Introduction to Truck Platooning

Steven E. Shladover, Sc.D.
University of California PATH Program
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What is truck platooning?

- Coordinated driving of clusters of heavy trucks using automatic control of their speed and separation (SAE Level 1 automation)
- Extension of adaptive cruise control (ACC), measuring truck separation using radar and controlling engine and brakes
- Addition of wireless vehicle-vehicle (V2V) communication to enable close coordination
- Loose coupling by cooperative ACC or tighter coupling with constant clearance gap
- Driver steers and watches for hazards
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
• *(Long term)* possible labor savings if platoon following trucks can be operated without drivers
Truck Platoons are not new…

- CHAUFFEUR Project in Europe 1996-2004
- First U.S. project – PATH research for Caltrans demo 2000-2003
- German KONVOI Project 2005-9
- Japanese Energy ITS Project 2008-2013
- European SARTRE Project 2009-2012
- European Truck Platooning Challenge 2015-16
- European multi-brand truck platoon project from 2018
SIS 57: Recent International Progress on Truck Platooning

- Steven Shladover: Development and Testing of a Three-Truck Cooperative ACC System
- Brian McAuliffe (NRC Canada): Aerodynamic Drag Reduction and Associated Fuel Savings from Multi-Vehicle Truck Platoons
- Bastiaan Krosse (TNO): Truck Platooning: An Evaluation of the Impact
- Richard Bishop (Peloton Technology): Update on Industry Collaboration Towards Commercial Deployment of Truck Platooning in North America
Development and Testing of a Three-Truck Cooperative ACC System

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The Current Truck Implementation

- SAE Level 1 automation – longitudinal control only (driver steers and monitors for hazards)
- Building on Volvo VNL series truck ACC system (using same radar and video sensors)
- Added 5.9 GHz dedicated short range communication (DSRC) radio for V2V data
- Added touch-screen tablet display to show status of trucks and select gap settings
- Driver usage tested on California freeways at gaps of 0.6 s to 1.5 s (15 to 37 m at 90 km/h truck speed limit)
- Developed under FHWA Exploratory Advanced Research Program
V2V Communication/Cooperation

Cooperative ACC:
• Constant time gap control
• Ad-hoc joining and leaving at driver’s option
• Broadcast DSRC communications
Truck CACC System Elements

- Dual DSRC Antennas
- Video camera (production)
- 5 Hz GPS
- ACC radar (Production)
- Supplementary display
- PC-104 computer
- Emergency disengage button by driver
Driver Interface

Steering wheel stalk control
Supplementary Display & Emergency Disengage Button Locations
Supplementary Display
Recent System Enhancements

- Wider range of gap settings implemented – from 4 m minimum fixed gap to 3 s maximum time gap (87 m at 65 mph)
  - Cooperative ACC at longer time gaps
  - Tightly-coupled platoon at shorter gaps
- Adjustments to control response to enhance energy efficiency
- Responses to cut-in vehicles between trucks
  - Performance trade-offs in rapidity of recovery vs. energy spent in more aggressive maneuvers
  - Need even earlier detection of cut-ins
Driver Acceptance Tests

- Driving in mixed traffic on California freeways I-580 (suburban) and I-5 (rural) for ~3 hours
- 9 experienced long-haul truck drivers, driving both truck 2 and truck 3 at their choice of gap
- No preference regarding truck 2 or 3 position
- Gap of 1.2 s was most preferred, but some drivers (most experienced group) preferred shortest gap (0.6 s)
- They need to feel they can trust the other drivers in the CACC string/platoon
- Preferred rural usage over urban
Fuel Economy Testing at Blainville, QC (August 2017)
Comprehensive Fuel Economy Tests

- Sponsorship by U.S. DOE SMART Mobility program and Transport Canada ecoTechnology for Vehicles program
- Experimental design and data analysis by National Research Council of Canada – Brian McAuliffe to follow
- SAE J1321 rigorous test procedure, weighing auxiliary fuel tanks before and after each 64-mile test run, each case repeated 3 times
- 65 mph, up to 3 trucks loaded to 65,000 lbs.
Simulations of Impacts in Urban Traffic

• Traffic microsimulation of I-710 corridor from Port of Long Beach to downtown Los Angeles
• 15-mile congested corridor, 10% to 19% trucks
• Assume all trucks use CACC at 1.2 s preferred time gap
  – 12% first follower position
  – 4% second or later follower
• Average truck speed 33 mph in base case, 40 mph with CACC relieving congestion
• Energy savings 2.5% from traffic smoothing, 0.5% from aerodynamic drag reductions