

# Commercial Vehicle Interoperability & Performance Considerations

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# Sources

- Interoperability Issues for Commercial Vehicle Safety Applications, March 2011, UMTRI
- Commercial Vehicle Driver-Vehicle Interface Needs Specification, Dec. 2010, Battelle
- Development of Performance Requirements for Commercial Vehicle Safety Applications, March 2011, VTTI
- CAMP VSC-A and other project developments

Plus...

- IVBSS (Integrated Vehicle-Based Safety Systems) - Heavy Truck Platform – requirements & performance guidelines, March 2008, UMTRI
- Toma et al – Crash Problem for Commercial Vehicles, Volpe
- Others...

- **THANKS TO INDUSTRY EXPERTS WHO PARTICIPATED IN SURVEYS & CONVERSATIONS WITH UMTRI, BATTELLE, VTTI**

# Connected Commercial Vehicle Safety Applications Development Project (CCV)

- Leveraging DSRC and safety applications technology already developed and proven
- Applying to the different – but related – problems of commercial vehicles.
- CCV will address unique needs of commercial vehicles.
- Some commercial vehicle needs will require the community to work together on a longer time scale.

# Connected Commercial Vehicle Safety Applications Development Project (CCV)

- Addressing time-critical safety applications
  - Crash warnings
  - In-vehicle signage
- Not developing applications for operations (e.g., wireless inspection, smart parking, etc.)

## Goals:

- Safety applications that deliver driver warnings within the equipped “host” vehicle (HV)
- Over-the-air broadcasts to nearby remote vehicles (RVs) to support safety applications in those vehicles
- Safety-positive technology for all involved (e.g., do not add to driver distraction)
- Comply with existing DSRC and other standards (or help adjust standards, if necessary)
- Acceptable and beneficial to drivers, fleets, society

# Assumptions

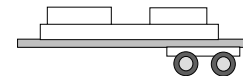
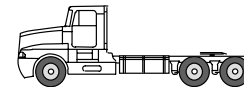
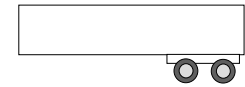
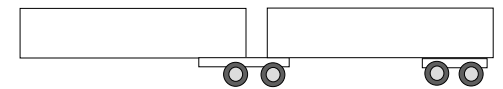
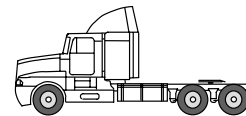
- Adopt the established architectures and concepts developed over the past several years in the Connected Vehicle Program
  - Broadcast (not mesh) DSRC for time-critical vehicle-to-vehicle communication
  - IEEE 1609, SAE J2735/2945, WAVE
  - Relative positioning of vehicles will use existing techniques (shared GPS solutions between vehicles)
  - Security

# Systems Engineering

- Crash Problem and Scenarios (Volpe)
- Technology Assessment
- Concept of Operations
- Functional Requirements
- Performance Guidelines
- Vehicle Build Plan and Test
- Communications & Application Performance Testing
- Interoperability (US DOT)
- Driver Acceptance Clinics
- Model Deployment -- Field Operational Test
- Safety Benefits and Acceptance (Volpe)

# Commercial Vehicles: Unique Aspects (Institutional/Business)

- Return on investment (ROI) drives voluntary adoption
- Fleet policies & emphasis on serviceability
- Industry structure & certification
  - Deployment often depends on fleet demand
  - Trailer & tractor ownership
- Vehicle diversity and longevity
- Driver behavior monitoring
- Access to data; data privacy
- Retrofit/aftermarket dynamic in commercial vehicles would be very different from passenger cars

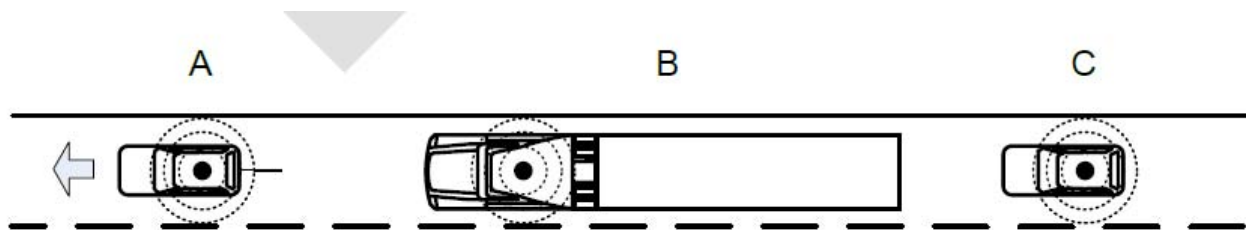


# Commercial Vehicles: Unique Issues (Technical)

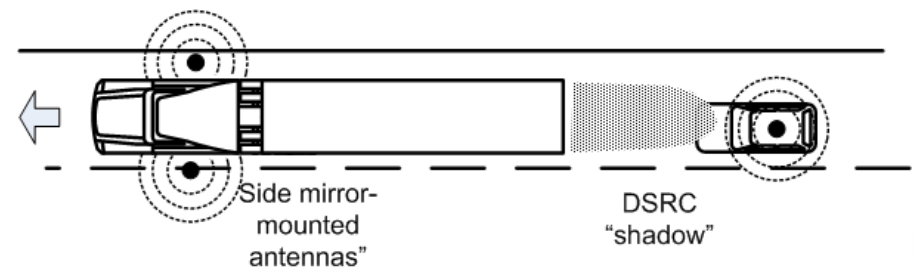
- Over the Air Communication (DSRC)
- Message content
- Application objectives

# Over the Air Communication

- Large vehicles can block DSRC signals and/or cause issues with multipath (reflections leading to 'nulls')
  - Depends on geometries, antennas, environment
  - Result is latency in communication, leading to latency in crash warnings or complexity of code

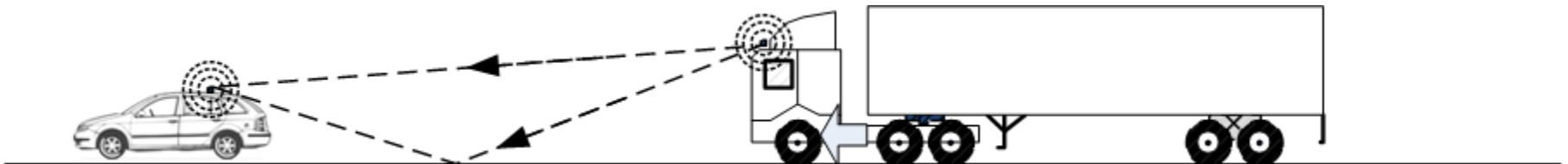


**Figure 2.2. Blockage scenarios in which DSRC communication between vehicle pairs (A,C) and (B,C) are negatively impacted by the tall trailer of vehicle B**



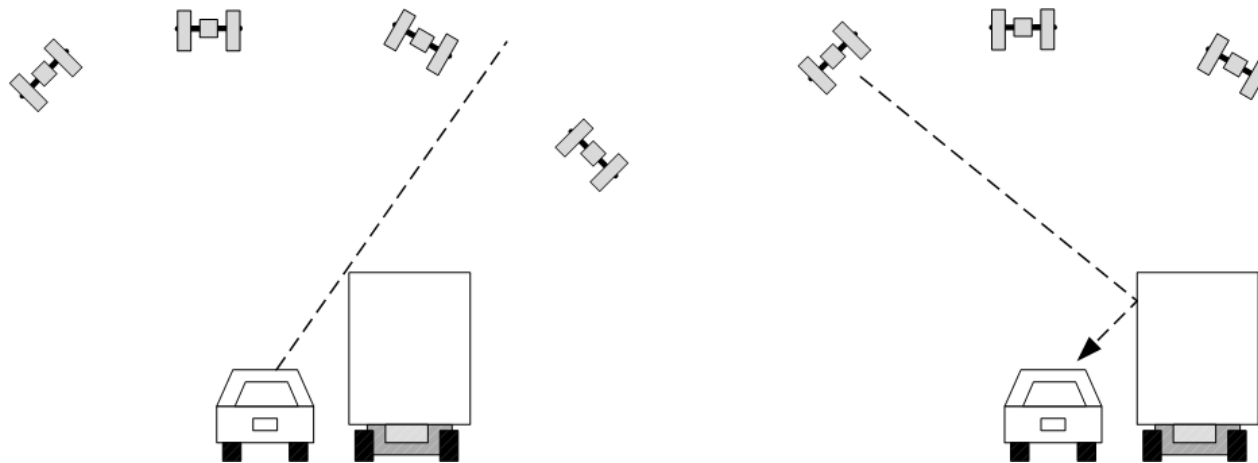
## Communication - continued

- Ground-induced nulls – exist for all vehicle pairs.
  - Loss of signal in specific geometries
  - For passenger vehicle pairs, CAMP experts believe the conditions are not problematic for performance.



# Estimating Position Between Vehicles

- Location of nearby vehicles is computed using GPS signals on the host, and DSRC-provided GPS signals from nearby vehicles.
  - Experts do not expect the masking of the sky to be an issue, but no work has been reported on this issue.

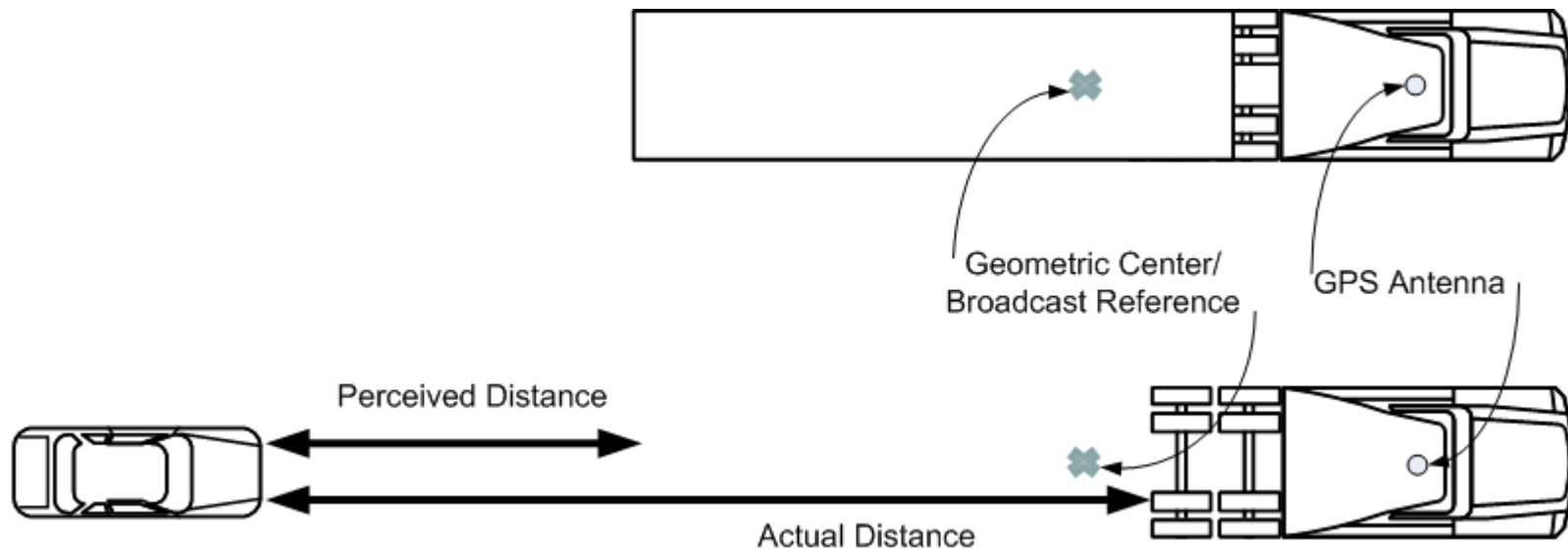


# Message Content

- SAE J2735 defines the basic safety message and other messages for V2V and V2I communication.
  - DSRC committee did not have benefit of significant commercial vehicle industry expertise
  - Model Deployment time frame: May not have enough time to revise the basic safety message.
  - CCV project may use the existing basic safety message
  - Considering some creative solutions
- Longer term: What, if any, adjustments are advisable or necessary to the basic safety message?

# Issues under consideration: Length and Antenna Placement

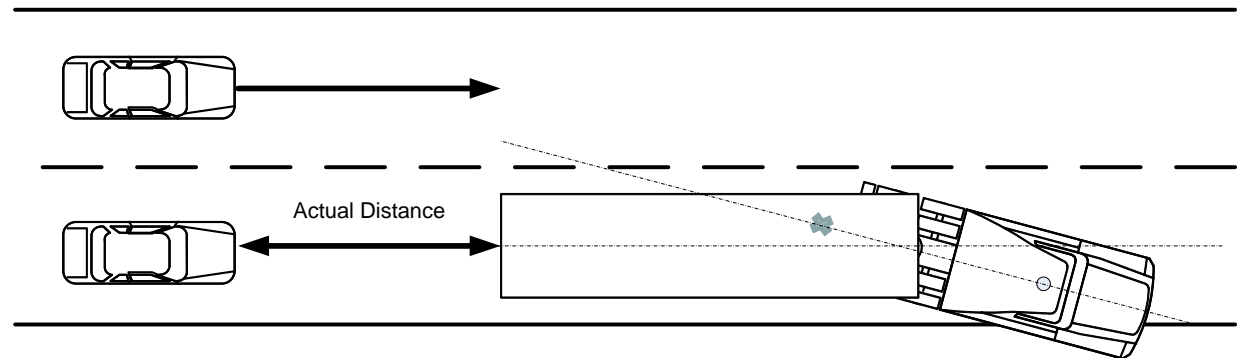
- Currently no way for a tractor to cheaply, reliably and automatically determine the length and configuration of trailers it is towing
- Collision avoidance applications assume broadcast location is the geometric center of the vehicle



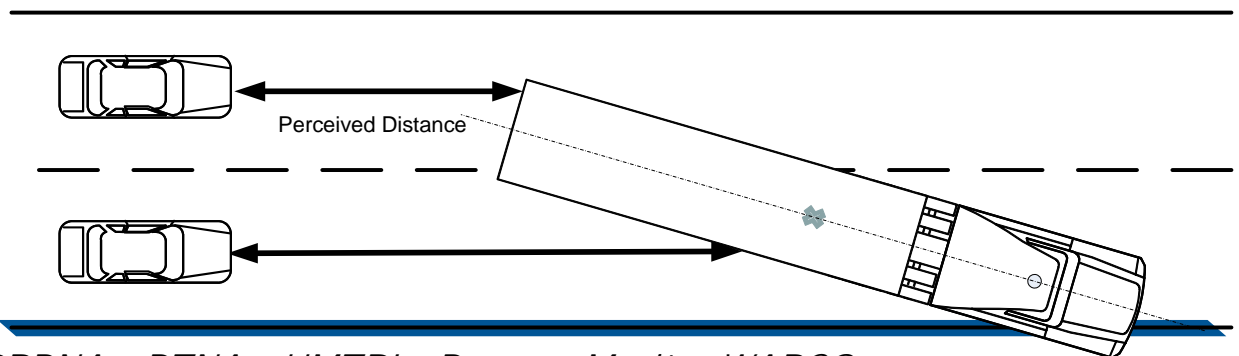
# Issues under consideration: Representation of articulated vehicles

- Collision avoidance applications assume straight vehicles
- Methods for effectively representing articulated trucks are under discussion

Turning articulated vehicle



Assumed geometry



# Safety Applications for Commercial Vehicles: Considerations

- Forward crash warning (FCW) and Emergency Electronic Brake Lamps (EEBL)
  - Safe following distance is emphasized in driver training and fleet policies
  - Commercial vehicle mass and length can vary dramatically within a day
- Blind Spot/Lane Change Warning
  - Blind spots are larger with commercial vehicles
  - Driver turn signal behavior and lane change decision-making is different

# Safety Applications for Commercial Vehicles: Considerations

- Intersection Movement Assist
  - Straight trucks have a high involvement in urban crossing path crashes at intersections
- Curve overspeed (potential application)
  - Commercial vehicles tip; passenger cars slip
  - Commercial vehicle rollover depends strongly on loading

# Driver Interface Issues

- Effective driver interfaces in commercial vehicles can be very different than in passenger vehicles
  - Noise and vibration
  - Different visual fields of view
  - Professional trained drivers
  - Vehicle is not agile – avoiding conflicts is important
- DSRC-enabled applications are not necessarily fundamentally different than existing applications, in terms of interface requirements
- Commercial Vehicle Driver-Vehicle Interface Needs Specification, Dec. 2010, Battelle

# System Engineering Documents

## Functional requirements

- Intention of safety applications
- Domain of applicability (e.g., minimum operating speed)
- Driver interface
- Functionality and required characteristics of communication, sensing, & onboard application decisions

## Performance guidelines

- Quantitative specifications for high level performance, operating characteristics, and information broadcasts

# Summary

- The CCV project will confront issues that are unique to commercial vehicles
  - Many issues have been identified in past USDOT projects.
- For the Model Deployment time frame, some issues can be explored and appropriate solutions implemented in CCV.
  - Other issues require a broader involvement. The CCV project may help to scope those issues and provide early insight.