
Role of Truck Platooning in Improving the Efficiency of Port-Hinterland Connections

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What is truck platooning?

- **Grouping two to four trucks in sequence so that they can drive close together, using automatic speed control to maintain spacing**
 - **Extension of adaptive cruise control, using radar to measure the gap to the preceding truck +**
 - **Closely coordinated maneuvering based on wireless data communication between them**
- **First truck is driven conventionally, but followers can have varying levels of automation**

SAE J3016™ LEVELS OF DRIVING AUTOMATION

What does the human in the driver's seat have to do?

SAE LEVEL 0

SAE LEVEL 1

SAE LEVEL 2

SAE LEVEL 3

SAE LEVEL 4

SAE LEVEL 5

You are driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering

You are not driving when these automated driving features are engaged – even if you are seated in “the driver’s seat”

You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety

When the feature requests, you must drive

These automated driving features will not require you to take over driving

These are driver support features

These are automated driving features

What do these features do?

These features are limited to providing warnings and momentary assistance

These features provide steering OR brake/acceleration support to the driver

These features provide steering AND brake/acceleration support to the driver

These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met

This feature can drive the vehicle under all conditions

Example Features

- automatic emergency braking
- blind spot warning
- lane departure warning

- lane centering OR
- adaptive cruise control

- lane centering AND
- adaptive cruise control at the same time

- traffic jam chauffeur

- local driverless taxi
- pedals/steering wheel may or may not be installed

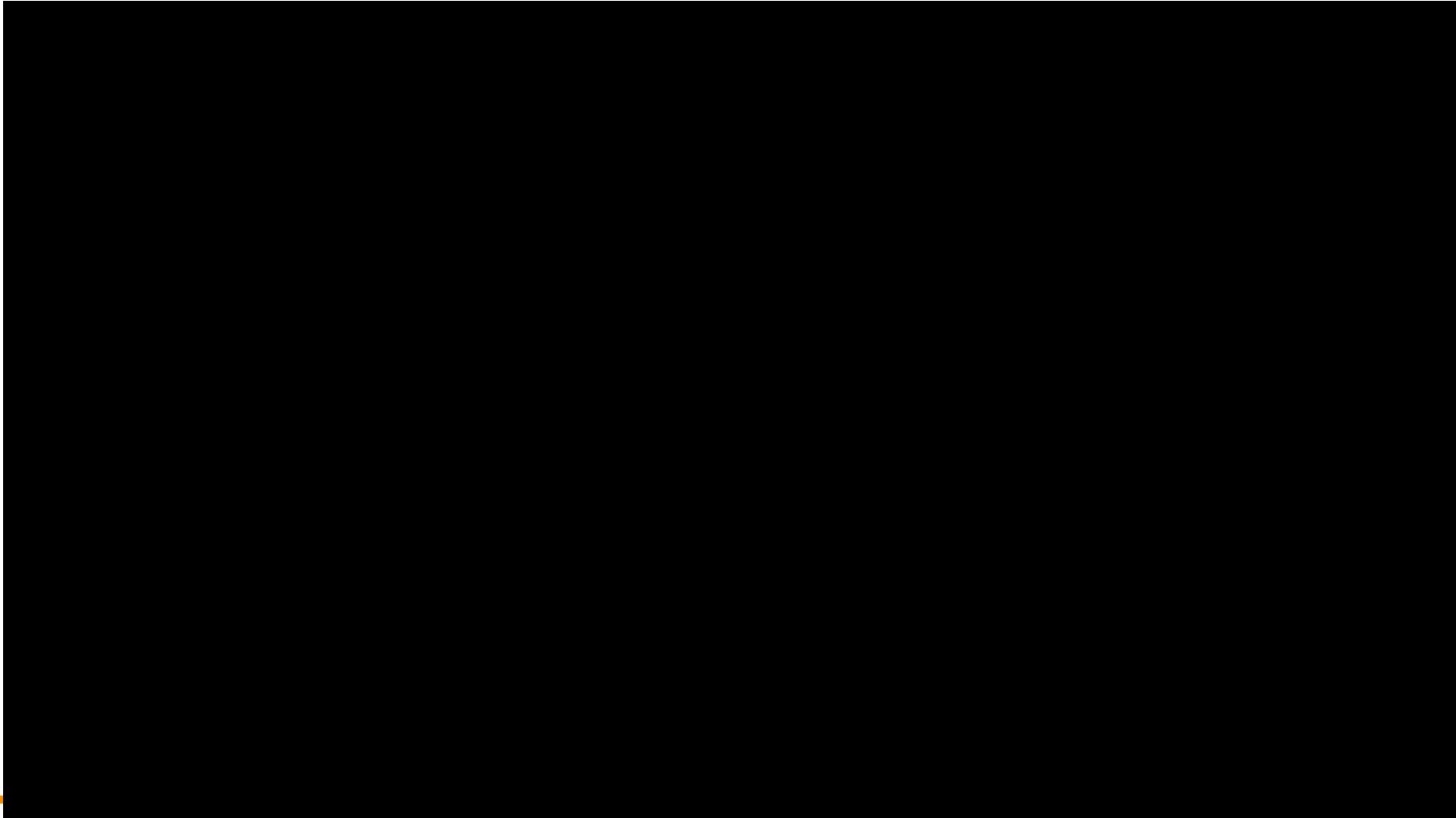
- same as level 4, but feature can drive everywhere in all conditions

Platoon Follower Automation Levels

- **Level 1 – speed/spacing controlled automatically, while driver steers and monitors for hazards**
- **Level 2 – speed/spacing and steering controlled automatically, while driver supervises and monitors for hazards**
- **Level 3 – driving is automated, but driver needs to be available to intervene when the system requests help (driver can do other tasks between these requests)**
- **Level 4 – system can ensure safety without driver action or presence (when driving within its ODD)**

Platoon Demo on Public Highway near Washington DC

Time gap of 0.6 s at 110 km/h = ~17.5 m separation



Platoon Test at Short Gap (4 m) on Test Track (Blainville, Quebec)



Benefits of Truck Platooning

- **Significant energy savings from aerodynamic drafting**
- **More stable vehicle following, reducing traffic flow disturbances, saving additional energy and emissions**
- **Increased lane capacity and reduced congestion from improved traffic dynamics and shorter gaps**
- ***(Potential) safety improvements***
- ***(When Level 3 automation of followers becomes feasible)***
Improvement in truck driving working conditions, with more diverse assignments for drivers
- ***(When Level 4 automation of followers becomes feasible)***
Reduced need for truck drivers in followers

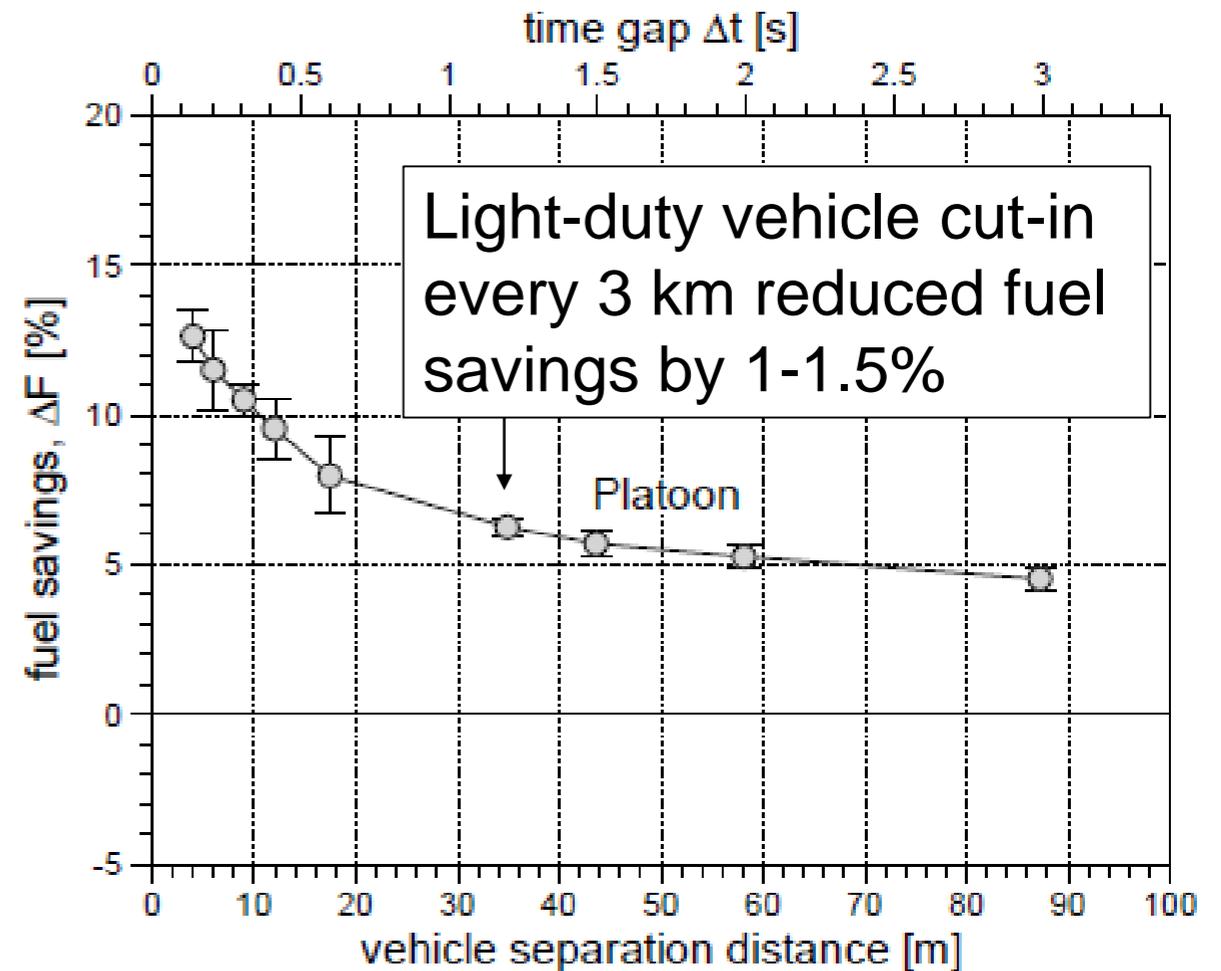
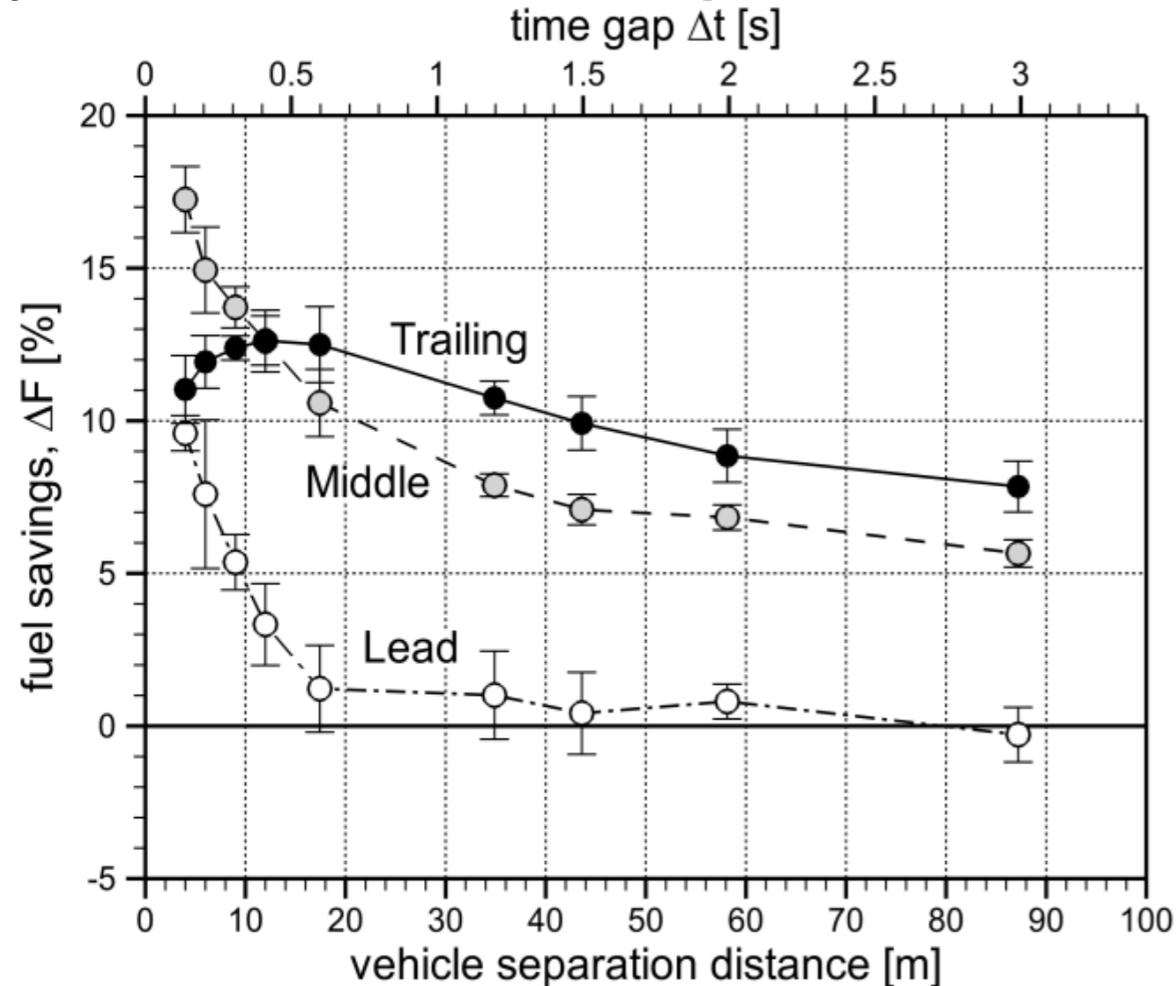
Level 1 Truck Platooning State of the Art

Automated longitudinal control only

- **Cooperative ACC as first step**
 - **V2V peer-peer data communication/coordination**
 - **Ad-hoc joining and leaving by truck drivers**
 - **Constant time-gap following**
- **Level 1 close-formation platooning**
 - **Add coordination/supervision (central or by leader)**
 - **May extend to constant distance gap and shorter distances**
- **Many R&D projects with homogeneous fleets, and EU ENSEMBLE project extending to multiple brands**
- **Active product development by several companies**

Fuel Savings per Truck by Position and Average of 3 Trucks in Platoon

Track tests under U.S. DOE SMART Mobility Program and Transport Canada sponsorship, by PATH, LBL, Volvo Group, National Research Council of Canada and NREL (2017)



Diverse Driver Preferences for Gaps

Percentages of time truck drivers used each gap setting driving on SF Bay Area freeways

Time gap (Distance at 90 km/h)	0.6 s 15 m	0.9 s 22 m	1.2 s 30 m	1.5 s 37 m	1.8 s 45 m
Least experienced driver	5%	9%	13%	-	73%
Middle experience drivers	3%	12%	57%	15%	13%
Most experienced drivers	63%	12%	22%	2%	1%

Traffic Flow Implications

- **Significant impacts only likely on congested highways with substantial truck traffic**
- **Traffic simulations for I-710 (Long Beach port to downtown Los Angeles), with heavy trucks being 10-19% of morning traffic volume along a 24-km urban corridor:**
 - **Upper limit case of all trucks able to platoon:**
 - **Truck average speed increased by 20%, car speed increased by 6%, mainly by improving flow at the dominant bottleneck on the corridor**
 - **Bottleneck relief also improves energy efficiency and reduces emissions**

Current Status of Development

- **Level 1 platooning (automatic speed control of trailing trucks, motivated by energy savings):**
 - **Development and field testing projects in Europe, U.S., Japan**
 - **Several companies preparing to introduce it for commercial use**
 - **Multi-brand platooning integration (6 truck manufacturers) in EU's ENSEMBLE Project**
- **Level 4 platooning (aiming for no drivers in trailing trucks to save on driver labor)**
 - **Current public projects aiming to test in Japan, Singapore**
 - **Several companies trying to develop it**