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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

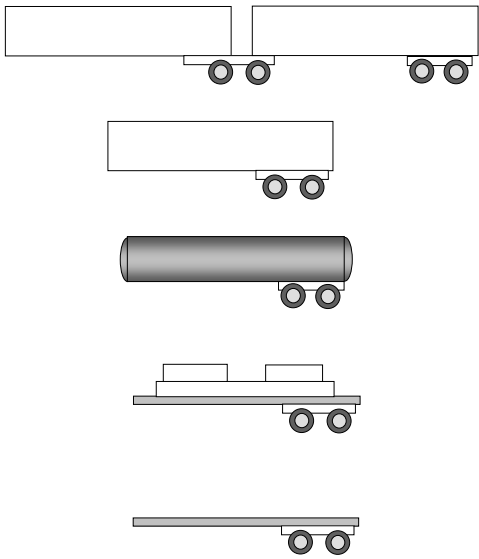
- Adopt the established architectures and concepts developed over the past several years in the Connected Vehicle Program
  - Broadcast (not mesh) DSRC for time-critical vehicle-to-vehicle communication
  - IEEE 1609, SAE J2735/2945, WAVE
  - Relative positioning of vehicles will use existing techniques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

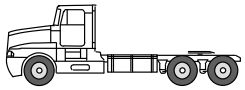
Systems Engineering

- 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

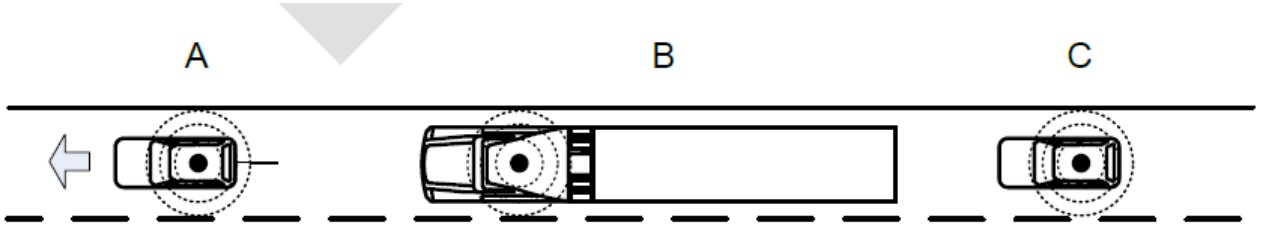
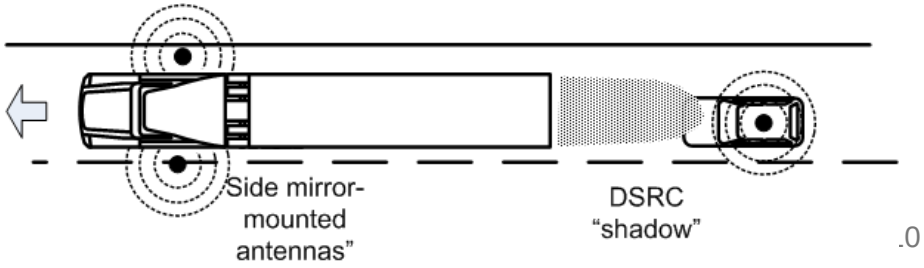
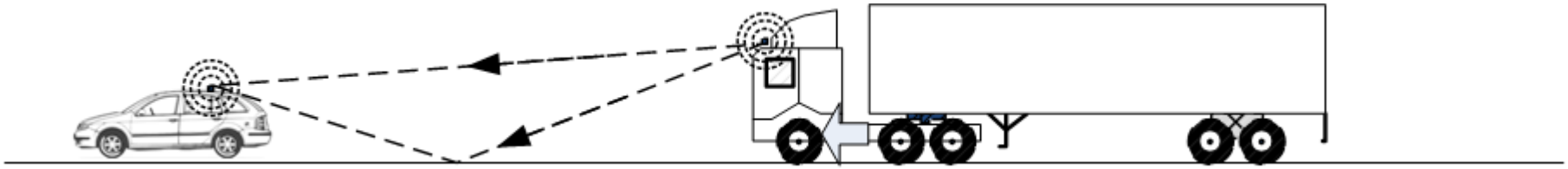


Figure 2.2. Blockage scenarios in which DSRC communication between vehicle pairs (A,C) and (B,C) are negatively impacted by the tall trailer of vehicle B



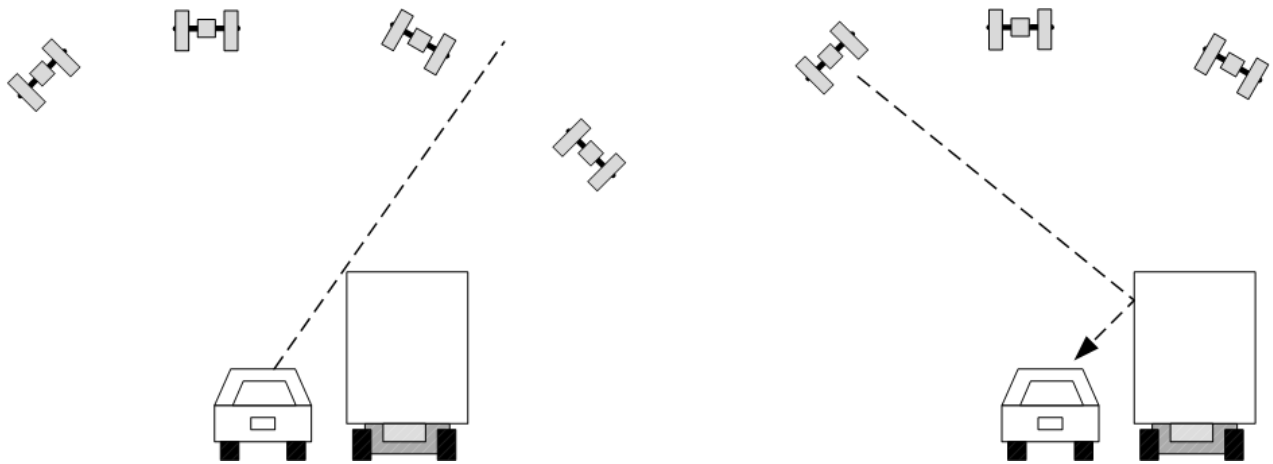
Communication - continued

- 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.

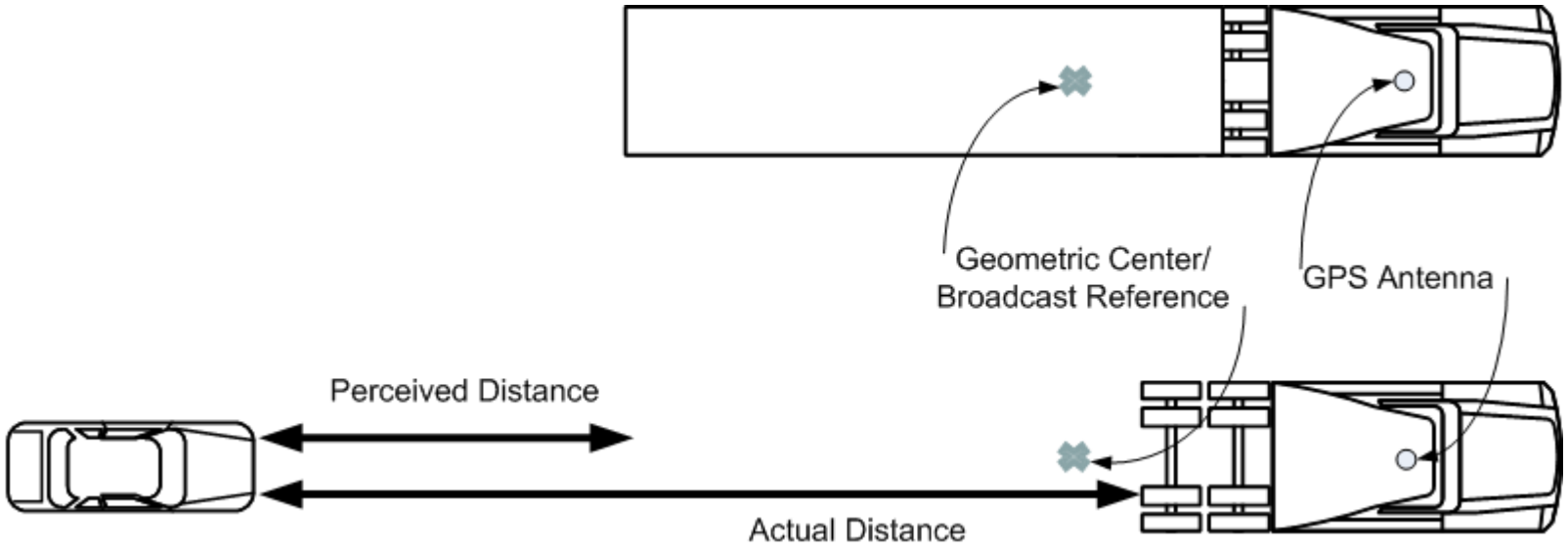


Message Content

- 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

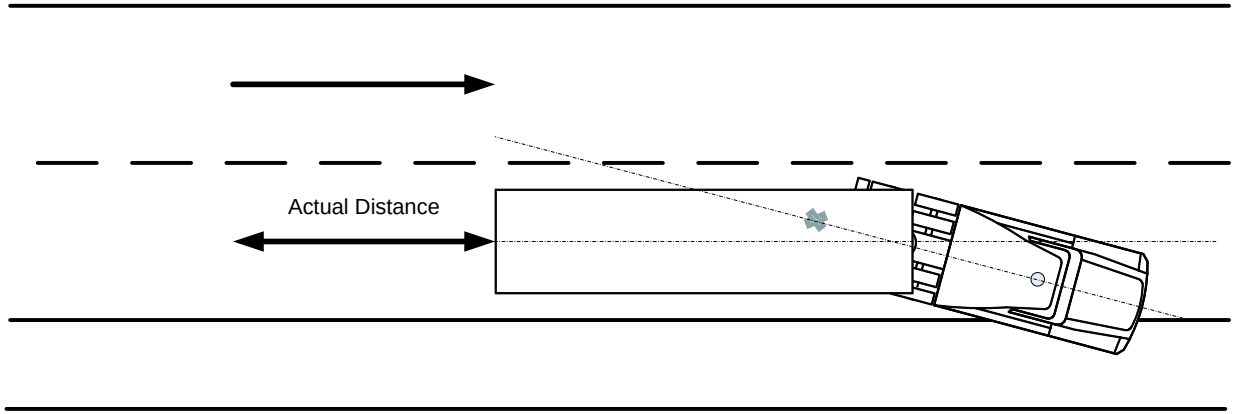
- Currently no way for a tractor to cheaply, reliably and automatically determine the length and configuration of trailers it is towing
- Collision avoidance applications assume broadcast location is the geometric center of the vehicle



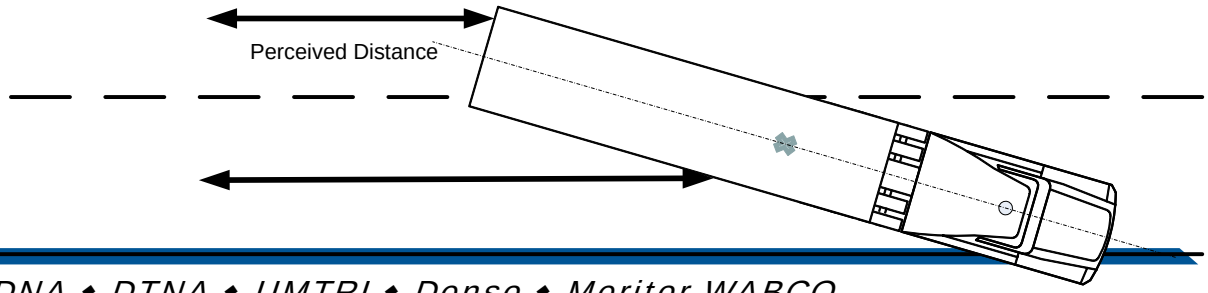
Issues under consideration: Representation of articulated vehicles

- 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.