Truck Automation in the U.S.

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Why the interest in truck automation?

- **Earlier adopters of automation than light-duty passenger vehicles, while the technology is still maturing and relatively expensive:**
  - **High-value vehicles, with high daily utilization and high operating costs produce faster return on investments that improve operational efficiency**
  - **More highly skilled drivers and fleet maintenance**
  - **Can provide useful service within limited Operational Design Domains constrained by technology immaturity**
- **For truck platooning: fuel cost savings from drag reduction**
- **For driverless Level 4 automation: expanding services now constrained by driver shortage, and reducing driver labor costs**

Current U.S. Truck Automation Activities

System development and testing work, not in full public operation yet

	Government	Industry
Truck platooning on highways (mainly Level 1 longitudinal control, limited Level 2)	O	O
Urban goods delivery, low speed (Level 4)		O
Interstate highway driving only (Level 4)		O
Special purpose, Level 4 low speed in closed sites (ports, warehouses)		O

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Recent Truck Platooning Activities

- Research and development projects
  - Federal Highway Administration, Exploratory Advanced Research
    - Caltrans/PATH/Volvo/Cambridge Systematics
    - Auburn University/Peloton/Peterbilt
  - Department of Energy, SMART Mobility Program
    - PATH/Volvo
  - Texas DOT/ Texas Transportation Institute
  - U.S. Army TARDEC
- Commercial product development and demonstrations
  - Peloton Technology
  - Volvo/Federal Express demonstration
  - Freightliner (Daimler) trucks

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3-Truck PATH/Volvo Platoon Demo for U.S. DOT in Public Traffic on I-66 Near Washington DC

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New U.S. Government Plans for Truck Platooning

- **Competition for field operational test to collect data on usage by truck fleets in regular operation (field testing to start ~2020)**
- **Research projects on:**
  - **Human factors issues for truck drivers and drivers of nearby vehicles**
  - **Truck maintenance and inspection needs**
  - **Determining safe following distances**
  - **Cybersecurity**
  - **Brake inspection policies and procedures**
  - **Hazard analyses**
  - **Extension from Level 1 to Level 2 automation**

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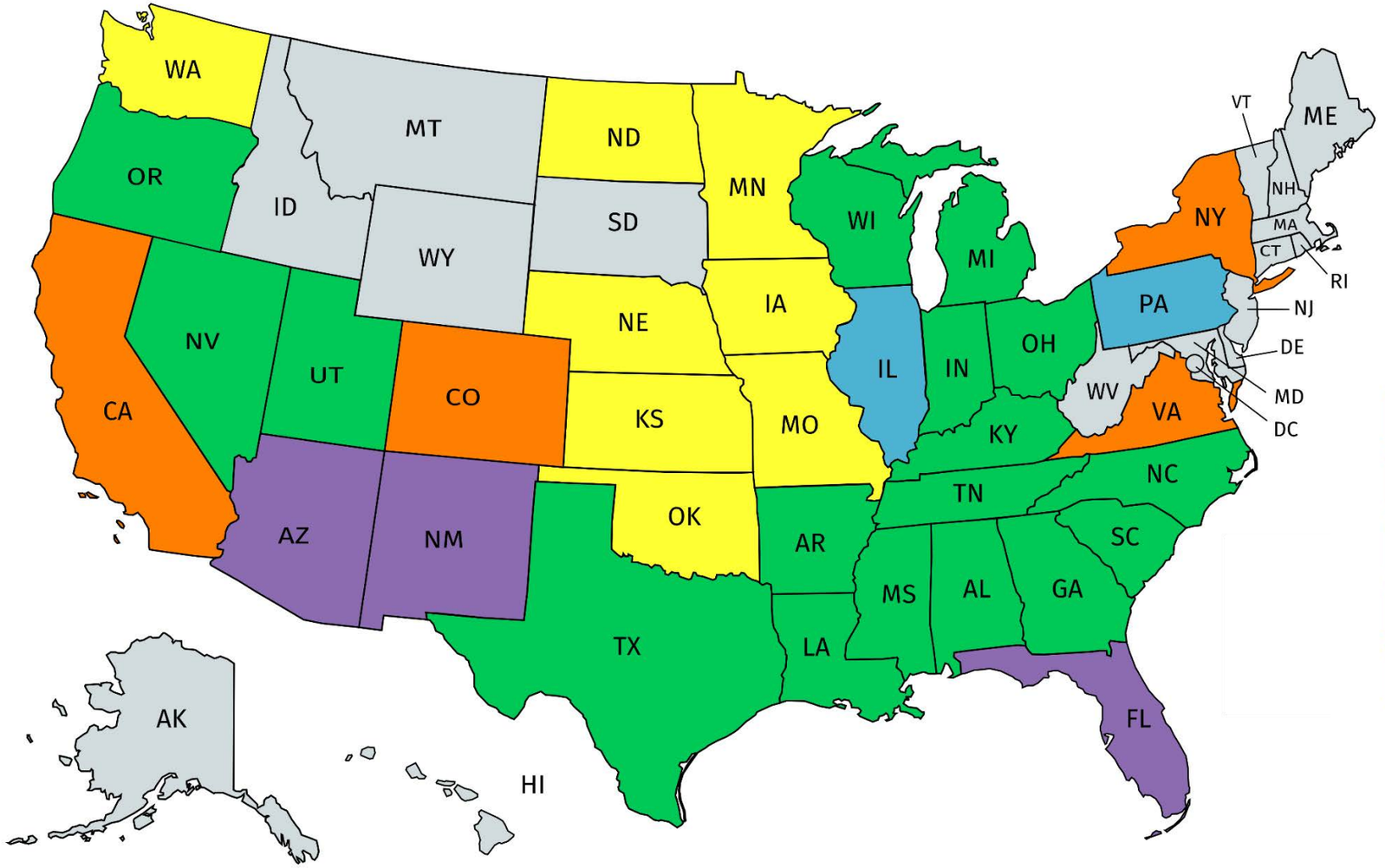
States Adjusting Regulations on Minimum Following Distance to Permit Truck Platooning



Source: Peloton Technology

- Testing
- Full Deployment Allowed
- Limited Commercial Deployment
- 2018 Legislation Pending
- In process already for 2019

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Automation of Low-Speed Urban Goods Delivery

- Level 4 automation in development to try to eliminate drivers for deliveries of small packages by light-duty vehicles
  - Modifications of existing vehicles
  - New purpose-built vehicles
  - Some very small vehicles (“beer coolers on wheels”)
- Recent interest among start-up companies led California to request inputs on definition of applicable regulations
- Companies include:
  - Nuro Robotics
  - AutoX Technologies
  - Ford

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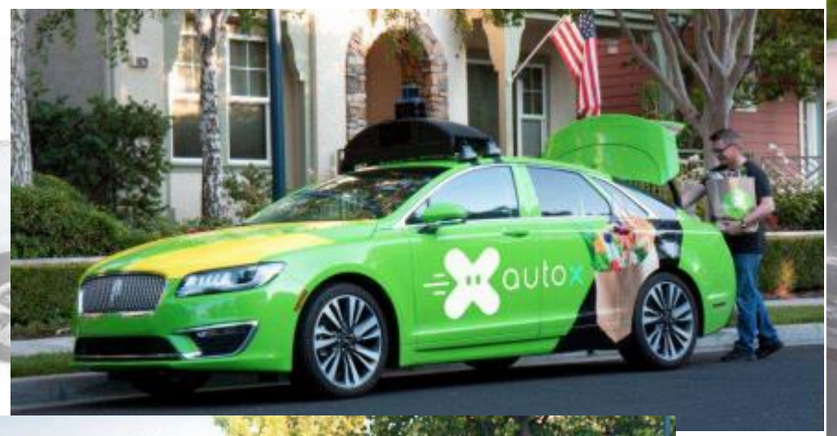
Prototype Local Package Delivery Vehicles

Nuro Robotics



AutoX

Ford pizza delivery

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Prototype Delivery Robots (mainly for sidewalks)

Marble
($10 M investment)

Robby Technologies
($2 M investment)

Dispatch.ai
($2 M investment)

Unsupervised.ai
(doorstep delivery)

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Level 4 Automation of Highway Driving

- **Industry efforts to develop trucks capable of driverless operation on some specific limited-access highways, generally:**
  - **Low-density rural areas for long hauls in light traffic**
  - **Driving between depots at freeway entrances/exits (not on local streets) – or remotely driven when off highway (Starsky)**
  - **Remote supervision by humans (varying levels of intervention)**
  - **Testing prototypes on public roads with safety drivers supervising**
- **Active companies include:**
  - **Embark (California – Texas testing)**
  - **TUSimple (Phoenix-Tucson highway testing and China port testing)**
  - **Starsky Robotics (Florida testing)**
  - **Waymo (Atlanta testing)**

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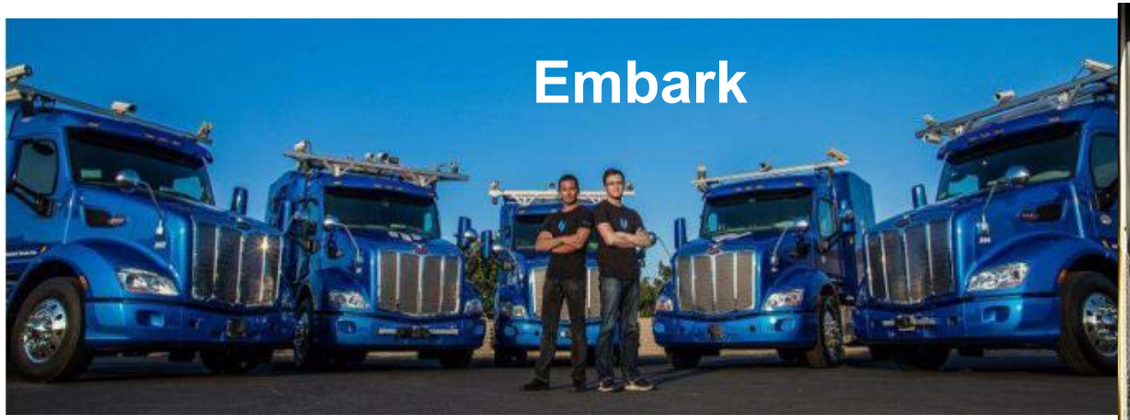
Level 4 Long-Haul Truck Prototypes

Waymo

Starsky


Embark


TUSimple

Special Purpose Level 4 Truck Automation in Restricted Sites

- **Low-profile activities, very little public information**
- **Extensions of factory and warehouse automation technologies for low speeds in protected environments:**
  - **Short-distance, low-speed trailer or shipping container movements at warehouse and terminal yards**
  - **Airport terminal apron support vehicles**
  - **Trash collection**
  - **Snow removal**

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Summary of U.S. Truck Automation Status

- **Emphasis of public agency R&D programs and major truck manufacturers on truck platooning (Level 1 automation)**
  - **Near-term opportunities within existing truck fleet operations**
  - **Risk of setback if DSRC communications are destroyed in current political environment**
- **Recent growth of interest in non-traditional approaches using Level 4 automation to replace drivers within narrowly-defined Operational Design Domains, and with new business models**
  - **Small urban pickup/delivery vehicle services**
  - **Highway-only driving between depots (long-haul, rural)**
  - **Speculative, disruptive start-up activities**

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