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**

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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 (?)**

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Research Projects Building the Foundation Over 20+ Years

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

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 CHAUFFEUR (1996-2004) to Konvoi, SARTRE, Energy ITS, etc.**
- **Some companies doing R&D on it (Daimler, Scania, Otto,…)**
- **Product releases??**

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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**

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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.**

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