer Profile:
- Hub to Hub Regional Haul
- Fleet drivers
- Scheduled and ad hoc truck pairings
- Similar tractor configurations
Peloton Customer Trials

- July 2018: Peloton began running freight with PlatoonPro, giving fleets and shippers the opportunity to experience the benefits of platooning by paying us to haul their freight.
- Many customers in Transport Topics Top 100 Fleets.
- High utilization -- as high as 90% of platoonable miles platooned.
- Platooned miles per day > 700 miles per truck in some cases
  - Projected gross fuel savings per truck of up to $7,000-10,000 per year.
- Trials to help customer fleets determine favorable operations for platooning and to introduce drivers to the system.
- Robust driver training curriculum enhanced

Ahead:
- Major multi-month, customer acceptance trial is now underway with using their trained fleet drivers and customer trucks.
Field Results from First 6 customers

Driver Feedback: Consistently positive

Hard Braking: None (0 above 0.4 g-force)

Cut-ins: Only 1 every 620 mi; Smooth dissolves

Safety Incidents: None

Fuel Savings: Approx. 7% team savings

Cargo Moved: +3,000,000 lbs of freight
Positive Fleet Driver Feedback

- Seeing it in action clears up misnomers about platooning.
- Greatly impressed by the reliable cut-in dissolve feature.
- “I don’t fixate on the back of the front trailer because I scan for traffic.”
- Platooning is easy.
- I think other drivers could learn to use the system quickly.
- System encourages teamwork
- Platooning makes sense and “who wouldn’t want to go traveling with his buddy?”
- “It’s a really well-designed system. I like the lay-out of it. I like the simplicity of it.”
Peloton Interstate Customer Trial: Aug. 2019

- First U.S. Interstate Customer Platooning Trial
- Two trucks, multi-week, hauling freight
- Peloton Network Operations Cloud enables interstate platooning on suitable multi-state highways without supervision interruption.
- Voluntary demonstration with department of public safety and highway patrol in Alexandria, LA prior to platooning for the first time in Louisiana.
Advancing Stakeholder Confidence in Our System Safety Approach

- Initiated development of a robust, voluntary safety system approach report to enhance regulator and stakeholder transparency and ensure adherence to overall best practices for AV systems.
  - **Purpose:** To provide transparency to the community about PlatoonPro and Peloton’s safety approach for platooning.
  - **Intended Audience:** Truck drivers, fleets, government, law enforcement, and the general public.

- Designed report to complement NHTSA voluntary guidance for HAV companies to develop self-assessment reports of their systems (L3–L5) in order to demonstrate to stakeholders their varied approaches to achieving safety.

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**Peloton Safety Principles**

- Safe Base Vehicle
- Constrain ODD
- Apples to Apples
- Right Functionality
- Right Implementation
- Handle Variation
- Work With Driver
- Work with Ind. / Gov.
- Test Proper
Thank You for Your Safety Spectrum Leadership

AASHTO 50 State DOT Letter- Aug. 2019

- “State DOTs understand that a CV environment holds the potential to support a fundamental advancement in ensuring the safety of our nation’s surface transportation system. And in order for this promising future to become a reality, the 5.9 GHz spectrum must be preserved for transportation safety purposes.”

- Cites the hundreds of millions of dollars of investment by private and public sectors to develop and deploy lifesaving CV technologies in the 5.9 GHz spectrum.

Coalition for Safety Sooner Letter- July 2018

- “[We] strongly support the protection, and accelerated utilization of the 5.9 Gigahertz (GHz) Dedicated Short Range Communications (DSRC) Spectrum for safety critical, life-saving transportation applications. DSRC communications technology is ready to deploy now.”

- Represents several U.S. state DOTs
General Outlook

Growing Commercial activity using Driver Assistive Truck Platooning Solutions:

• **US:**
  • Peloton bringing driver-assistive truck platooning into operations with selected fleets, 2019-20.
  • Other OEMs continue to develop commercial systems including Kenworth, Peterbilt, Volvo.
  • FHWA and NHTSA projects underway exploring best-practices.

• **International:**
  • MAN Trucks, Scania commercial fleets trials -- Germany and Scandinavia, 2019-20.
  • EU Multi-brand platooning project: Platooning by the 6 European Truck OEMs, 2019-2020+.
  • Platooning commercial demonstration and fleet programs beginning -- UK, Australia, Asia.

• **Key Activity Ahead – Peloton Technology:**
  • Ongoing work with allies to arrange commercial allowance in additional states and int’l markets.
  • Continued collaboration with industry and state officials in the MAASTO region.
  • Ongoing work w/ industry: Purdue, Cummins, ZF/TRW, Wabash, NACFE, others.
Michigan Leading in L1/L4 Platooning Testing

- Michigan is a U.S. leader in on-road testing of automated platooning.
- U.S. Army-TARDEC tested automated following technology on Continental and Magna international crossing in 2017.
- Crossed over the Blue Water Bridge in Port Huron, Michigan, to Sarnia, Ontario, and back again.
- Four vehicles, including two M915 line haul tractors carrying flatbed trailers loaded with cargo containers
- Semi-autonomous driving along a pre-programmed path to test of TARDEC’s autonomous steering and leader-follower platooning technologies.
- Lead vehicle instructs follower vehicles on where and how to drive — including how closely to follow — and when to brake, accelerate and steer.
AutoFollow: Drivers Lead, Technology Follows

Driven Lead Truck

- Active Truck Safety Systems
- Lead Driver Actions
- Lead Truck Sensor Data

L4 Follow Truck

- Active Truck Safety Systems
- Lead Driver Actions
- Lead Truck Sensor Data
- Follow Truck Sensor Data

V2V
Harnessing the World’s Best Sensor: Drivers

- Lead Driver
- Lead Sensors
- Follow Sensors

V2V

= Achievable Near Term L4

Earlier Deployment
More Deployable Miles
Construction

Traffic Control

Erratic Drivers

Weather Changes
L4 Automated Following

More Deployable Miles

PlatoonPro

Standalone Driverless

Increasing Availability

Value

Time
Peloton Benefits Trucking and Drivers

- Accommodate growth in industry
- Alleviate growing driver shortage
- Increased skills: Integral to system operation
- Improved WORK: Better routes, trucks, compensation
- Improved LIFE: Shift to hub-to-hub, returning home every night

Drivers become twice as productive
Stephen Boyd
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