Vehicle Safety Communications – Applications (VSC-A) Project: System Design & Test Bed Implementation

Hariharan Krishnan
General Motors Corporation
VSC-A Hardware

- VGA monitor (for EGUI)
- Video Quad Splitter
- Frame Grabber
- GPS Antenna & Receiver
- Serial
- Car PC – Relative Positioning
- ENET
- Cameras (x4)
- Laptop for Data Logging and Visualization
- ENET
- DMU
- Vehicle CAN OBE Interface
- CAN
- Ethernet Switch
- ENET
- Car PC - Security

NTSC
USB
### VSC-A Interoperable Communication

- Periodic safety message broadcast (10 times per second)
- Event-driven safety message broadcast (immediate on event occurrence)

<table>
<thead>
<tr>
<th>VSC-A DSRC Common Safety Message</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
</tr>
<tr>
<td><strong>Part I</strong></td>
</tr>
<tr>
<td>SAE J2735 Basic Safety Message - Part I (position, motion, control, veh. size)</td>
</tr>
<tr>
<td><strong>Part II</strong></td>
</tr>
<tr>
<td>Vehicle Event Object (hard braking, control loss, etc.)</td>
</tr>
<tr>
<td>Message Sequence Number Object</td>
</tr>
<tr>
<td>Vehicle Path History Object</td>
</tr>
<tr>
<td>Vehicle Path Prediction Object</td>
</tr>
<tr>
<td>Relative Positioning RTCM 1002 data</td>
</tr>
</tbody>
</table>

- Part I conforms to current draft J2735 Basic Safety Message (BSM).
- Fields after Part I are to potentially be added to Part II of BSM.
Path History

3 methods of generating vehicle path history for VSC-A system have been implemented and evaluated.
Path History: Oval Track with One Meter Allowable Error

• The oval track consists of straight paths, tight and wide curves.
• Tight curves has an average estimated radius of 278.0 meters.
• Minimum of 2 points and a maximum of 9 points needed to represent a minimum distance of 300 meter of the oval path.
Host Vehicle Path Prediction Subsystem

- Computes path radius using
  - Vehicle Speed
  - Yaw Rate

- Computes path radius center point GPS
  Lat/Long coordinates for potential OTA transmission to other vehicles

- Computes confidence of the predicted path
Target Classification (TC) Subsystem

The TC module provides “360 degree” relative classification of the locations of communicating remote vehicles relative to the host vehicle.
Target Classification Locations

Illustration of remote vehicle Oncoming Left

Illustration of remote vehicle Intersecting from Right

Illustration of Same Direction

Illustration of Different Height

9
VSC-A Relative Positioning - Methods

- Vehicles share two data types for relative positioning
  - Latitude, Longitude, Height (LatLon)
  - Raw GPS Data
- Primary focus is to establish the relative position vector (i.e., distance and orientation)
- VSC-A Positioning System is capable of using two relative positioning methods:
  1. Using LatLon reported by two vehicles
  2. Using GPS raw data and Real-Time Kinematic (RTK) positioning (RTKNav Software)
Multiple Vehicle Test with RTK

- Estimated using two methods:
  - GPS LatLon
  - GPS Real-Time Kinematic Positioning (RTK)
Multiple Vehicle Test with RTK

Along Distance to Each Remote

- RTK method improves the relative positioning quality
VSC-A System Test Bed (Level II)

Legend:
- Common blocks (minimum)
- Common blocks (additional)
- OEM specific or proprietary blocks

- Vehicle Sensors (Non Production)
- Vehicle Signals (Production)
- Engineering DVI
- Display
- Data Logger & Visualization Tools
- CAN
- ENET
- Serial
- GPS unit
- Relative Positioning Platform
- Forward Looking Camera System (LDW)
- V-V Safety Applications
- VSC-A System Test Bed (Level II)
Summary

- Level 1 Milestone: V2V interoperability between GM, Ford, Mercedes, Toyota & Honda vehicles demonstrated for the first time to USDOT and OEM leadership (Aug 21, 2008)

- The six safety applications were designed based on consortium-developed standards generated within the VSC-A project

- Current Level I Refinements
  - Safety Applications refinements
  - Vehicle Relative Positioning evaluation
  - Security Implementation evaluation
  - Data Logger & Visualization Tool testing

- Forthcoming Level II Design and Implementation – Late Spring 2009
  - Dual Radio Capability (Channel 172 usage)
  - Message Dissemination Protocols (use power, rate, and other controls to mitigate network congestion and improve message delivery)
  - Objective Test Procedures and System Testing
  - Integration of Forward Looking camera system to analyze potential improvements of V2V relative positioning
Thank You