Development and Evaluation of Selected Mobility Applications for VII (a.k.a. IntelliDrive)

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Background

- **Topic area in first EARP solicitation based on FHWA interest in *mobility* applications enabled by *vehicle-infrastructure cooperation***
  - **Complements safety focus of mainstream VII**
  - **Longer-term than "Day One"**
- **Three related PATH pre-proposals integrated in one project**
  - **Active traffic management (variable speed limits combined with adaptive ramp metering)**
  - **Cooperative and traffic-responsive adaptive cruise control (ACC)**
  - **Automated truck platoons**

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Building on Prior PATH Research

- **Existing Caltrans-sponsored projects established technical foundation and initial cost share**
- **Many years of traffic research and enabling technology**
  - **Berkeley Highway Laboratory (BHL)**
  - **Tools for Operations Planning (TOPL)**
  - **Coordinated Ramp Metering**
- **Development of cooperative ACC test vehicles and initial human factors testing**
- **Development of automated trucks**

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Active Traffic Management

- **Goal: Avert traffic flow breakdown by controlling highway speed and density**
- **Approach: Combine dynamic ramp metering with variable speed limits (VSL) to control highway speed and density, averting traffic flow breakdowns**
  - **Learn from European experience with similar traffic management approaches at bottlenecks**
  - **Gather traffic data from infrastructure detectors and/or vehicles as probes**
  - **Indicate VSL by communication to in-vehicle displays and/or roadway-mounted variable message signs**

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Active Traffic Management
Research Questions Being Addressed

- **Range of conditions for which this can save travel time, energy and emissions?**
  - **Traffic speeds and densities**
  - **Temporary or durable improvement?**
- **Willingness of drivers to follow variable speed limits?**
  - **(How dependent on enforcement?)**
- **Ability of drivers to follow variable speed limits accurately enough, even if willing?**

→ Net improvements to traffic?

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Active Traffic Management - Activities

- Traffic modeling and control strategy development
- Testing control software in simulation
- Testing driver acceptance and ability to comply with in-vehicle variable speed limit display
- Estimating net effectiveness

- Testing traffic effects with variable speed limit signs – future initiative with Caltrans cooperation

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Cooperative ACC (CACC)

- **V2V cooperation enables higher ACC performance capabilities**
  - **Smaller gaps → higher lane capacity and fewer cut-ins**
  - **Faster response to lead vehicle changes → enhanced traffic flow stability**
- **I2V cooperation enables dynamic adjustment to traffic conditions**
  - **Change set speed and gap to promote active traffic management goals**
  - **Reduce speed prior to traffic slow-downs (effectively extending sensor range)**

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CACC with V2V Cooperation

- **Traffic simulations showed that CACC with 0.5 s time gap could double lane capacity**
- **Current human factors experiment is measuring driver acceptance of short CACC gaps for daily commute trips**
- **Enables car following at gaps of 1.1, 0.9, 0.7 or 0.6 seconds (compared to 2.2, 1.6 or 1.1 seconds with standard ACC)**
- **Results of experiment will determine gap values to use in simulation, predicting achievable lane capacity increases**

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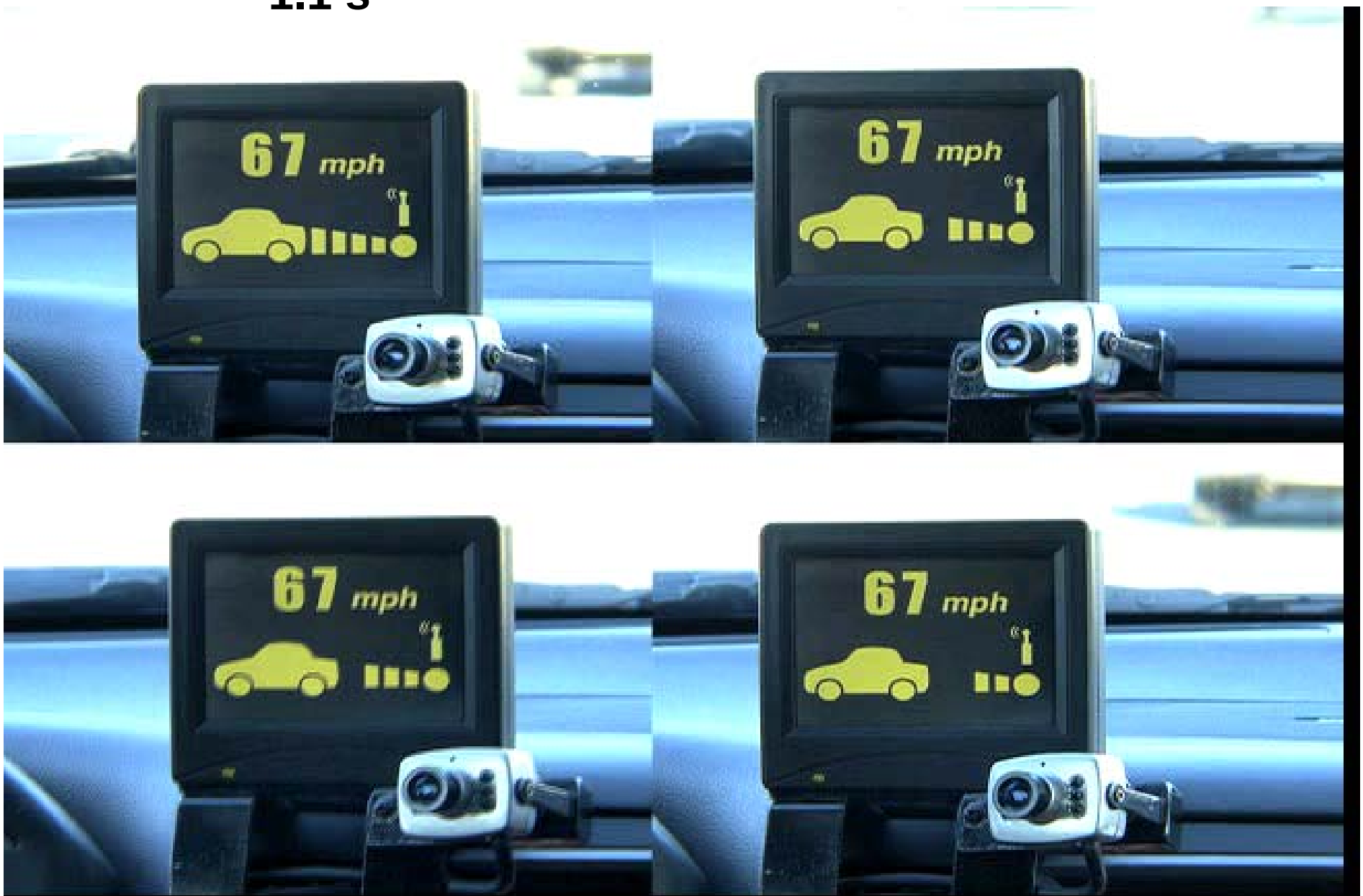
CACC Driving at Four Gap Settings



Lead Vehicle Braking, 1.1 s Gap

ACC

CACC

Traffic-Responsive CACC (Using I2V Cooperation)

- **Adjust CACC set speed and desired gap based on downstream traffic conditions**
  - **Choose set speed and gap for system-level traffic flow optimization**
  - **Measure interactions with surrounding vehicles driven normally to check for possible adverse effects**
- **Decelerate earlier and more gently for impediments beyond ACC sensor range**

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Testing Traffic-Responsive CACC

- **Equipping CACC test vehicles to receive speed and gap adjustment advisories**
- **Generating speed and gap advisories from active traffic management task**
- **Driving test vehicles through instrumented Berkeley Highway Laboratory section of I-80 –**
  - **Video tracking of vehicles and their neighbors**
  - **Measuring interactions of vehicle trajectories for possible adverse effects of speed differences**

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Automated Truck Platoons

- **Automatic vehicle following, combining sensors and V2V communication, enables trucks to drive at short gaps (3 m)**
- **Prior PATH research (2003) showed benefits for two tractor-trailer trucks:**
  - **Energy saving of 10 – 15% at highway speed**
  - **Doubling capacity of a truck-only lane**
- **Current research:**
  - **Extending to three trucks**
  - **Using DSRC for V2V communication**
  - **Coordinated maneuvering of trucks**

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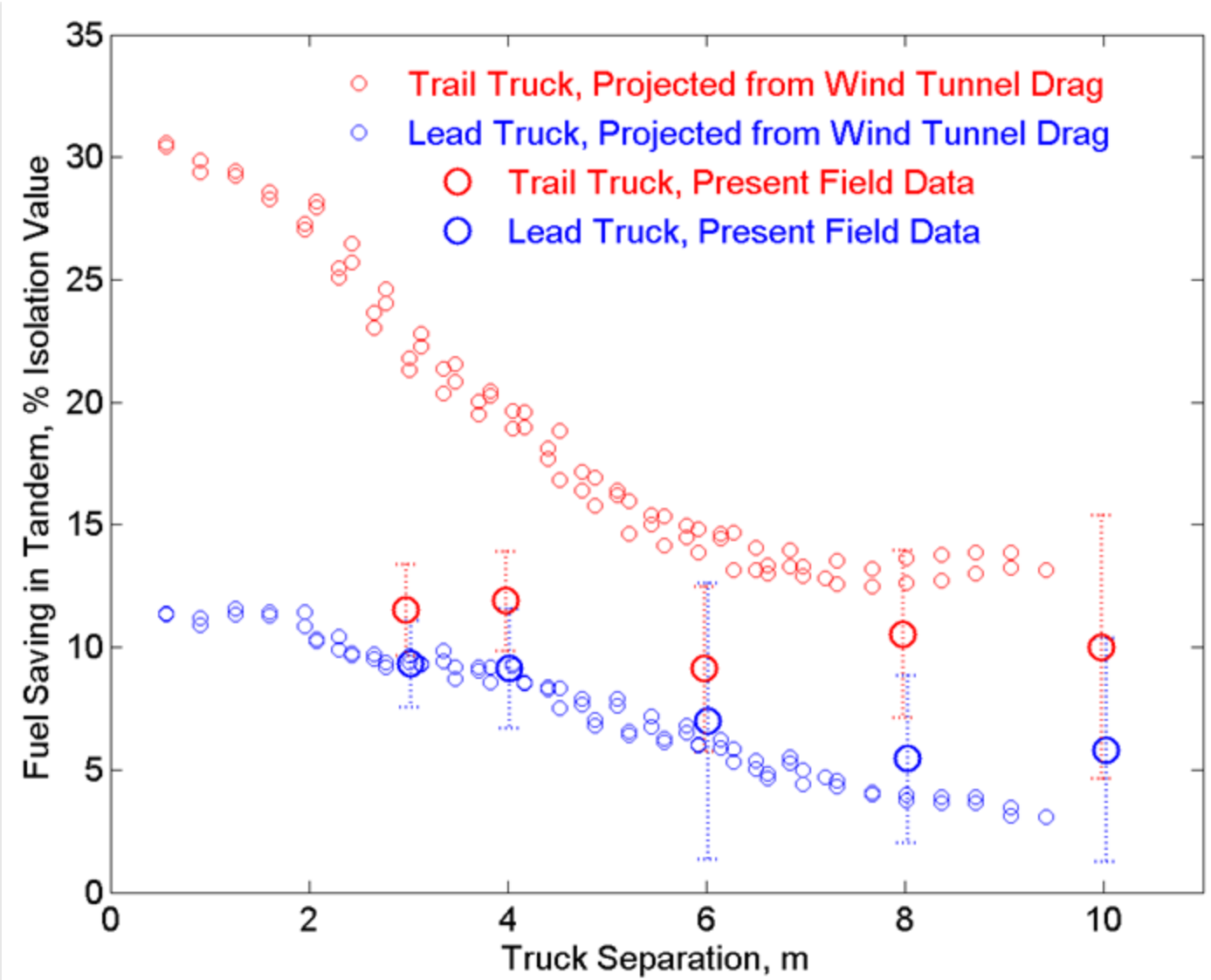
Fuel Saved by Trucks Driving in Close-Formation Platoons (2003)



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Truck Platoon at 3 m Separation (2003)

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Truck Platoon Development Activities

- **Two-truck platoon tested at low speed with new hardware and software**
- **Two-truck high speed testing**
- **Design of control software for three-truck platoon following and testing**
- **Design of truck maneuvers and testing**
- **Estimation of large-scale energy and capacity benefits**

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Importance of this EARP Research

- **Enabling exploration of new concepts and technologies with significant potential long-term impact on transportation**
- **Beyond the immediate planning horizon of direct customers or stakeholders**
- **Establishing technical feasibility to motivate follow-on field testing research, leading toward deployment**

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