PATH’s Recent Truck Platooning Research for FHWA EARP and DOE

Steven E. Shladover, Sc.D.
University of California PATH Program and Lawrence Berkeley National Laboratory
ITFVHA, Montreal
October 29, 2017
The Current PATH Truck Implementation

• SAE Level 1 CACC – 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 55 mph truck speed limit)
• Developed under FHWA Exploratory Advanced Research Program
V2V Communication/Cooperation

Radar & Video Camera

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

Resume or ON  OFF
Supplementary Display & Emergency Disengage Button Locations
Supplementary Display
Recent System Enhancements

• Wide range of gap settings tested – 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
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

- 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.
Testing at Blainville, QC (August 2017)
Fuel Savings per Truck by Position
Average Fuel Savings for all Trucks

![Graph showing fuel savings for different time gaps and vehicle separation distances for 3-Truck Platoon and 2-Truck Platoon.]
Summary of Main Fuel Consumption Test Results

- Energy saving trends compared to solo driving vary based on gap and truck position, but look consistent with multiple prior tests by various teams.
- Even at 87 m, the second and third trucks saved 6% and 8%.
- Average savings of 3 trucks ranged from 4.5% at 87 m to 13% at 4 m, significantly better than 2 trucks at comparable gaps.
- Long combination vehicle carrying same trailer load behind one tractor saved 28% energy compared to solos.
- Cut-ins every 2 miles reduced fuel savings by 1% - 1.5%.
- Following light-duty vehicles can produce some fuel savings (1% - 2%).