Heavy Vehicle V2V Basic Safety Message and Implementation

ATA ITLC

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Overview

• Introduction
• Background
• Project Description and Objectives
• Approach
• Discussion
Acknowledgements

• Industry stakeholders
  – Great Dane Trailers
  – New Flyer
  – Motor Coach Industries (MCI)
  – IC Bus, Navistar, Inc.
  – Kenworth Trucks, PACCAR, Inc.
  – ATA
Virginia Tech Facts

• 32,000 students
• 4th largest College of Engineering in the U.S.
• 140 new engineering faculty in the next 10 years (more than 500 total)
• Allows us to perform completely proprietary and confidential research
  – No disclosure without sponsor approval
  – Vast experience conducting propriety/confidential research
VTTI Facts

• #1 or #2 largest transportation institute in the U.S., depending upon metric
  – #1 in federal grants and contracts
  – #1 in private-sector contracts
  – Largest group of driving safety researchers in the world
    • Active + Passive
    • Experimental, Naturalistic, Epidemiological
    • Pioneer of Naturalistic Driving Study Research Method

• 72 sponsors; 270 projects
  – More than 40 ongoing proprietary projects

• 475 employees

• More than 150 grads/undergrads supported annually
• Projected to grow 50% during the next three years
Connected Vehicles and Infrastructure

• Since 2005, VTTI has conducted $30M+ in connected V2V, V2I, and V2X projects
• VTTI is working on 30+ connected-vehicle projects
  – Working on both DSRC and cellular applications for V2I, V2V, and V2X
Smart Road Connect-vehicle Test Bed
Background
Vehicle-to-Vehicle Communication

• SAE Standards
  – J2735 – defines a message set for V2X communication
  – J2945/1 – defines minimum performance requirements for V2V safety applications for light vehicles
Heavy Vehicle V2V Research Overview*

• Demonstrated V2V on Heavy Vehicles in Controlled and Naturalistic Environments
  – Developed prototype V2V trucks and retrofit systems
  – Driver feedback from Commercial Vehicle Driver Clinics.
  – Safety Pilot Model Deployment
  – Performance requirements for safety applications and radio and communications performance (antenna placement, safety applications)

• Heavy Vehicle Specific Data Analysis and Safety Benefits
  – Applicable heavy vehicle V2V crash scenarios and target population.
  – Determined V2V safety application effectiveness on tractor trailers and calculated preliminary safety benefits.

• Evaluated unique heavy vehicle issues
  – Developed Basic Safety Message (BSM) for articulated vehicles including combination vehicles with 1 or more trailers

Development of HV BSM

• Primary sources related to Tractor Trailer Basic Safety Message (TT-BSM) Development project
  – Key findings
    • Trailer modeled as separate “vehicle” during turn maneuvers
    • Computed based on trailer geometry and tractor dynamics
  – Key take-away: proposed parameters for HV BSM
    • DF_TrailerInfo is proposed and describes the trailer position and heading.
    • Need length and pivot locations (kingpin and axle locations) of trailer
Project Objectives

- Identify single unit trucks that require additional information in the BSM
- For combination trucks, develop and evaluate system concepts to capture the length and pivot locations of the trailer
- Build and test a prototype of one of the system concepts
Strategy

• Identify the spectrum of possible solutions
  – Default values, driver input -> automated identification -> “smart” trailers
System Architecture

- Sensor ECU
  - Sensor 1
  - Sensor 2 (opt.)
  - Sensor \( n \) (opt.)
    - User Interface (opt.)
  - Truck network (J1939)
- OBU
  - IMU
  - GNSS
- DSRC Antenna
- GNSS Antenna
Strategy

- Identify technologies needed to implement possible solutions
- Develop system concepts to support solutions
- Evaluate the design concepts based on the following high level categories:
  - performance, cost, manufacturability, installation, maintenance, cross functionality
Workflow

- Review Existing HV V2V Research
- BSM Evaluation
- HV Related Classifications
- Model Development
Workflow

Key Parameters for HVs

Identify Vehicle Types & BSM Recommendation

Single Unit Trucks

Combination Unit Trucks

Identify Technologies to Measure Key Parameters

System Concept Development

System Evaluation Matrix

Build and Test Prototype
## Evaluation Criteria

<table>
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<tr>
<th>System Features</th>
<th>System Dependencies</th>
<th>Cost Estimates</th>
<th>System Evaluation</th>
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</thead>
<tbody>
<tr>
<td>Mounting requirements</td>
<td>Placement</td>
<td>Material costs</td>
<td>Cost Estimates</td>
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<tr>
<td>Installation requirements (OEM, Fleet, Owner-operator)</td>
<td>Limitations on truck types</td>
<td>Manufacturing cost</td>
<td>Adaptability - different truck/trailers</td>
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<tr>
<td>CPU</td>
<td>Calibration requirements</td>
<td>Installation cost</td>
<td>Scalability (volume)</td>
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<td>Truck interface</td>
<td>Service needs</td>
<td>Maintenance cost</td>
<td>Maturity of Technology</td>
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<td>Enclosures</td>
<td>Special installation req’s</td>
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<td>Manufacturability</td>
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<tr>
<td>Manufacturability (DFM)</td>
<td>Driver interactions</td>
<td></td>
<td>Maintenance</td>
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<tr>
<td>Software requirements</td>
<td>Required updates (SW)</td>
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<td>SW updates implementation</td>
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<td>Health monitoring</td>
<td>Regulation compliance</td>
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<td>Component costs</td>
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<td>Redundant measurements</td>
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<td>Replacement procedure</td>
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<tr>
<td>Component count</td>
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<td>System health monitoring</td>
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<td>Cabling</td>
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<td>Cross platform applicability (LV)</td>
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<td>Tamper resistance</td>
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<td>Additional functionality (BSW)</td>
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</tbody>
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1. **Advancing Transportation Through Innovation**

   ![NHTSA Logo](www.nhtsa.gov)

   ![Virginia Tech Logo](www.vt.edu)
Summary

• Project Goal: Identify methods to identify trailer parameters to support heavy vehicle V2V applications

• Next Step: Continue discussion among industry stakeholders and invite feedback now and as the project moves forward
Discussion
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