Truck Platooning: State of the Art Review

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Why care about truck platooning?

• Significant energy savings from aerodynamic drafting
• More stable vehicle following dynamics, reducing traffic flow disturbances and saving additional energy and emissions
• Increased highway capacity and reduced congestion from improved traffic dynamics and shorter gaps
• (Potential) safety improvement
• (When Level 3 automation 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
Enablers of Truck Platooning

- Adaptive cruise control (forward ranging sensor, plus engine, braking and transmission control)
- Fast, highly reliable V2V communication
- Informative driver-vehicle interface
- Reliable early detection of cut-in vehicles
- (For L2+) Lane position detection and automatic steering control
- (For L3+) Central supervision, I2V comm.
- (For L4) Extensive safety assurance + dedicated, segregated truck lanes (?)
## Research Projects Building the Foundation Over 20+ Years

<table>
<thead>
<tr>
<th>Years</th>
<th>Where</th>
<th>Project</th>
<th># Trucks</th>
<th>Operating Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996-2004</td>
<td>EU</td>
<td>CHAUFFEUR</td>
<td>2, 3</td>
<td>CACC (mixed), L2 Towbar Platoon (dedicated), 6-12 m gap</td>
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<tr>
<td>2000-2003</td>
<td>US</td>
<td>Caltrans/PATH truck platooning</td>
<td>2</td>
<td>L1 platoon, 3-10 m gaps, closed track tests</td>
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<tr>
<td>2005-2009</td>
<td>EU</td>
<td>Konvoi</td>
<td>4</td>
<td>L2 platoon, 10-15 m gaps, mixed traffic tests</td>
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<tr>
<td>2008-2013</td>
<td>JP</td>
<td>Energy ITS</td>
<td>4</td>
<td>L2 platoon, closed track tests, 4-10 m gaps</td>
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<tr>
<td>2009-2012</td>
<td>EU</td>
<td>SARTRE (mixed truck and car platoon)</td>
<td>2</td>
<td>L2 Towbar platoon, mixed traffic tests, 6 m gaps for cars</td>
</tr>
<tr>
<td>2008-2011</td>
<td>US</td>
<td>FHWA EARP/PATH truck platooning</td>
<td>3</td>
<td>L1 platoon, 4 – 10 m gaps, closed track tests</td>
</tr>
<tr>
<td>2013-2017</td>
<td>US</td>
<td>FHWA EARP – PATH and Auburn Univ.</td>
<td>3, 2</td>
<td>L1 CACC for mixed traffic tests, 0.6 – 1.5 s gap (15 – 37 m)</td>
</tr>
<tr>
<td>2015-2016</td>
<td>US</td>
<td>TXDOT/TTI truck platooning</td>
<td>2</td>
<td>L2 platoon, 15+ m gap, closed track tests</td>
</tr>
<tr>
<td>2015-2016</td>
<td>EU</td>
<td>European Truck Platooning Challenge</td>
<td>2 (3 mfg)</td>
<td>L1 platoons from 6 manufacturers, on public roads</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 (3 mfg)</td>
<td></td>
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</tbody>
</table>
L1 Truck Platooning State of the Art

Automated longitudinal control only

• Cooperative ACC as first step (pre-platoon)
  – V2V communication/coordination
  – Ad-hoc joining and leaving
  – Constant time-gap following

• L1 Platooning
  – Add coordination/supervision by leader
  – Extend to constant clearance distance gap and shorter distances

• Many research and development projects
• Peloton Technology planning 2-truck product release
• Major truck manufacturers considering it seriously, but no announcements yet
PATH/Volvo Truck CACC at 0.6 s Gap on Transport Canada’s Test Track
L2 Truck Platooning State of the Art

L1 platooning + automatic steering control

– Automatic steering likely necessary for shorter longitudinal gaps (visibility limitations)

• Multiple research projects have tested it, from CHAUZZEUR (1996-2004) to Konvoi, SARTRE, Energy ITS, etc.

• Some companies doing R&D on it (Daimler, Scania, Otto,...)

• Product releases??
L3 Truck Platooning State of the Art

L2 + driver can divert attention temporarily to other tasks, while remaining available to intervene when needed

- Follower truck driver could work as sales person or logistics manager *en route*

- Research needed on driver-vehicle interface to try to ensure driver availability when needed

- Remote supervision (by lead driver over V2V or central supervisor over I2V communication link) could be needed

- Passenger car applications likely to precede heavy trucks
L4 Truck Platooning State of the Art

L3 + ability to ensure minimal risk condition without any human intervention (while operating within its specified Operational Design Domain – ODD)

- L4 platoon followers likely to be coupled behind a leader driven at L0, L1 or L2.
- Singapore requesting this for a 10 km route connecting two container terminals
- Safety assurance state of the art not sufficient to support this level of automation for mixed traffic and highway-speed operations
- Likely to need segregated truck-only lanes to simplify the ODD.