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

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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

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U.S. Department of Transportation Federal Highway Administration

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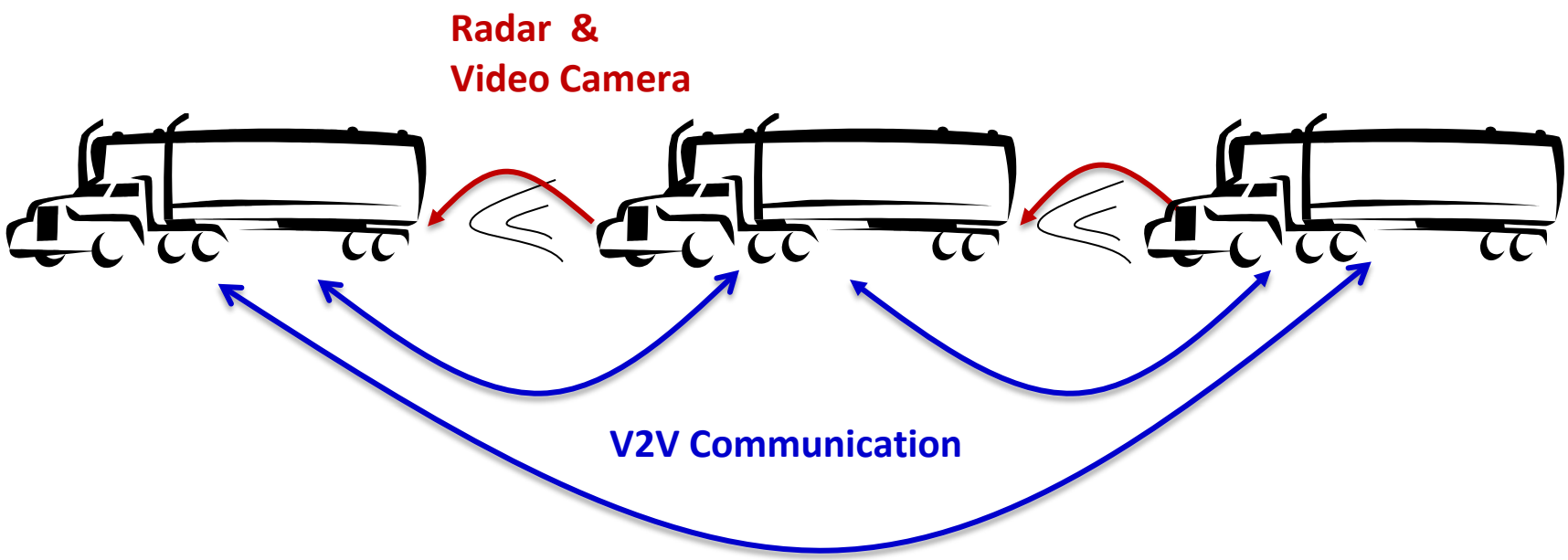
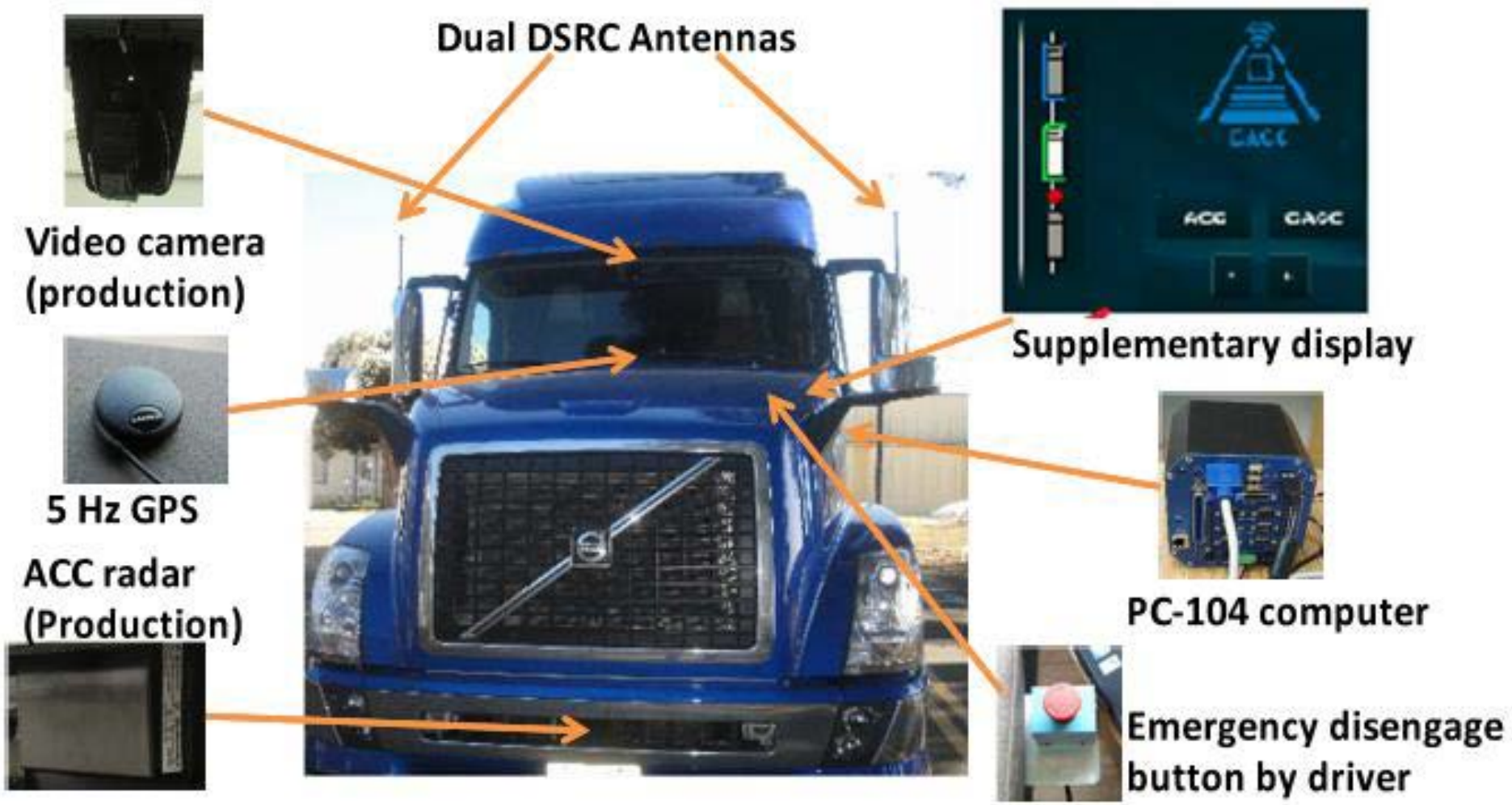
V2V Communication/Cooperation



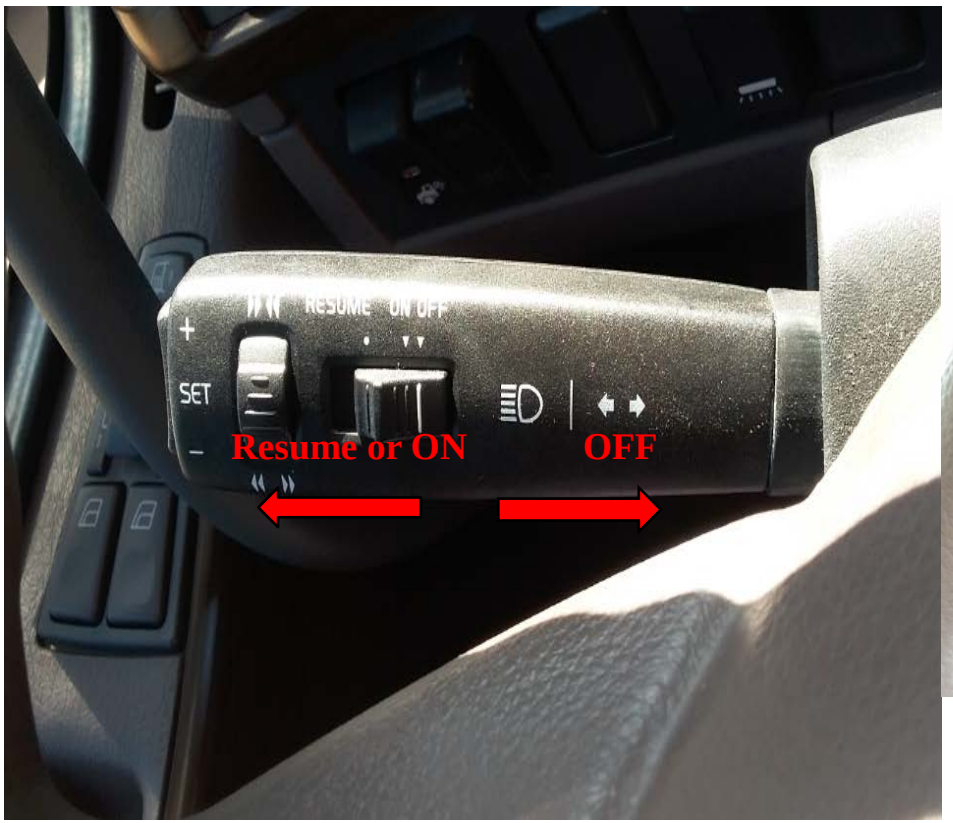
Cooperative ACC:

- **Constant time gap control**
- **Ad-hoc joining and leaving at driver's option**
- **Broadcast DSRC communications**

Truck CACC System Elements



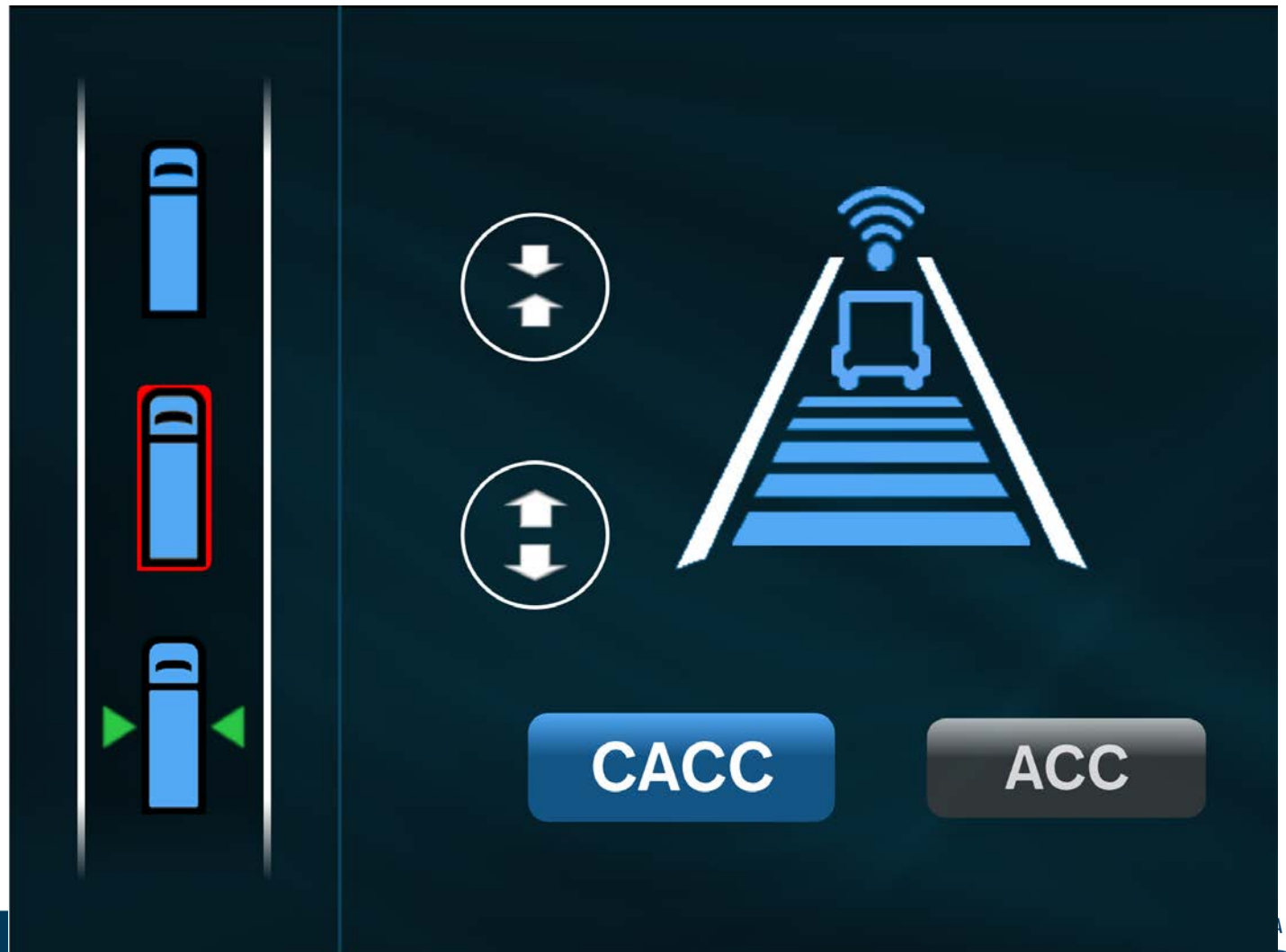
Driver Interface



Steering wheel stalk control

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**

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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

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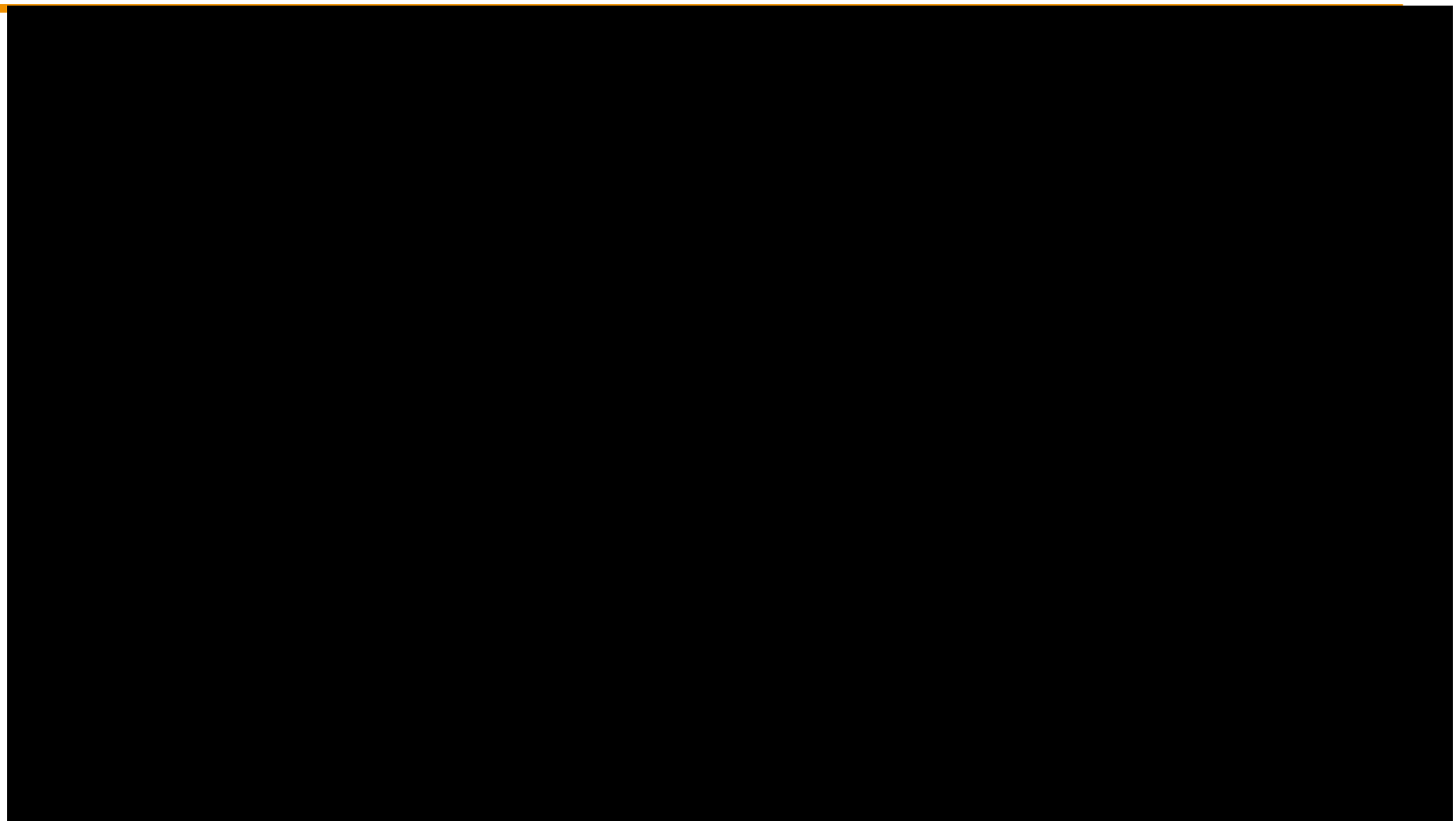
Comprehensive Fuel Economy Tests

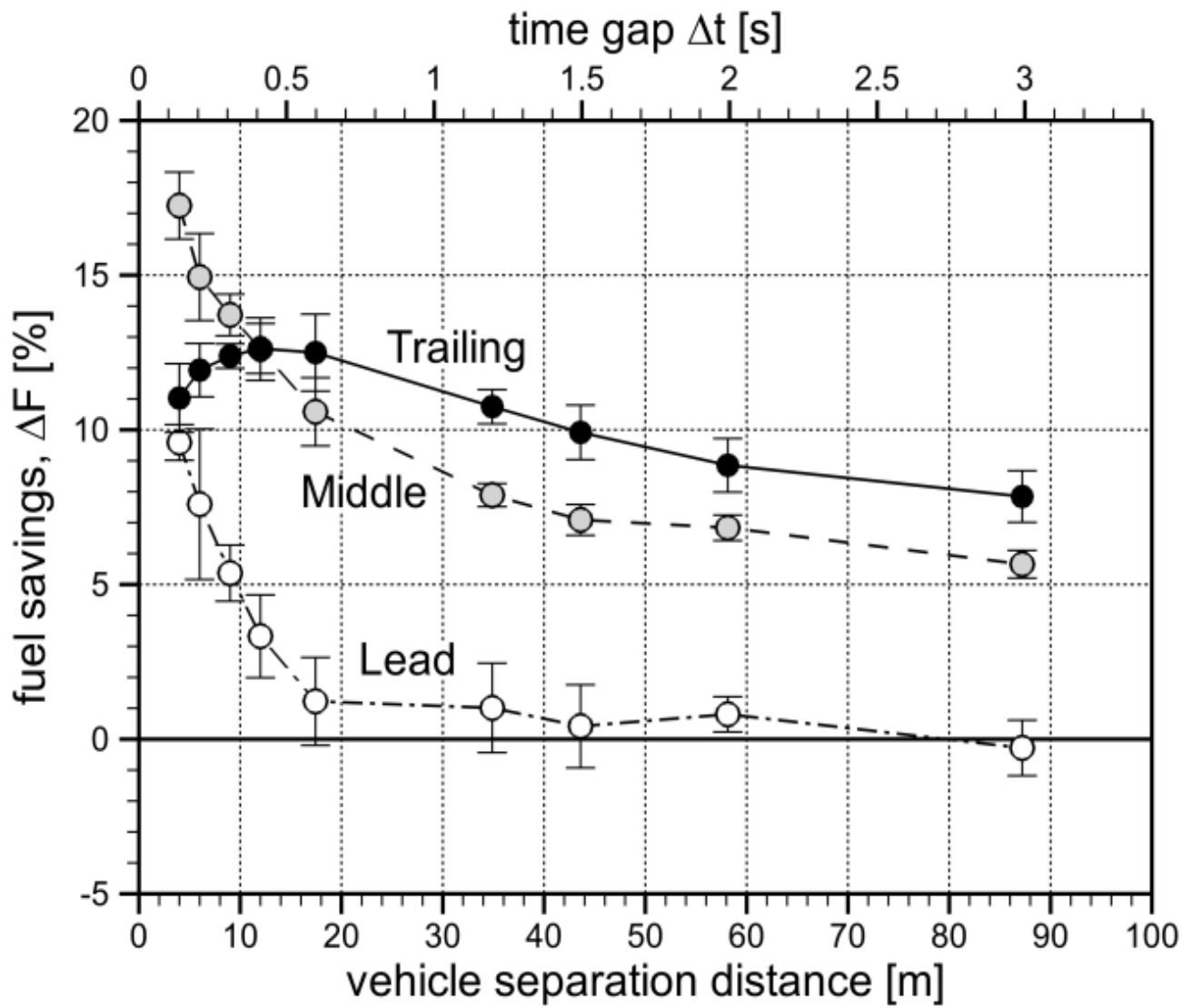
- **Sponsorship by U.S. DOE SMART Mobility program and Transport Canada ecoTechnology for Vehicles program**
- **Experimental design and data analysis by National Research Council of Canada**
- **SAE J1321 rigorous test procedure, weighing auxiliary fuel tanks before and after each 64-mile test run,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

Volvo Group North America

Testing at Blainville, QC (August 2017)



Fuel Savings per Truck by Position



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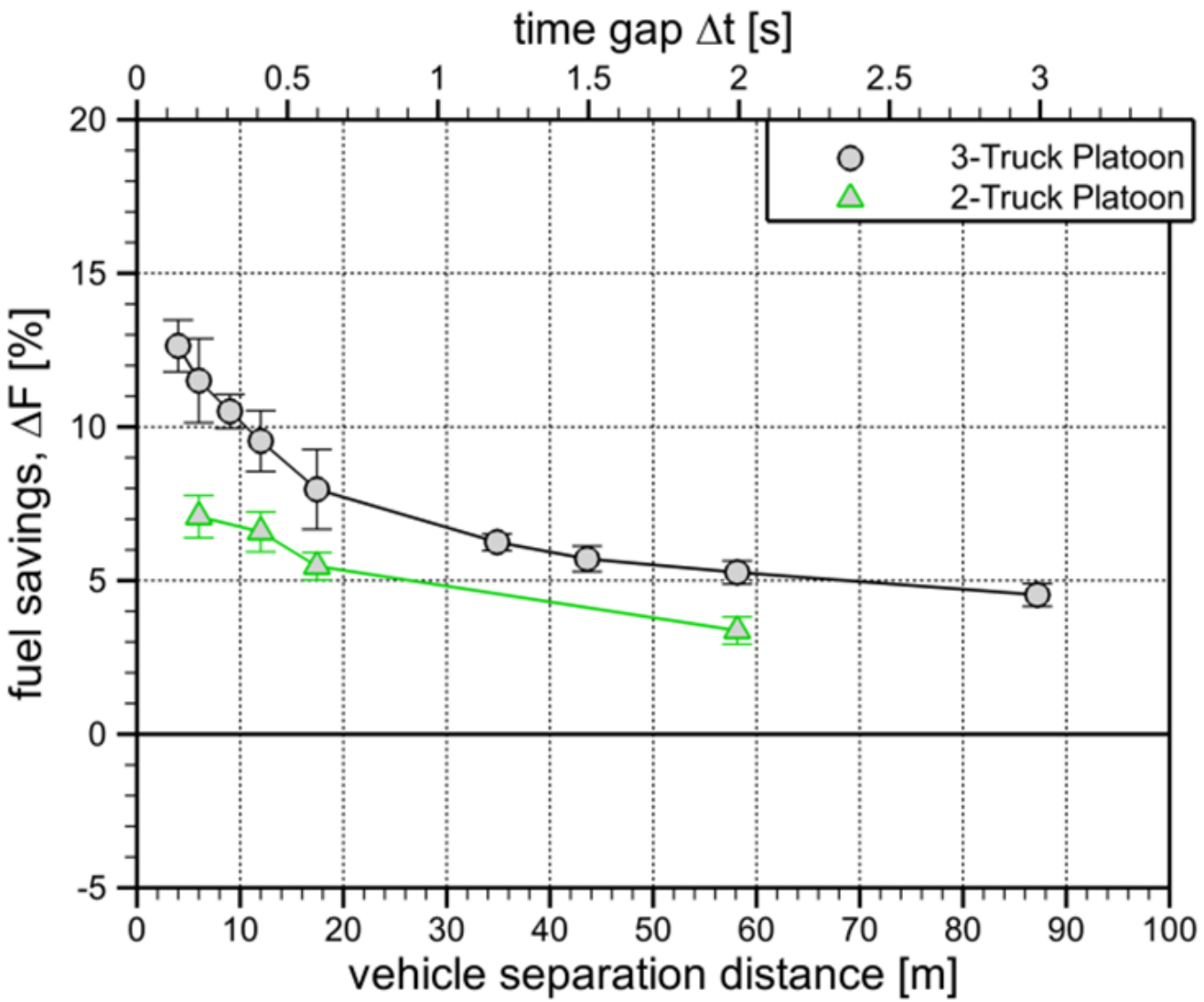
Average Fuel Savings for all Trucks



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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%)

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