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

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Livorno, May 23, 2019
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**
- You are driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering.
- You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety.

**SAE LEVEL 1**
- You are not driving when these automated driving features are engaged – even if you are seated in “the driver’s seat.”

**SAE LEVEL 2**
- 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 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 are automated driving features

- 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.

What do these features do?

**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

For a more complete description, please download a free copy of SAE J3016: [https://www.sae.org/standards/content/J3016_201806/](https://www.sae.org/standards/content/J3016_201806/)
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)

- Light-duty vehicle cut-in every 3 km reduced fuel savings by 1-1.5%
## Diverse Driver Preferences for Gaps

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

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