Overview of California PATH's Cooperative Truck Platooning Systems

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Outline

- Context for current joint activity – U.S. Department of Energy SMART Mobility Program
- 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

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Current Project Work

- **Funded by DOE Energy Efficient Mobility Systems (EEMS), SMART Mobility**

U.S. DEPARTMENT OF ENERGY

Berkeley UNIVERSITY OF CALIFORNIA

VOLVO

Volvo Group North America

NREL NATIONAL RENEWABLE ENERGY LABORATORY

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What is truck platooning?

- Coordinated driving of clusters of heavy trucks using automatic control of their speed and separation
- 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**

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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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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 (basis for current tests)**

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2003 Tests of 2-Truck Platoon

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2010 Tests of 3-Truck Platoon

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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)**

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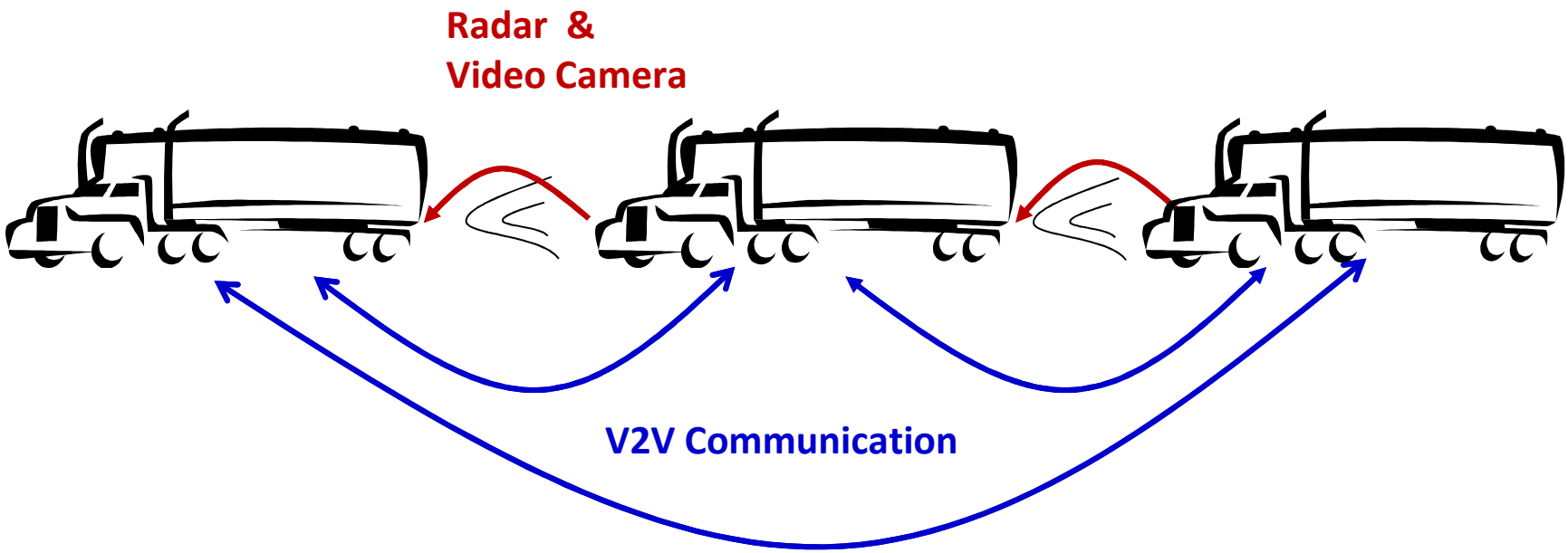
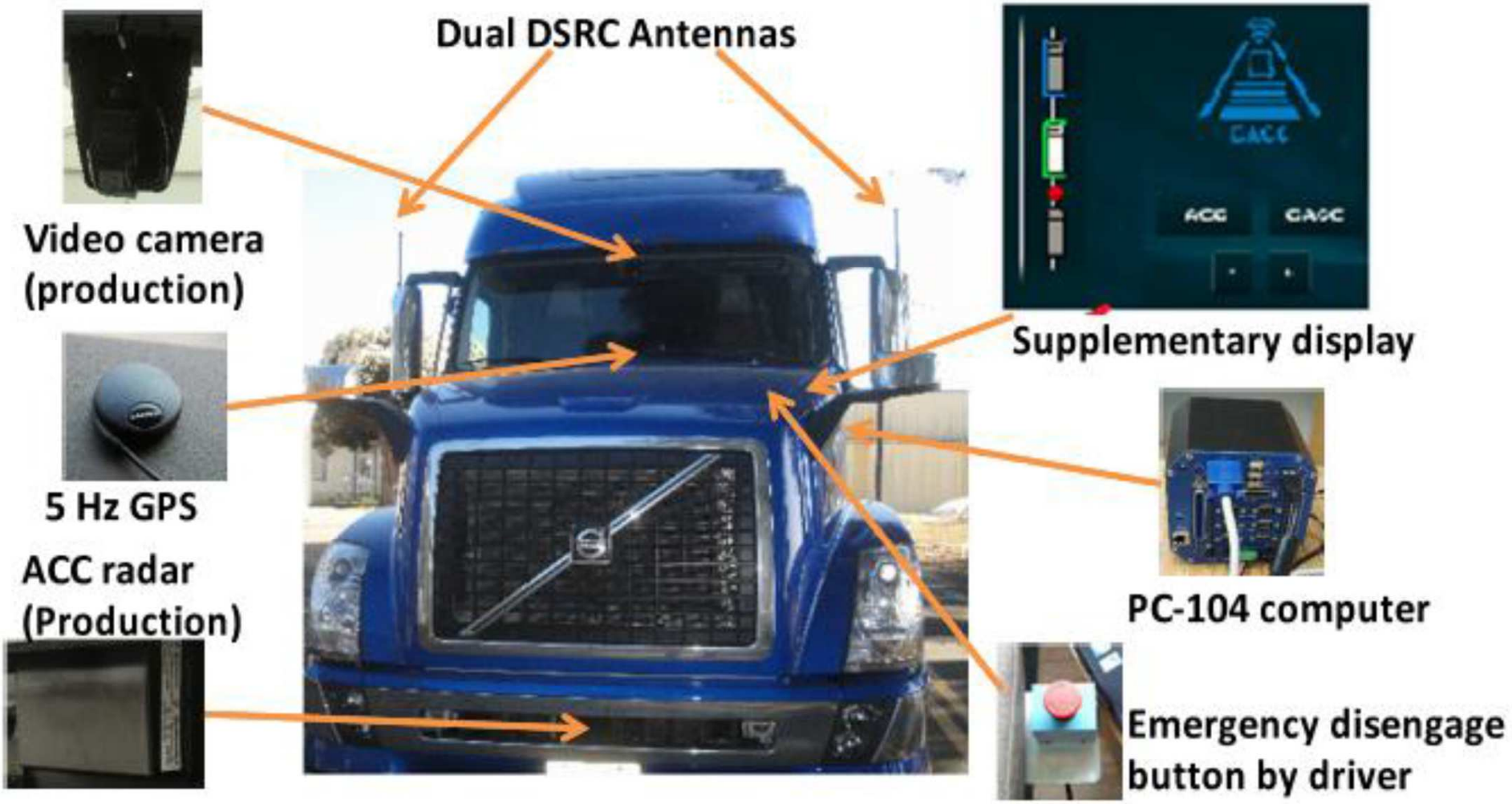
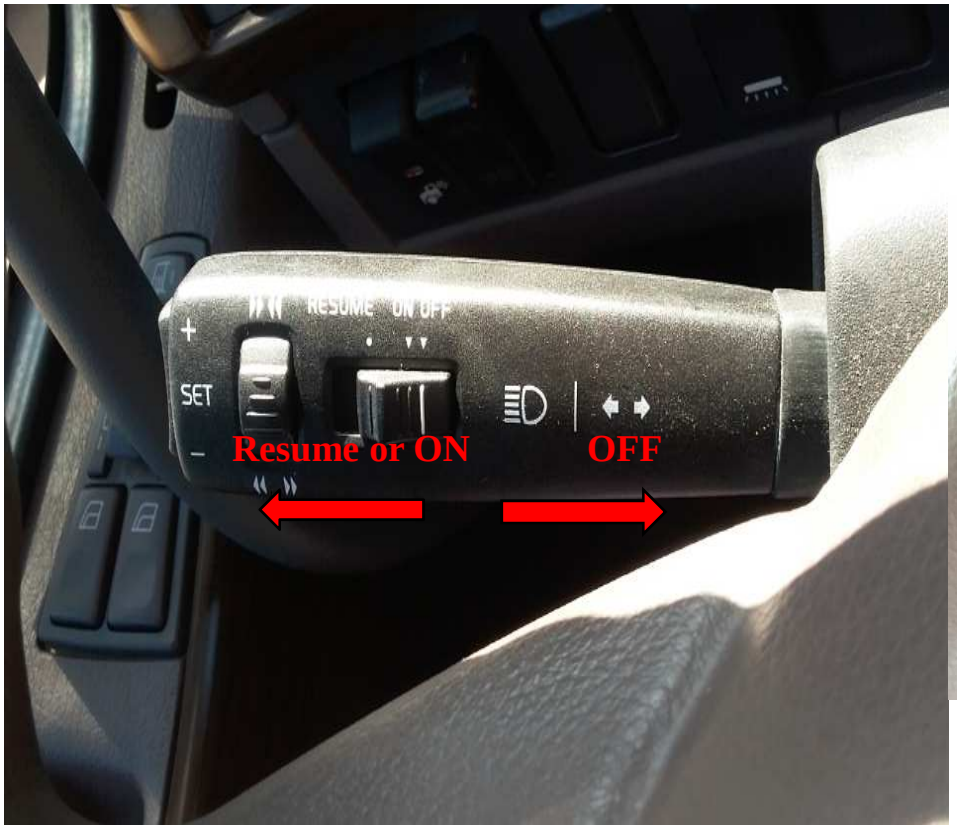
V2V Communication/Cooperation



System Elements



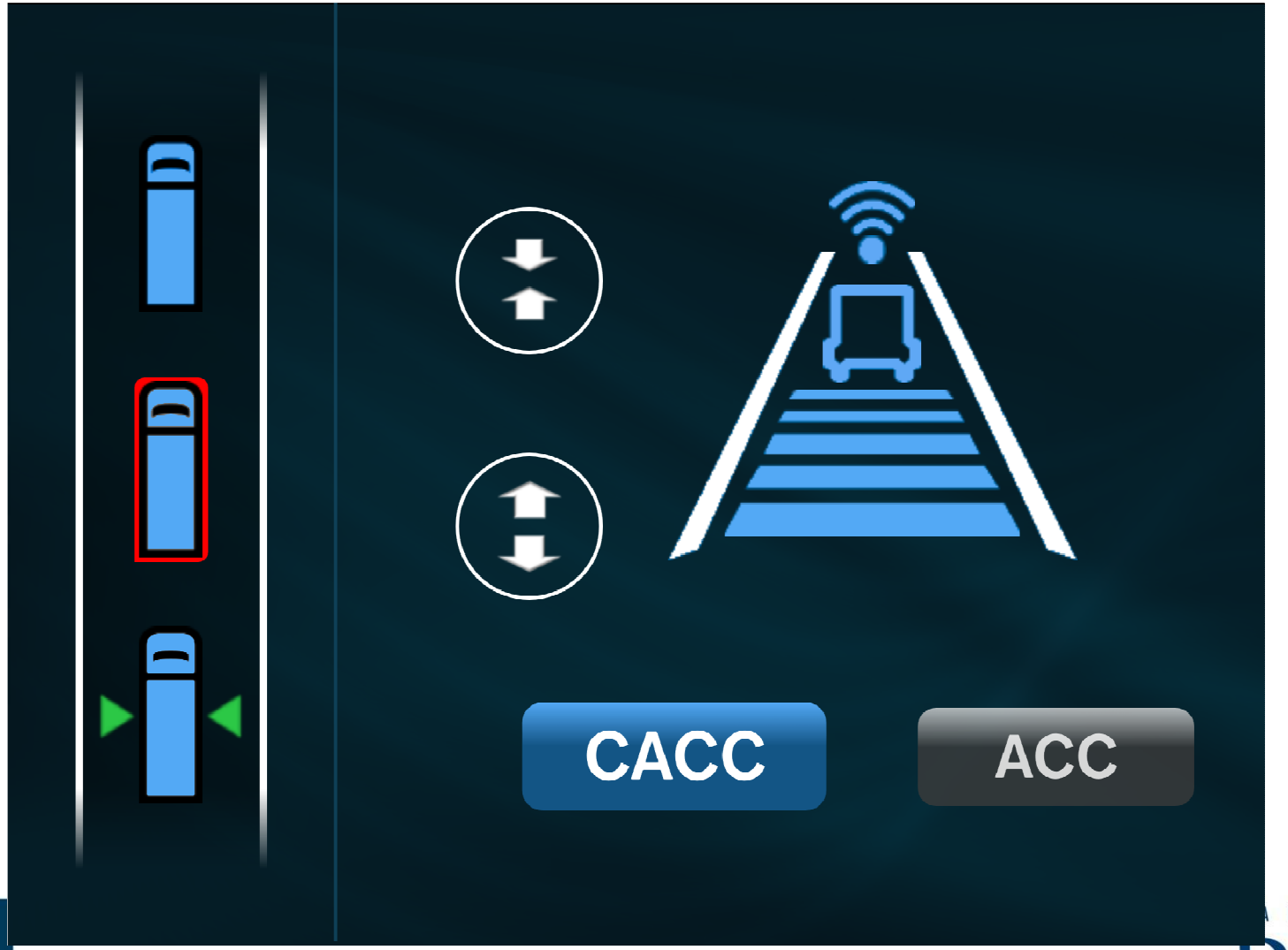
Driver Interface



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 4 m Gap in Platoon

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