Truck Platooning: Current and Future Generations

Transforming Freight Movements through ITS – Part II (SIS30)

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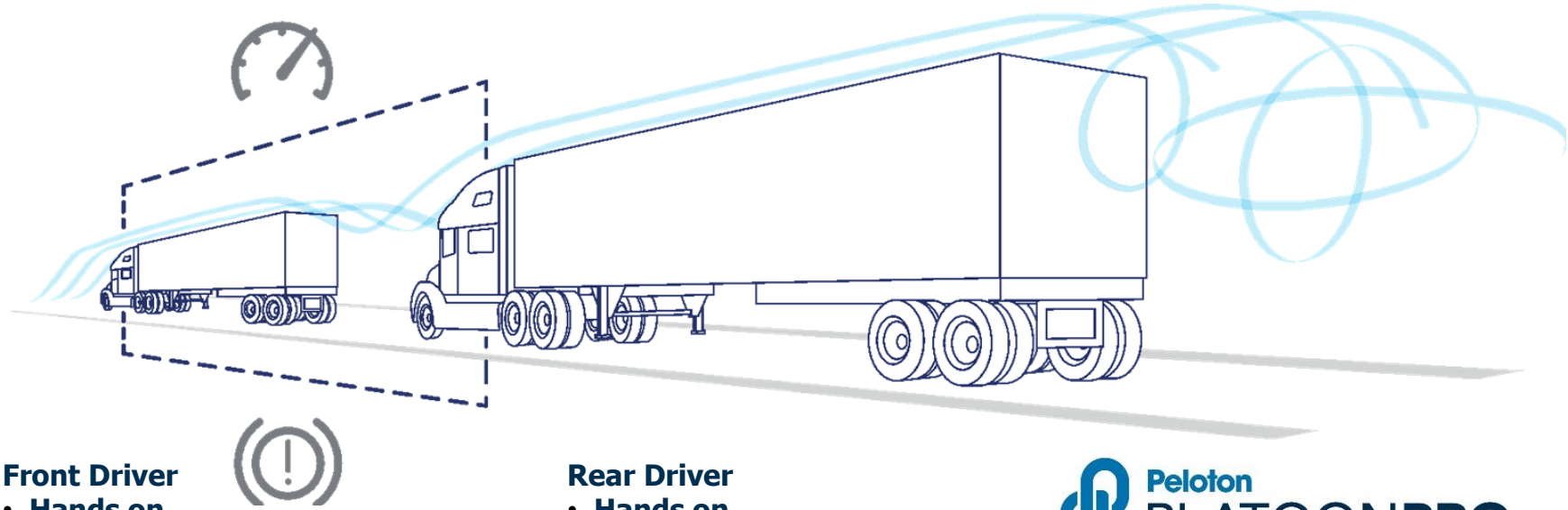
Connected Automation / Platooning – Industry Players

Many Companies in US, Europe and Asia are involved with Truck Platooning

PlatoonPro™

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

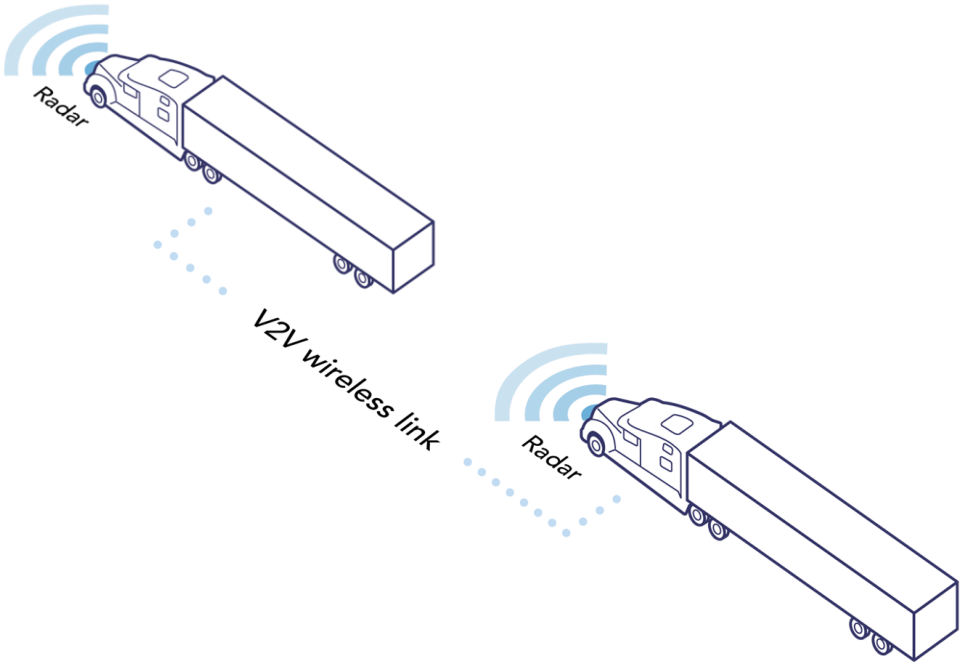
Rear Driver
- **Hands on**
- Feet off + Collision Avoidance
- Eyes/Mind on

Peloton PLATOONPRO

Power of V2V

Peloton

PlatoonPro: Linked Active Safety using **V2V**



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

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

Vehicle-to-Cloud Connectivity

Vehicle-to-Vehicle Communications

Collision avoidance and LDW systems always on

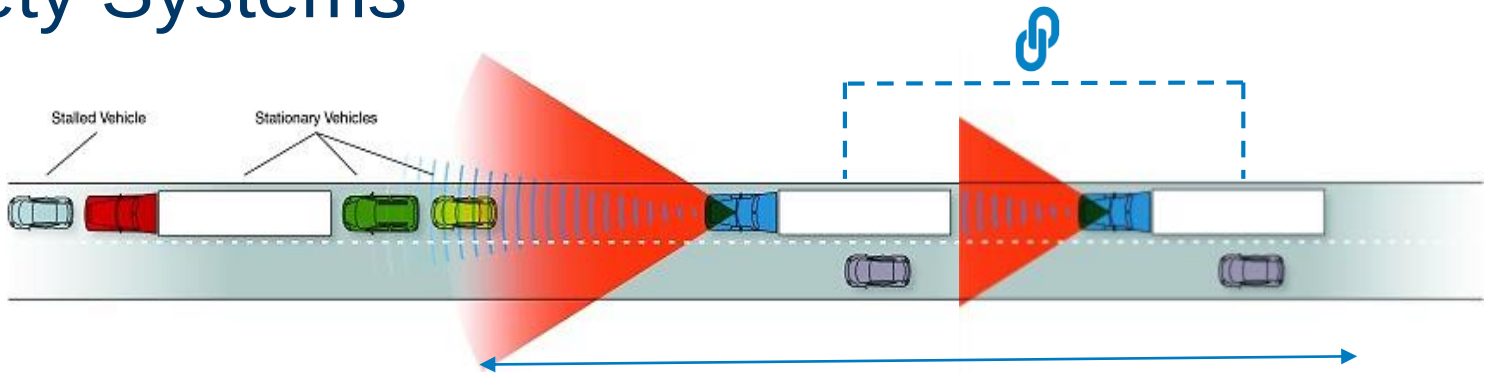
Air Disc Brakes, Electronic Stability Control

Continuous Safety Monitoring

System vs. Driver Control & Responsibilities

	System	Driver
ODD	• NOC enforces ODD to specific sections of Limited Access Divided Highways • Enforces minimum and maximum platooning speeds	• No responsibilities
Traffic	• The NOC can limit platooning in known high density traffic areas	• Trained to assess other conditions (merges, entry/exit ramps, etc.)
Weather	• The NOC can limit platooning in extreme weather circumstances • The system prevents platooning in precipitation (e.g. if the windshield wipers are in use)	• Trained to assess other conditions (damp roads, high winds, etc.)
Construction	The NOC can limit platooning in known construction areas	• Trained to evaluate when it is safe to platoon (lane restrictions, K-rails/Jersey barriers, etc.)

Platooning Trucks Benefit from Linked Active Safety Systems



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.

5.9 GHz Spectrum

Preserving DSRC and 5.9 GHz Spectrum Essential

- Only DSRC can meet requirements for low-latency safety applications in commercial use at this time.
- Core principles of V2X must be preserved
  - Maintain 5.9 GHz spectrum for transportation safety applications only
  - Retain 7 channels
  - Future protocols should be designed to co-exist in same channels, be inter-operable, and have backwards compatibility
- Only DSRC can meet requirements for low-latency safety applications in commercial use at this time
- Seeking for both interoperability and innovation, without slowing deployment of V2X and bringing benefits faster.
- Support from AASHTO, Coalition for Safety Sooner, American Trucking Associations

Deploying PlatoonPro™

Integration & Safety Validation working with OEMs

PlatoonPro: Commercial Deployment Pathway

Fuel Savings Verified	Production Hardware/Software	Safety Validated	User-Centered Design
C.R. England, NREL Major Fleets, US DOE, US DOT	Bendix, NAVISTAR, VOLVO, PACCAR, WABCO Developed with OEMs and brake suppliers	ISO Safety: ISO26262 Only known connected/automation system validated to ISO standard	 Extensive driver research and validation

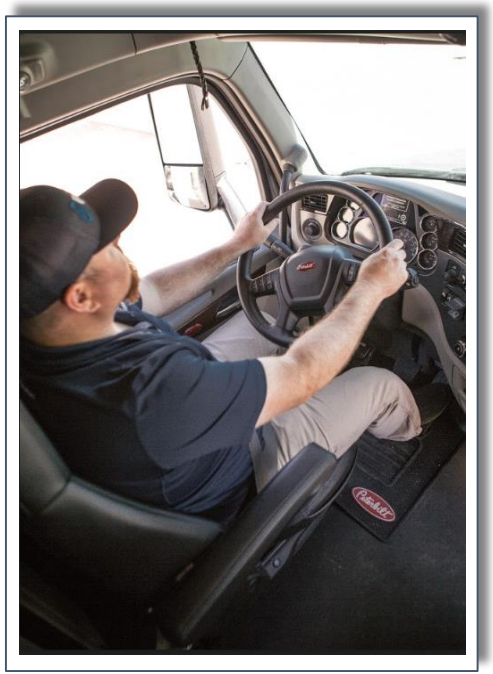
Factory Pre-Wire
(Install Harness in Factory)

Install by 3rd Party Upfitter

Customer (Fleet) Use

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."



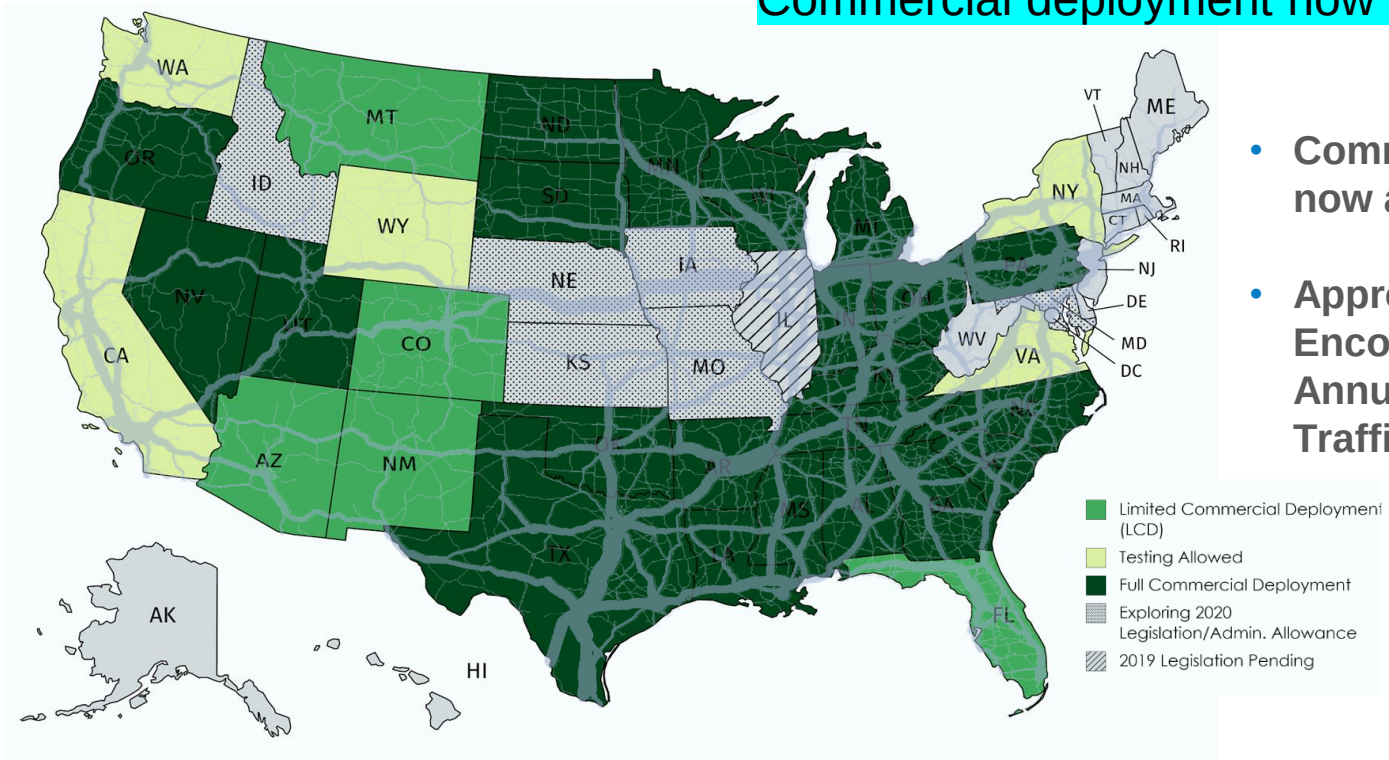
National Context: No Federal Barriers; Govt-Industry Collaboration

- 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*

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 75% of Annual US Freight Truck Traffic**

PlatoonPro™ Customer Trials Results

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 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.

Customer Fleet Trials Began July 2018

Diverse group of 6 Fleets & Shippers

Field Results from First 6 customers

Driver Feedback:	Consistently positive
Hard Braking:	None (0 above 0.4g)
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

Driver Assistive Truck Platooning: Wider Benefits

- **Safety:** Crash reduction and crash congestion-related fuel savings
- **Air Quality:** Corresponding reductions in GHG & Diesel emissions
- **Insight:** High quality data generation for fleets & governments
- **Mobility:** Increased freight efficiency
- **Economy:** <1 year payback period for typical regional/longhaul trucks

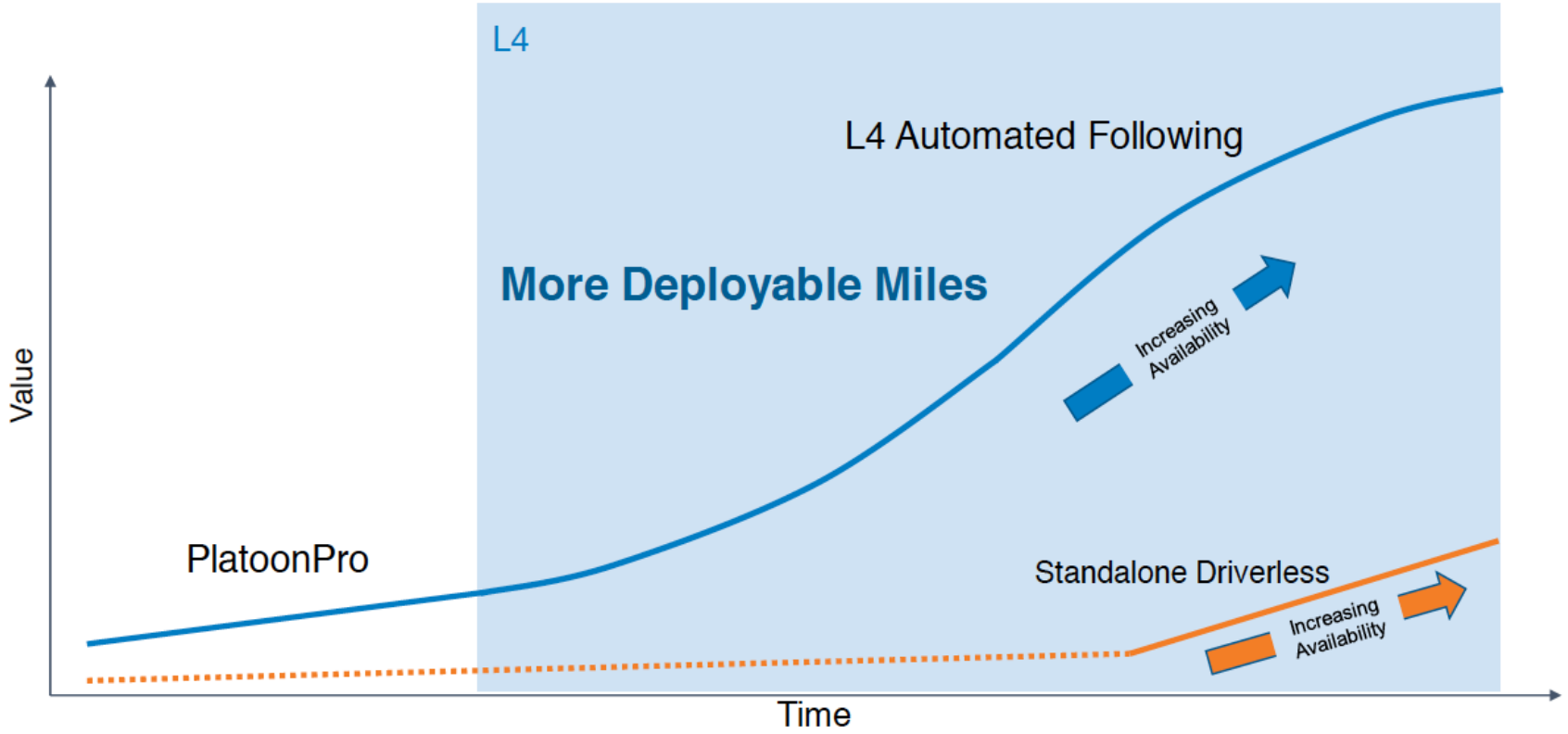
Next Generation: AutoFollow

Peloton Benefits Trucking and Drivers

Drivers become twice as productive

- 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

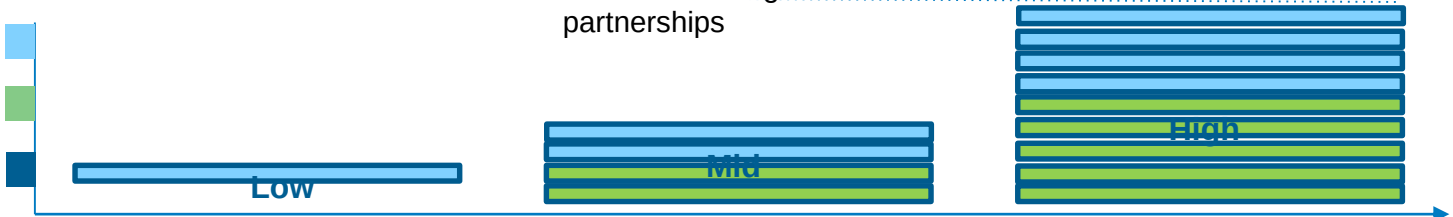
L4 Automated Following



AutoFollow Strategy

AutoFollow remains the quickest and most viable GotoMarket solution.

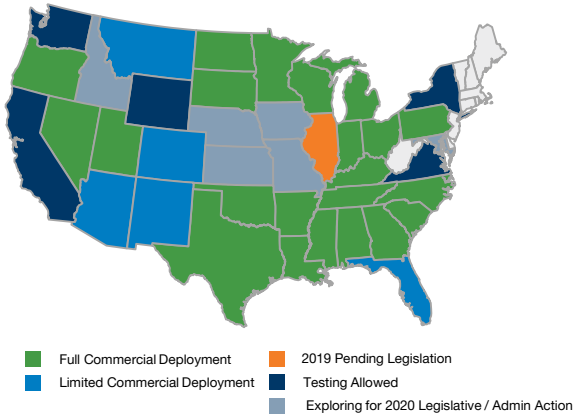
Phase	Phase 1 (Development)	Phase 2 (Commercial)	Phase 3 (Scale)
Definition	**Small, Peloton-owned fleet moving freight on-road as carrier**	**Commercialization via leased fleet of vehicles and development of data driven services**	**Intent to scale. OEM / Tier 1 partnerships & sales channels, leasing model and Data Driven Services**
Reasoning	Limit liability, choose specific use-cases and test/develop/iterate on technology	Expansion of use cases (limit ODD constraints), penetration of market through Shippers / Carriers	Product in market at scale. Continuous use case expansion through to Single Vehicle L4 capability
Keys to Success	Limit liability, work within tightly defined ODD, Sensor / Stack Validation	Push the boundaries, expand use cases, establish leasing partnerships	Achieve Product – Market Fit, Eliminate ODD Constraints, OEM Partners



State Policy Leadership / Market Development

- Developed a **clear regulatory path for AutoFollow** due to Peloton's strong reputational foundation built with state officials during its process to secure L1 platooning allowances.
  - States DOTs and SHPs are ready to work with us to advance testing and commercial pilot opportunities in multiple states including with or without a safety driver.
  - Participating in multiple state government-led working groups to develop recommendations for future legislation or regulations for AV testing and deployment.
- Recognized in Sept. 2019 by the Pioneer Institute's Better Policy Innovation Award for advancing a sound policy solution (L1 truck platooning) that addresses a significant transportation or mobility need.

U.S. Truck Platooning Allowances



U.S. States Allowing Testing and Deployment of AV Trucks

Summary

Summary

- Level 1 PlatoonPro™ Commercial Trials establish benefits and robustness of system, fulfilling customer needs.
- Best in class safety on each truck, making trucks safer at all times.
- Clear commercial deployment pathway established.
- Wide regulatory allowance across USA, continuing to expand.
- Spectrum: core principles of V2X must be preserved with evolution path that supports early deployment; only DSRC meets requirements for low-latency safety applications in commercial use at this time.
- AutoFollow platooning now under development, remains the quickest and most viable Go-to-Market solution.