Overview of California PATH's Cooperative Truck Platooning Systems

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Outline

- What is truck platooning and why care about it?
- Background on prior truck platooning work
- PATH's earlier truck platoon tests
- The current implementation – cooperative adaptive cruise control and close-formation platooning

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**

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

PATH History with Truck Platooning

- **Demonstration project for California Department of Transportation 2000-2003**
  - **2-truck platoon at gaps from 3 m – 10 m, with energy saving measurements**
- **Development project for FHWA Exploratory Advanced Research Project (EARP) 2007-11**
  - **3-truck platoon at gaps from 4 m – 10m, with energy saving and maneuver tests**
- **Development project for FHWA EARP, 2014-17**
  - **3-truck cooperative ACC system at time gaps from 0.6 s – 1.5 s**
- **Fuel economy enhancements and testing for U.S. Department of Energy, 2017--**

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2003 Tests of 2-Truck Platoon

2010 Tests of 3-Truck Platoon

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)

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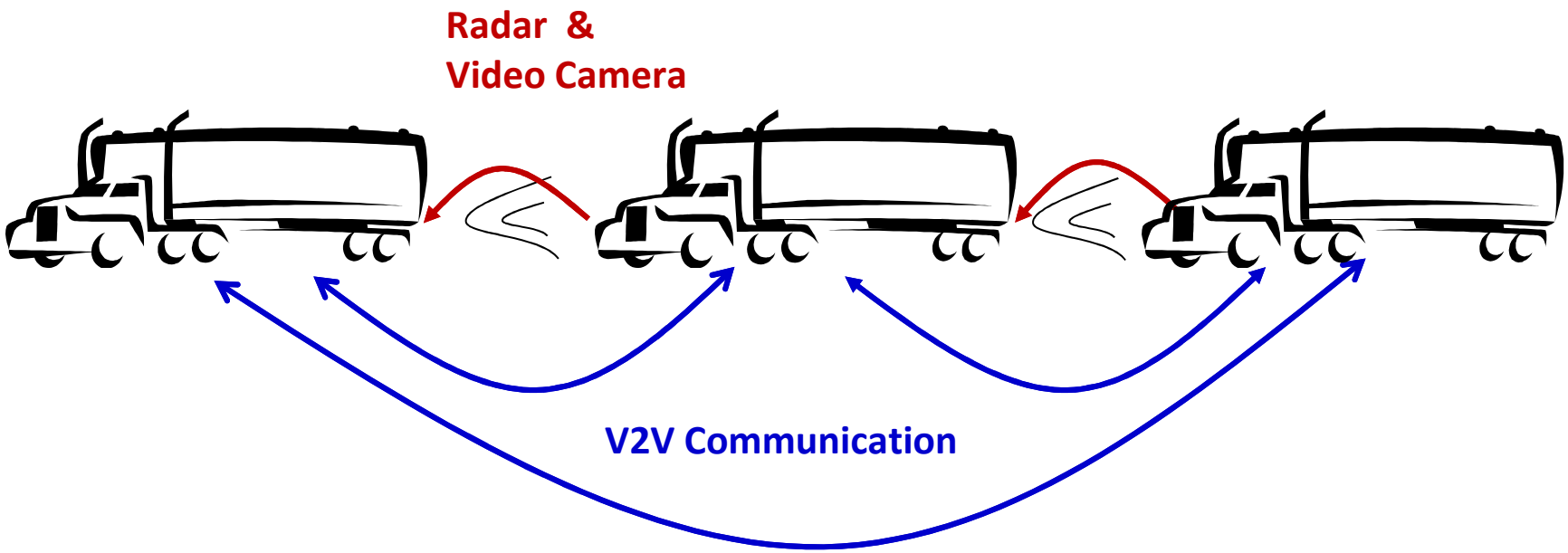
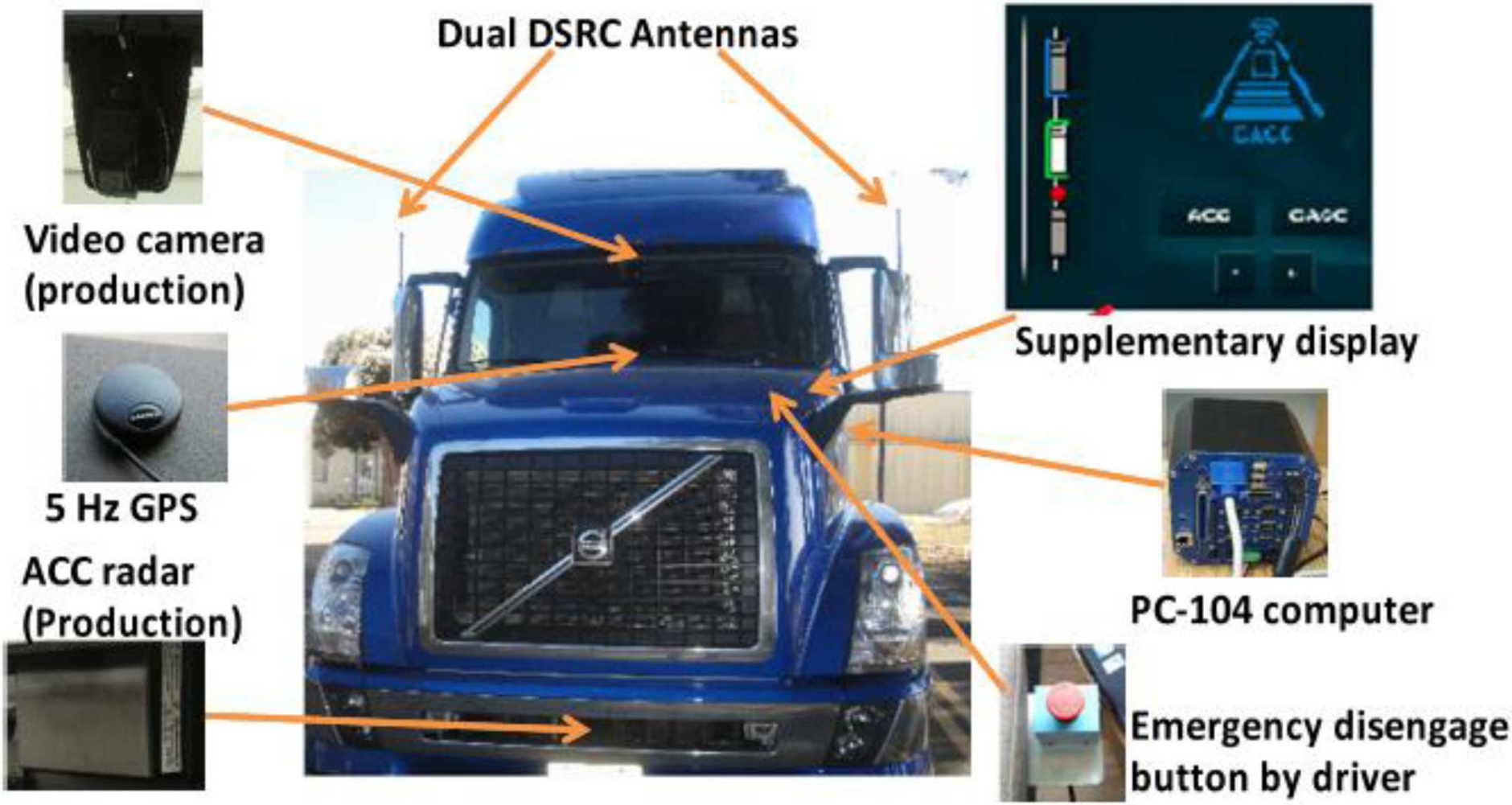
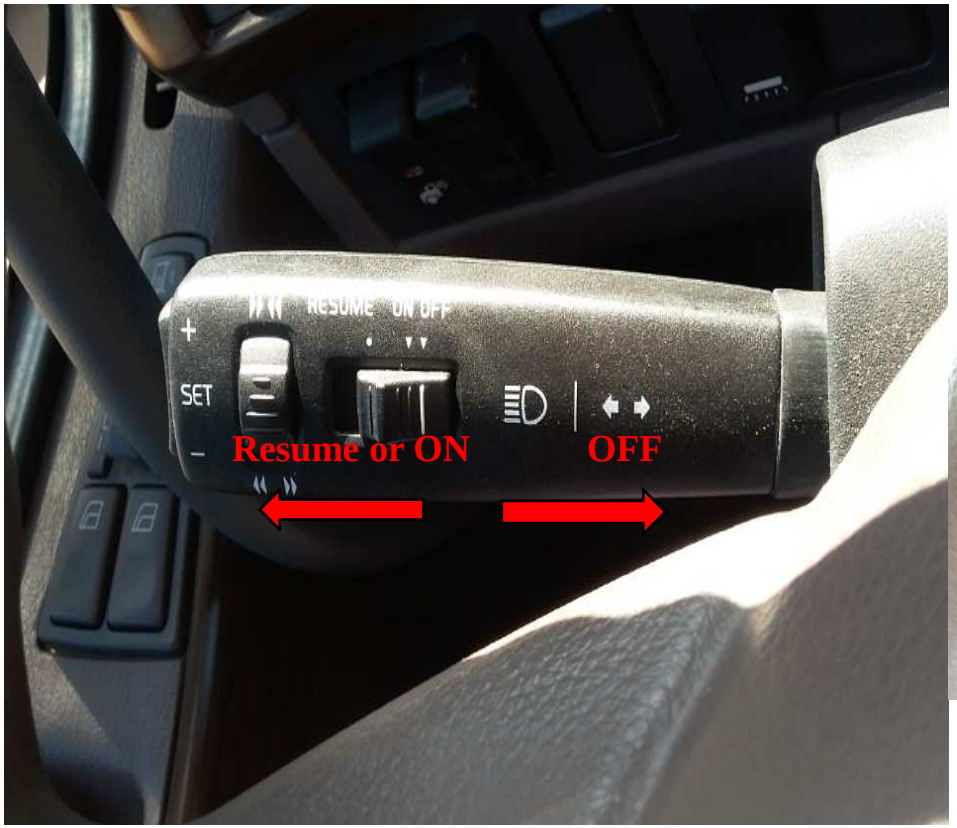
V2V Communication/Cooperation



System Elements



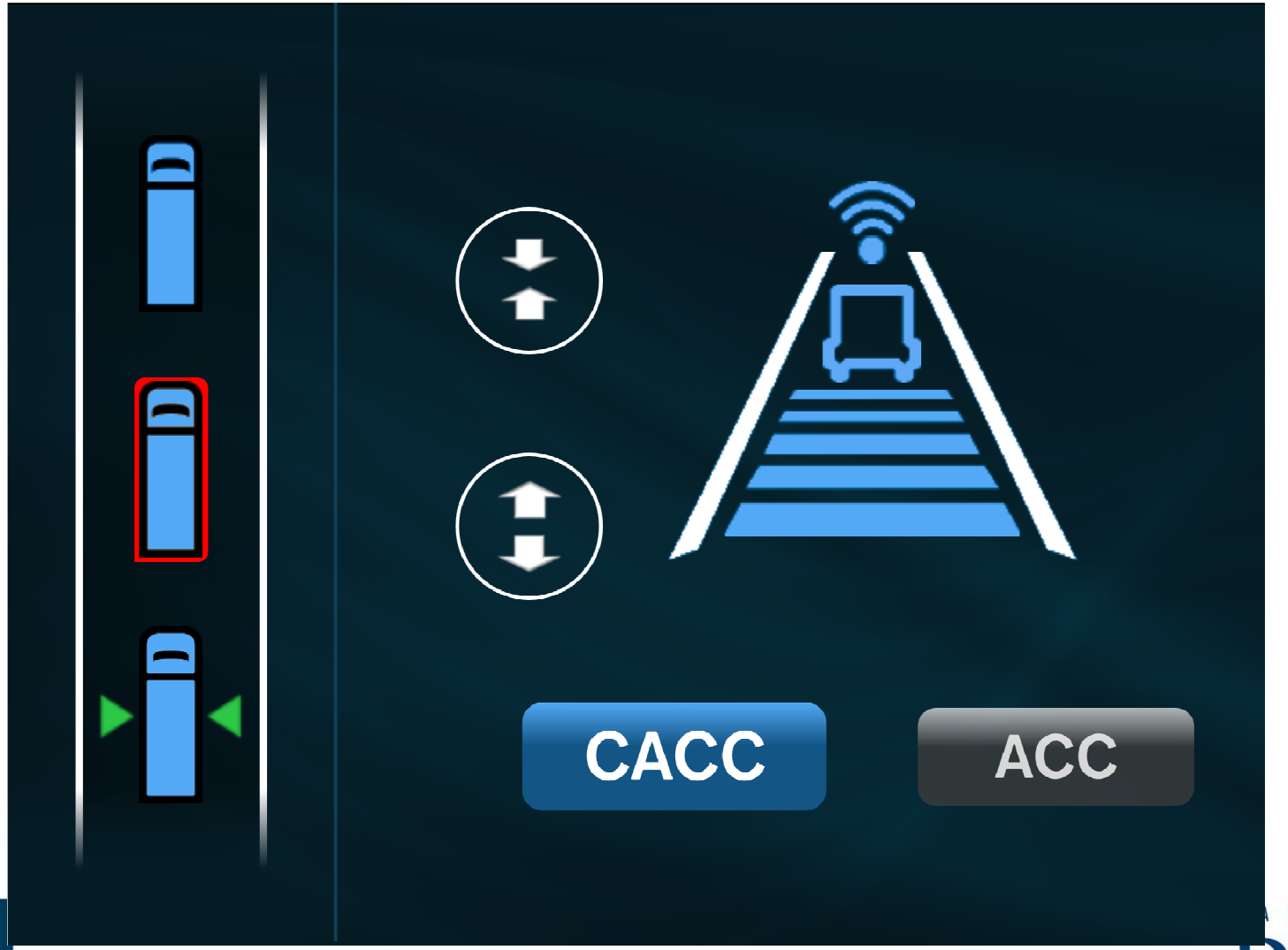
Driver Interface



Steering wheel stalk control

Display & Emergency Disengage Button

Supplementary Display



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**
- **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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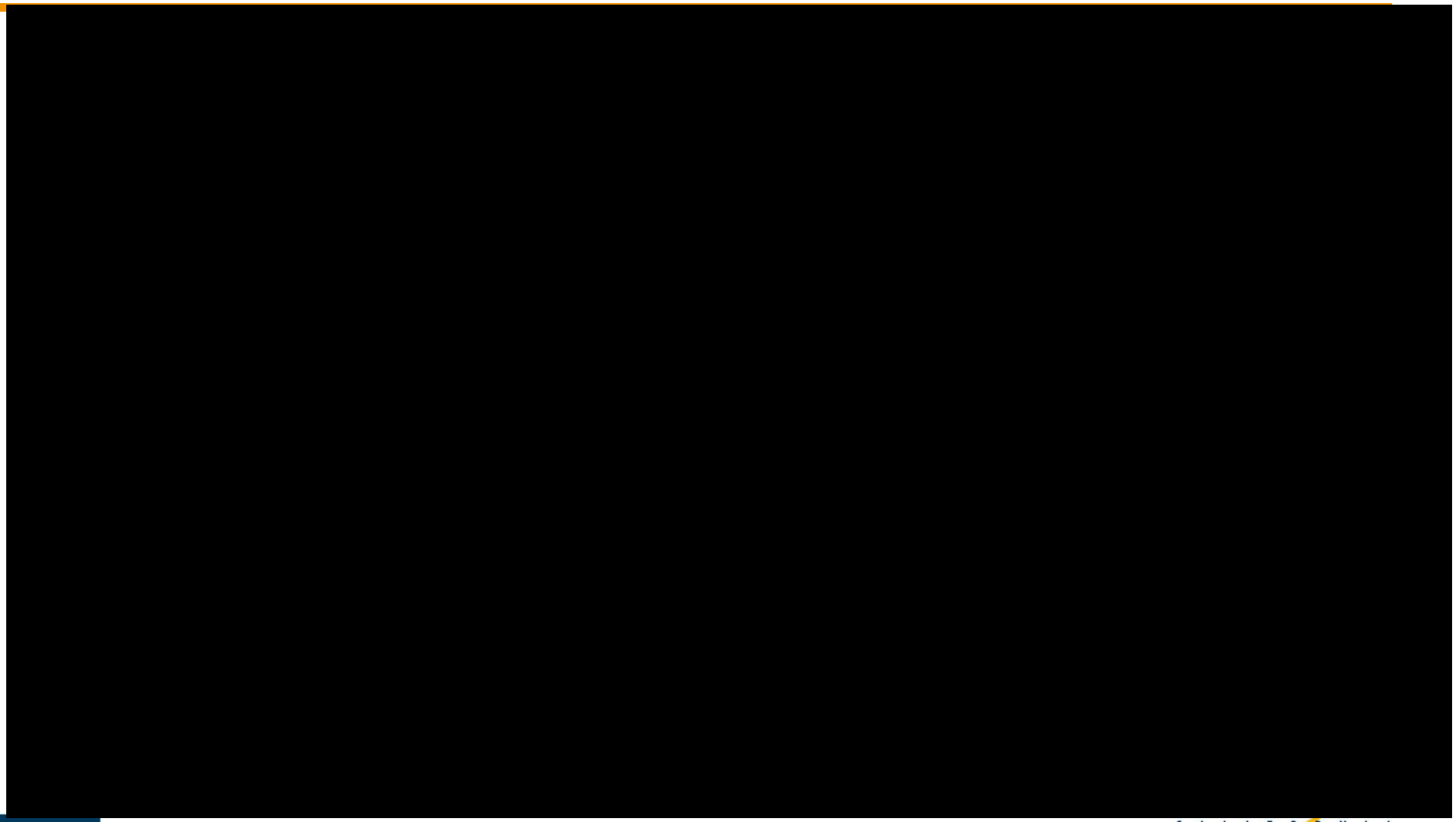
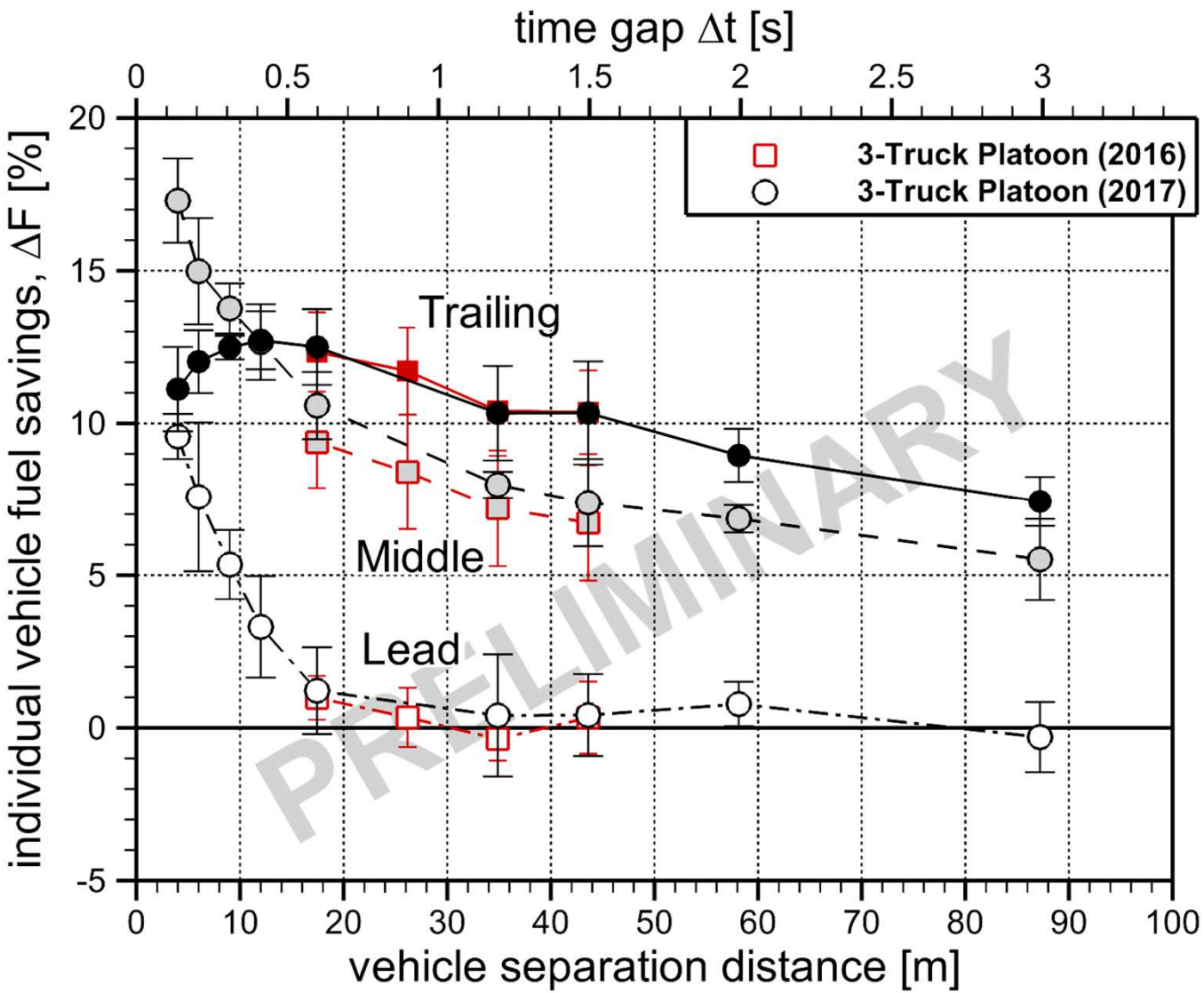
Driving at 0.6 s Time Gap (2016)



Driving at 4 m Gap (August 2017)

Transport Canada Transports Canada

Fuel Savings per Truck at 110 km/h



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