Introduction to Truck Platooning

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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

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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**
- **(*Long term*) possible labor savings if platoon following trucks can be operated without drivers**

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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

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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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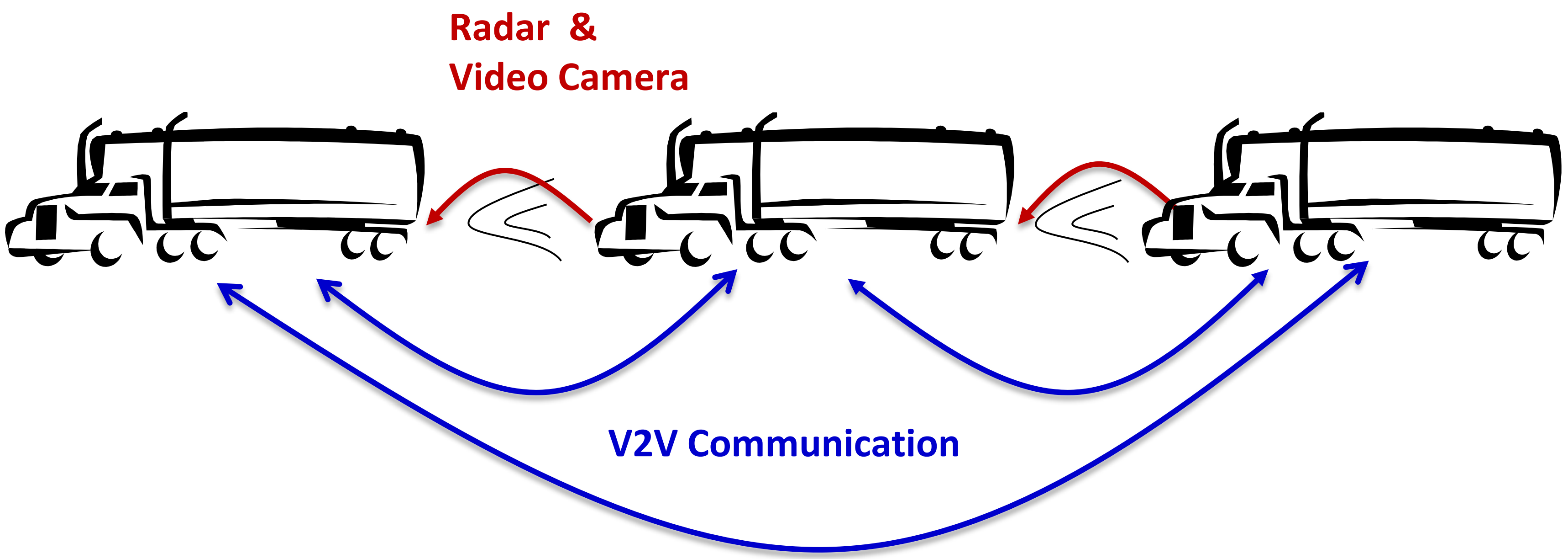
The Current Truck Implementation

- 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

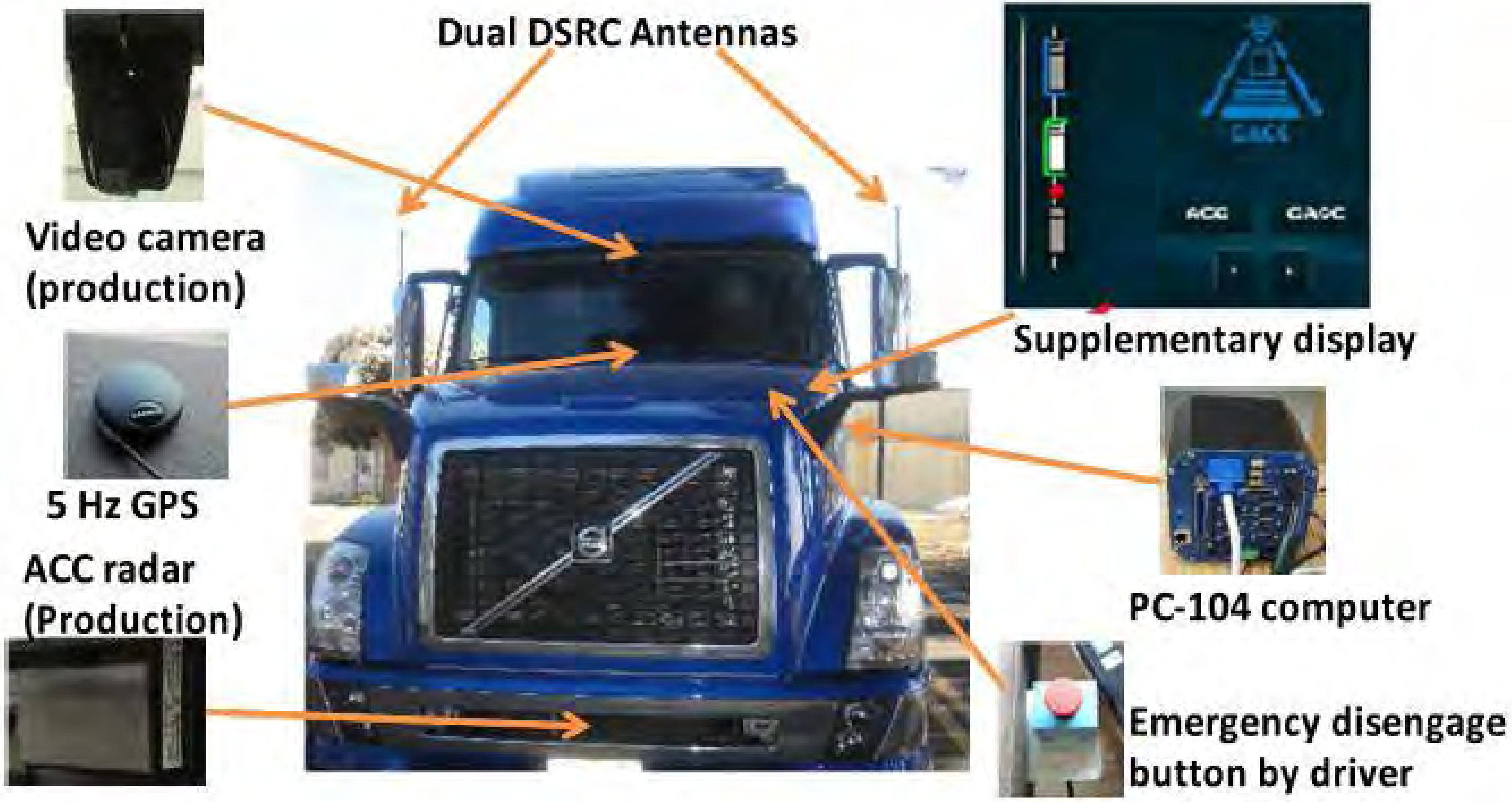
V2V Communication/Cooperation



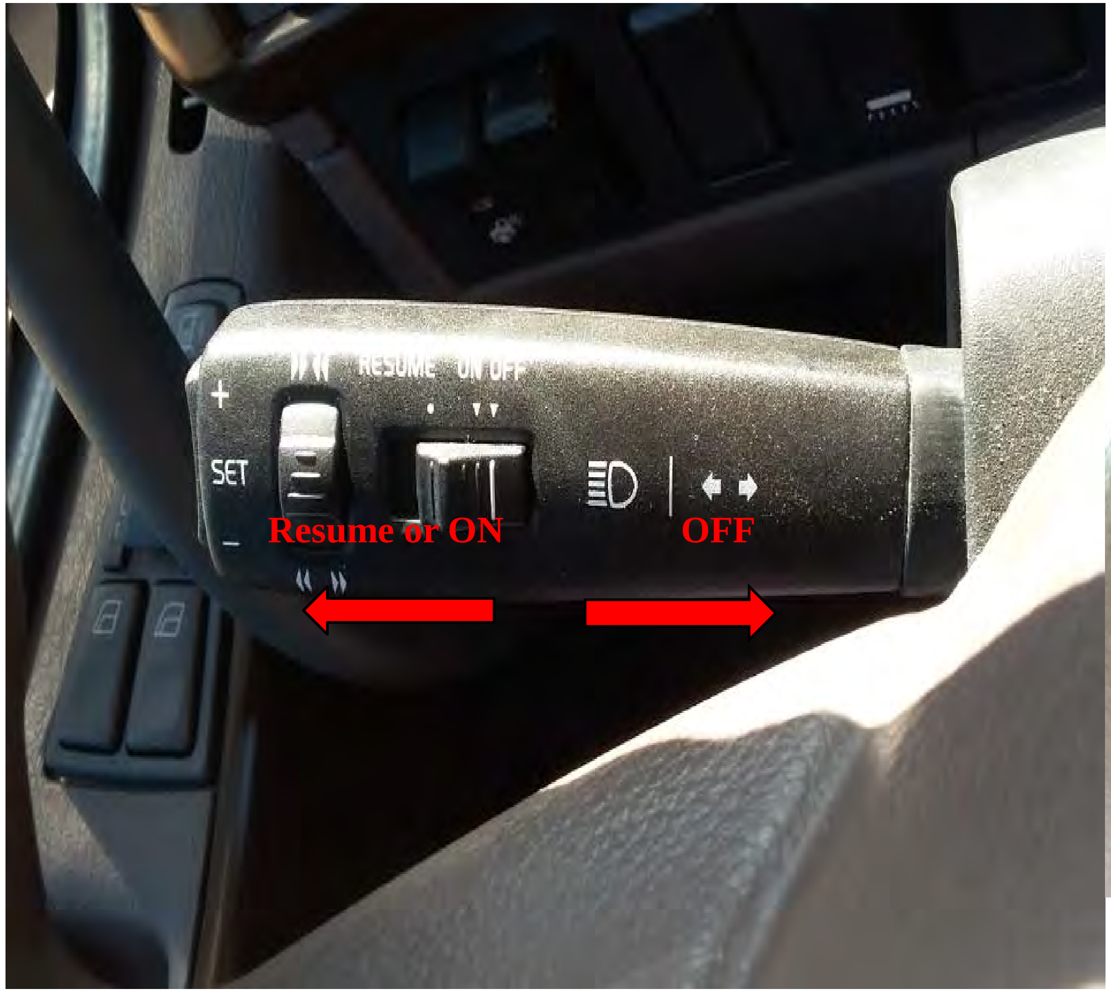
Cooperative ACC:

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

Truck CACC System Elements



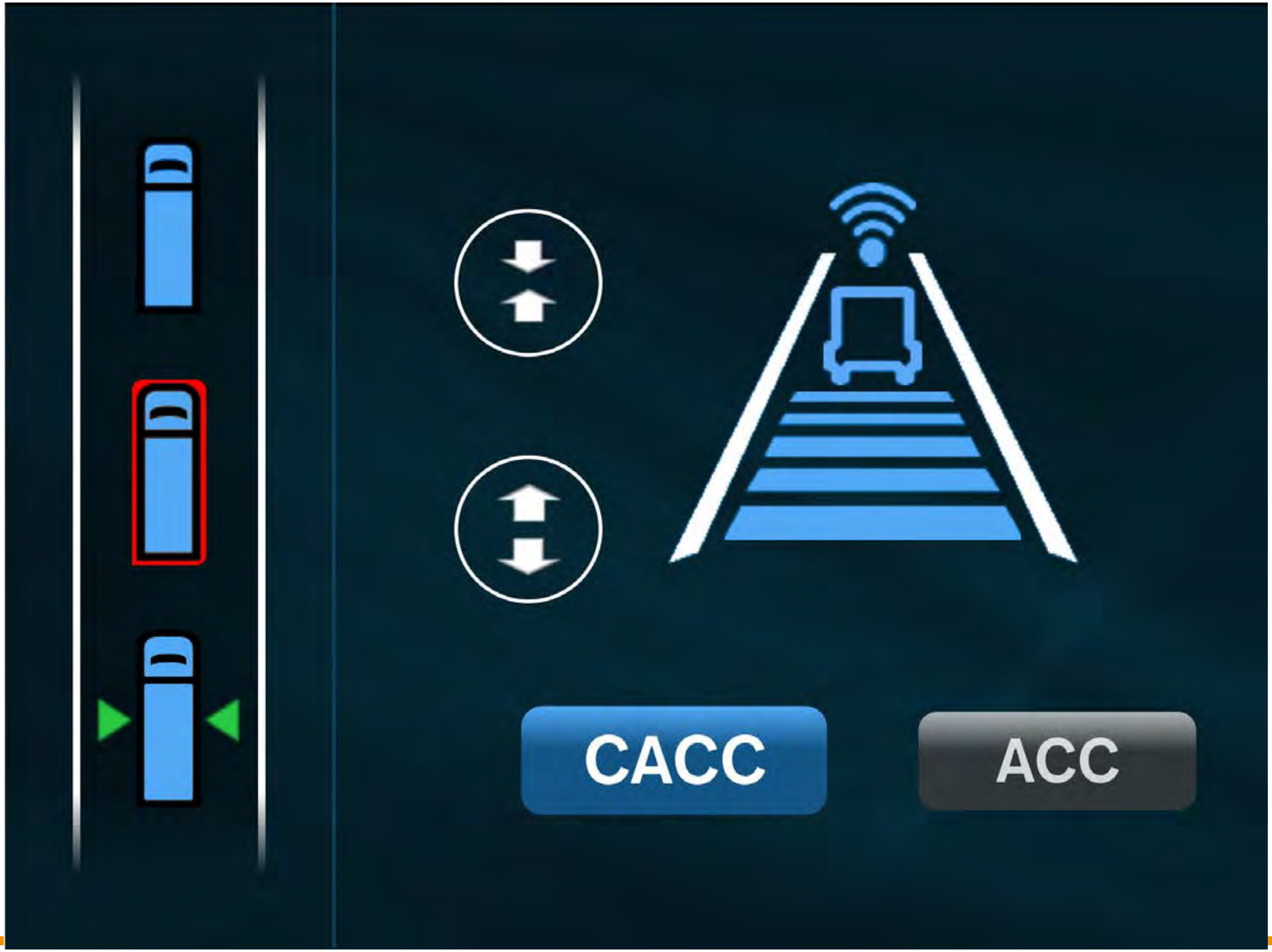
Driver Interface



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

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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

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**

Transport Canada Transports Canada

U.S. DEPARTMENT OF ENERGY

- **Experimental design and data analysis by National Research Council of Canada – Brian McAuliffe to follow**

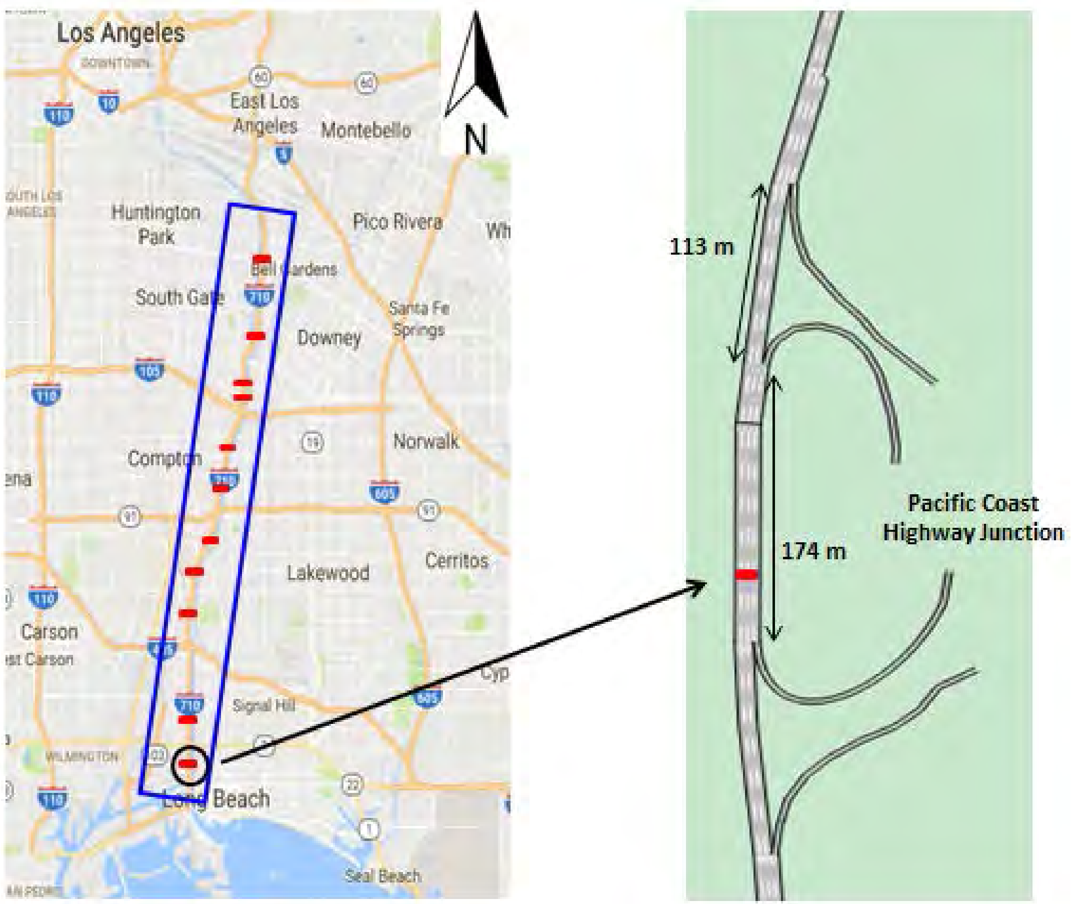
NRC · CNRC

- **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 Volvo Group North America · PIT Group by FPInnovations · PMG www.pmgtest.com · NREL NATIONAL RENEWABLE ENERGY LABORATORY · cftr · BERKELEY LAB · CALIFORNIA PATH

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**



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