



ITS DEPLOYMENT EVALUATION

Executive Briefing

Truck Platooning



Source: Getty Images

Highlights

- Connectivity between trucks equipped with automated vehicle technology allow them to operate more smoothly as a unit and automatically reduce and control following gaps between vehicles.
- A study funded by the Department of Energy, NREL, found that 55.7 percent of all classifiable miles driven were platoonaable, presenting the opportunity for significant fuel and emissions savings.

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This brief is based on past evaluation data contained in the ITS Knowledge Resources database at: www.itskrs.its.dot.gov The database is maintained by the USDOT's ITS JPO Evaluation Program to support informed decision making regarding ITS investments by tracking the effectiveness of deployed ITS. The brief presents benefits, costs and lessons learned from past evaluations of ITS projects.

Truck Platooning

Introduction

The United States Department of Transportation (USDOT) recognizes that cooperative automated driving systems (ADS) will have a transformative impact on how the nation's highways will operate in the future. A near-term application of ADS technology is truck platooning. Truck platooning, where trucks follow each other more closely using cooperative adaptive cruise control (CACC) has the potential to deliver substantial fuel savings, improved safety benefits, and improve both operational and capacity efficiencies. The promise of this technology has spurred investment in research and development of truck platooning technology, as demonstrated by research projects of the private and public sector and recent proof-of-concept demonstrations of truck platoons on both closed tracks and highways. Whereas fully ADS are not expected to be deployed on roads in the immediate future, truck platooning is closer on the horizon, with an estimated seven-to-ten-year implementation timeline.

Summary of Truck Platooning Technology

Truck platooning works by creating a close, constant coupling between platooning vehicles, separated by limited distances and operating as a unit. Trucks equipped with on-board computers monitor sensor systems and integrate data from adaptive speed control, automatic braking, lane-departure warning systems, and vehicle-to-vehicle (V2V) communications systems, such as dedicated short-range communication (DSRC) systems and utilize cooperative adaptive cruise control (CACC) to form a platoon of two or more trucks. Technology and devices commonly associated with truck platooning include:

- **Sensors** - A combination of both short- and long-range sensors are used to evaluate the complete environment around the vehicle so it can track, not only other vehicles in the platoon, but all other objects on the road, including pedestrians and cyclists. Sensors, that may include LIDAR (light detection and ranging), radar, and cameras, all work in conjunction to provide a complete image of the vehicle's surroundings. The use of different types of sensors provides data veracity and redundancy in the system.



Summary of Truck Platooning Technology (continued):

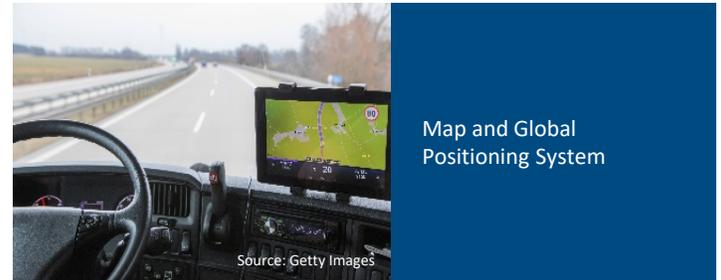
- **Localization services** - Global positioning systems (GPS) and inertial navigation systems (INS) are used to determine the location of the vehicle. These systems provide the necessary information to the vehicle to accurately establish the spacing between the platooning vehicles. As with sensors, the system must be redundant so if the GPS temporarily fails (such as in low coverage areas or tunnels) the INS can use motion and rotation sensors to determine the vehicle orientation until the GPS reestablishes connection.



Sensors and Global Positioning System

- **V2V Communication** - DSRC is utilized for low latency exchange of vehicle performance parameters between vehicles. An extension of Wi-Fi technology, DSRC communicates passing speed and locational information, which allows the CACC system to quickly adjust to changing speeds and positions, facilitating an effective platoon.
- **Software** - Each CACC system requires software-based algorithms to process the information from the sensors, the vehicle, and V2V communications. These algorithms are the core of the CACC systems as they are required to predict the movement and speed of the vehicle in front to set the new speed of the following vehicle(s).
- **Hardware** - There are hardware components distributed throughout the vehicle to house the array of sensors collecting data, connects critical systems, and controls the vehicle speed and braking.

- **Human interface** - The Human Machine Interface informs the user about changes in the CACC stages. As CACC matures, methods of providing CACC information without causing driver distraction will need to be developed and tested.



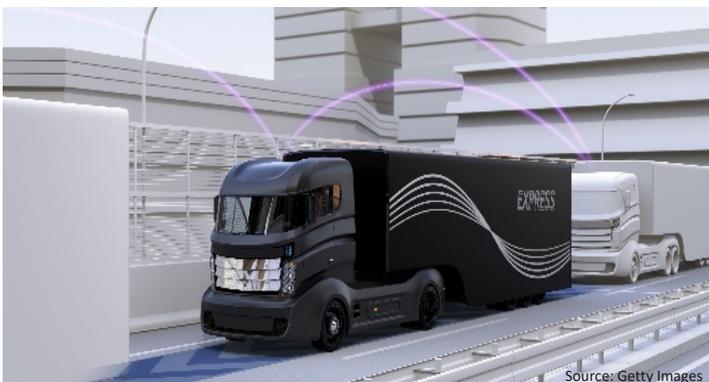
Researchers at the California Partners for Advanced Transportation Technology (PATH) describe four primary stages of truck platooning operations [1].

1. **Forming** – During the first stage of truck platooning, trucks must identify potential platoon partners based a range of characteristics, including their current location, destination, the number of stops, type of truck, and other variables. This information may be difficult to ascertain if other drivers work for competing firms. To mitigate this issue, current research is evaluating three different methods for forming the platoon:
 - Scheduled Platooning - A transport company planner can schedule multiple trucks to form a platoon at a given departure time and location. Trucks assigned as part of the platoon know when to break off.
 - Platooning Service Provider (PSP) - Similar to scheduled platooning, in this method an external specialized company works with multiple trucking companies and individual truck drivers to match them up based on their starting location, departure time, and final destination. The trucks would need to be outfitted with platooning technology and devices allowing the PSP to know where they are headed and their travel times. Using this information, the PSP matches trucks for given sections of their trips and then forms new platoons later with different trucks going in other directions.



Summary of Truck Platooning Technology (continued):

- On-the-fly platooning - As platooning becomes more mainstream, trucks will not need a single entity like the PSP to coordinate travel. Trucks will be able to form platoons spontaneously with required information being transmitted between partnering trucks. This method provides the most flexibility over the other methods but also requires the largest market penetration of platooning-equipped trucks for proper execution.
- 2. Steady-State Cruising** - The cruising stage occupies the largest period of time while the platooning system is activated. Once a platoon is formed, the drivers will operate the vehicle based on the level of automation in the vehicle. Steady-state cruising would be modified as trucks join or drop out of the platoon or when an unequipped vehicle cuts in. The majority of truck platooning benefits accrue during the cruising stage.
 - 3. Departing or Splitting** - Trucks may depart from the platoon when needed in order to complete their trips or make a trip deviation. Once the departing truck has left, the trucks that were following it rejoin the original platoon and close the gap left by the departing vehicle.
 - 4. Abnormal Conditions** - This last stage accounts for other situations that are not addressed in the previous three stages. This stage can include potential errors in the system or abnormal operating conditions. Any truck platooning system will need to be able to identify and resolve these unexpected abnormalities.



Truck Platooning Simulation Graphic

Benefits

Evaluation studies and demonstrations by both the private and public sector of truck platooning have taken place in across 16 states in the U.S., and in Europe, and Asia. The benefits of truck platooning focus on increased fuel efficiency due to the aerodynamic effects of closer vehicle spacing, more efficient use of highway facilities, increased mobility and throughput, and safety benefits of vehicle-to-vehicle communication technologies and hazard detection. Additional benefits can be found below.

TABLE 1: Selected Benefits of Truck Platooning

SELECTED BENEFITS

A highway truck platooning demonstration of two Class-8 trucks in North Carolina by private sector partners was expected to result in up to 10 percent fuel savings for fleet customers (2018-01315).

A study funded by the Department of Energy, NREL, found that 55.7 percent of all classifiable miles driven were platoonable, presenting the opportunity for significant fuel and emissions savings (2018-01313).

Connectivity between trucks equipped with automated vehicle technology allow them to operate more smoothly as a unit and automatically reduce and control following gaps between vehicles. Class-8 trucks with standard-trailers net a fuel savings of between 5.2 and 7.8 percent in a three-truck CACC platoon. With aerodynamic-trailers, these savings grow to 14.2 percent at a minimum separation distance of 17.4 m (57.1 ft) (2018-01246).

Costs

Although promising, the business case or return on investment (ROI) for truck platooning remains unclear due to the nascency of the technology.



Costs (continued)

When surveyed by the American Trucking Research Institute (ATRI) regarding the business case for truck platooning as part of the FHWA-sponsored study of DATP, owner-operators expected a mean payback on investment period of 10 months, while fleet respondents expressed a mean payback expectation of 18 months. Freight companies are currently analyzing the benefits and costs of adopting platooning technology. Additional costs may include equipment acquisition, driver training, logistics and coordination, testing, and insurance costs [2].

Best Practices

Though truck platooning technology using CACC hasn't been commercially deployed in the U.S., research into the benefits and best practices from a regulatory standpoint as well as the potential economic benefits have been well documented. In January 2018, the New York State Department of Transportation commissioned a study to investigate heavy truck platooning technology readiness, projected commercialization timeframe, fleet knowledge and interest in truck platooning technology and deployment, as well as the potential policy solutions to address barriers that will enable safe truck platooning in New York State (NYS).

Data were collected via literature review and interviews with industry experts, including platooning technology developers, heavy truck manufacturers, third-party technology analysts, fleet end users, and NYS roadway operators. Most platooning system providers agreed that the technology itself will be ready in the near-future with initial production in the 2017-2018 timeframe, but regulatory development will delay widespread commercial deployment.

The NYS DOT study concluded that there are no specific federal policies or regulations that prohibit the use, operation, or deployment of truck platooning technologies for light or heavy-duty vehicles and that regulation at the state level is the primary barrier to wide-spread truck platooning technology deployment, though Congress has introduced two separate bills related to automated vehicles.

Under both bills, states retained the authority to set rules on registration, licensing, liability, insurance, and safety inspections, but not performance standards. Neither bill included provisions for the heavy-duty truck classes covered by this study. The study examined the following areas:

Technology Availability:

- Platooning technology is in the final stages of commercialization and will be readily available for market in the 2017–2018 timeframe. Customer adoption will depend on a positive business case, which will require performance, reliability, and safety data to be collected and analyzed.
- Some issues remain for interfleet operations (communications, standards, and inter-fleet agreements), though when solved, will bolster the viability of the technology through multiple fleet types.
- Deployment will also likely be geographically dependent with more use in good weather (not heavy rain, snow, or strong winds) and areas with limited access highways and light traffic.
- The most-mentioned barrier to implementation was scheduling multiple trucks to go to a nearby destination for platooning purposes.

Fuel Consumption:

- Platooning's primary benefit for fleets are reduced fuel consumption and associated reductions in greenhouse gas emissions, though benefits derived would depend on the vehicle's weight, driving speed, and following distance.
- Peloton Technology (Peloton) system test using Peterbilt trucks (consisting of a two-truck platoon) resulted in an average fuel consumption saving of 4.5 percent for the lead truck and 10% for the following truck (overall "team" savings were an estimated 7.25 percent). To provide an example, a two-truck platoon traveling between Buffalo and Albany would save 7.1 gallons of fuel, equating to a cost savings of \$18.55 (assuming a base of 6.0 mpg and a fuel cost of \$2.62 per gallon of diesel fuel).



Best Practices (continued)

- On a regular five-day week route yield, the estimated savings per year would be \$4800, \$14,500 savings over the typical first owner's three-year ownership period, and a 10-year lifetime savings of \$48,500.

Safety Benefit:

- The trucking industry views increased safety as a primary reason to adopt platooning technology.
- Truck platooning technology implementation would lead to fewer injuries, fewer deaths, and lower crash rates, resulting in reduced insurance costs.

Dedicated Short-Range Communications (DSRC) Rule:

- The National Highway Traffic Safety Administration (NHTSA) issued a proposed Dedicated Short-Range Communications (DSRC) rule for light-duty vehicles in December 2016.
- If approved, the communications defined in the rulemaking would be mandatory for light-duty vehicles. Several project stakeholders suggested that a medium-duty/heavy-duty version or extension of the DSRC rulemaking could follow if the light-duty rule is approved and would hasten the implementation of truck platooning technologies.

Testing in the United States:

- Several states have permitted platooning tests as an involved way of receiving real-world information on platooning and an up-close perspective on the technology's potential opportunities and barriers.
- Platooning testing has been completed in Texas, Ohio, Michigan, California, and Nevada. Higher-level automated HD truck platooning technology has been tested in limited amounts in the U.S.

Feedback from Trucking Fleet:

- Trucking fleets housed in, or operating in, NYS that are interested in truck platooning were interviewed.
- All were interested in testing or adopting for use in their fleets. Each fleet's operation, however, is very different, which highlighted platooning's benefits and how widespread application may be slowed by operational differences.

Policies/Regulation:

- There are no specific federal policies or regulations that prohibit the use, operation, or deployment of platooning technology, though the U.S. Congress has introduced bills to accelerate automated vehicle testing and deployment.
- Policy barriers to implementation are primarily at the state level.
- In New York State's regulation, truck following distance and speed requirements would need to be amended and updated prior to truck platooning testing and deployment.
- Several states have found it valuable to develop policy language that defines what the term "platooning" specifically means and in what capacity it relates to commercial vehicle operations. These definitions differentiate between platooning-specific operation and automated vehicles, and create a simpler and more focused policy.
- Multiple States require "Permission to Operate Platooning Vehicles" to allow platooning on public roads. The state requires that truck fleets secure pre-deployment permission via an approved platooning plan or application to operate platooning trucks on public roads.



Longer-Term Policy Needs:

- More highly automated vehicle technology will likely be integrated into future heavy duty truck applications. As technology advances, additional vehicle automation, not necessarily platooning-specific, policies may be needed to support testing and widespread deployment, so its benefits can be realized.

Case Study

Commercial Truck Platooning Demonstration in Texas Level 2 Automation

The Texas Department of Transportation (TxDOT) funded the creation of a comprehensive truck platooning demonstration in Texas with assistance from the Texas A&M Transportation Institute (TTI). TTI investigated and documented lessons learned from past platooning projects; identified potential regulatory or legislative roadblocks that could hamper or facilitate introduction of platooning into commercial fleet operations; and explored the possible business cases and implementation scenarios within the existing infrastructure and operational environment.

The TTI team also developed, tested, and demonstrated the platooning technology (proof-of-concept), which culminated in a full-scale demonstration workshop in July 2016 in College Station, Texas, to disseminate the results; capture insights, comments, and buy-in from stakeholders; and set the stage for further development and deployment on Texas roadways.



Truck Platooning on Rural Road

Methodology:

For this study, TTI conducted literature reviews of the state of practice of truck platooning, examined potential state and federal legislative hurdles, and performed modeling and simulation of truck platooning in a closed environment to determine quantifiable environmental and operational impacts of truck platooning.

The final task as part of this study was a proof-of-concept demonstration in two Class-8 commercial vehicles and a workshop on the state of practice of truck platooning and future planning activities.

Findings:

The study concluded that the following benefits can be derived from truck platooning:

- Truck platooning can reduce fuel consumption up to 12 percent on average. From the individual trucks' viewpoint, the upper ranges of savings were observed at 40 percent for the follower and 20 percent for the leader in a platoon.
- Freeway capacity can be increased with two vehicle platooning without any large-scale infrastructure expansion.

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