V2V and V2I Safety Applications

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Outline

Vehicle Communications for Safety Applications

• Vehicle – Vehicle Communications Safety Applications Examples
• Vehicle – Infrastructure Communications Safety Application Examples

Infrastructure Support for Autonomous Driving

Implications for Future Infrastructure

Outlook
Motivation

Vehicle communications has the potential to revolutionize traffic and traffic operations

• Fewer accidents
• Better signal timing and speed harmonization for improved traffic flow
• Better information for DOTs for decision making
• Improved operations

But

• Requires new equipment
• RSEs, possible replacement of old signal controllers and/or protocols (170s, AB 3418)
Communication based safety applications

Applications use 5.9GHz Dedicated Short Range Communication (DSRC) or mobile communications to communicate vehicle and infrastructure status information.

Two basic types:

• Vehicle-Infrastructure communication (V2I)
• Vehicle-Vehicle communication (V2V)

Systems use absolute positioning and relative positioning:

• This includes differential corrections

Maps are sent from the infrastructure to the vehicle.

Positioning based on GPS and dead reckoning.
V2V communication based safety applications

Information is transmitted between vehicles
 Enables vehicles to know where the vehicles in its vicinity are and what they are doing

Applications include

• Forward Collision Warning
• Emergency Electronic Brake Light
• Blind Spot/Lane Change Warning
• Intersection Movement Assist
• Do Not Pass Warning
• Control Loss Warning

• Currently the applications are warning only, but could include braking later on
# Basic Safety Message as per SAE J2735

### BSM Part I

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
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<tbody>
<tr>
<td>DE_DSRCMsgID</td>
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<tr>
<td>DE_MsgCount</td>
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<tr>
<td>DE_TemporaryID</td>
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<tr>
<td>DE_Dsecond</td>
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</tr>
<tr>
<td>DE_Latitude</td>
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</tr>
<tr>
<td>DE_Longitude</td>
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</tr>
<tr>
<td>DE_Elevation</td>
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</tr>
<tr>
<td>DF_PositionalAccuracy</td>
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<tr>
<td>DF_TransmissionAndSpeed</td>
<td>Speed</td>
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<td></td>
<td>Transmission</td>
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<td>DE_Heading</td>
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<td>DE_SteeringWheelAngle</td>
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<tr>
<td>DF_AccelerationSet4Way</td>
<td>LongitudinalAcceleration</td>
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<td></td>
<td>LateralAcceleration</td>
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<td></td>
<td>VerticalAcceleration</td>
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<tr>
<td></td>
<td>Yaw</td>
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<td>DF_BrakeSystemStatus</td>
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<td>DF_VehicleSize</td>
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### BSM Part II

<table>
<thead>
<tr>
<th>Event Flags (EEBL, CLW)</th>
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<tbody>
<tr>
<td>Path History</td>
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<tr>
<td>Path Prediction</td>
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<tr>
<td>RTCM DATA</td>
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<tr>
<td>Exterior Lights</td>
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<tr>
<td>Wiper Status</td>
</tr>
<tr>
<td>Vehicle Height</td>
</tr>
<tr>
<td>Bumper Heights</td>
</tr>
<tr>
<td>Throttle Position</td>
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<tr>
<td>Vehicle Type</td>
</tr>
</tbody>
</table>

- BSM Part I with every broadcast
- BSM Part II Path History and Path Prediction with every broadcast
- Part II Events as occurring
- Other data as needed
Where are we with this?

- V2V was developed and tested successfully in the Model Deployment in Ann Arbor, MI
- Nearly 3000 vehicles – cars, busses and trucks equipped with V2V communication technology
- Mixture of fully integrated vehicles (64) and carry-in devices
- Possible NPRM in 2016 for the V2V communications technology

Increasing number of connected vehicles on the road

- Broadcasting and receiving information to and from vehicles and infrastructure
- Large source of data
- Is the BSM enough or do infrastructure operators need other information
V2I communication based safety applications

Information is transmitted from the infrastructure to a vehicle.

Infrastructure uses Roadside Equipment (RSE) that includes a DSRC radio.

Examples are:
- Cooperative Intersection Collision Avoidance Systems
- Road departure warning
- Danger zones
- Speed limits
- Weather based hazards

Information can contain a local map.

CICAS application will be described in more detail.
Infrastructure support for Autonomous Driving

Traffic signal information
Intersection maps and updates
Stop sign and stop location information
Recommended speed
Position correction
Lane closures
Hazards/Construction sites
Weather related information
…
Some implications for future infrastructure

Future Infrastructure needs to be networked, equipped with communications
Infrastructure communications needs to be part of the overall security system
The denser the network of RSEs, the more information about traffic can be gained
Data analysis/data mining capabilities in TMCs
There will be different communication channels for different applications
  • Mobile Communications
  • DSRC
What are the data needs and how can they be satisfied
Outlook

Upcoming USDOT/FHWA projects will address infrastructure
- Safety
- Mobility
- Weather

The projects will address application development and field tests

Opportunity to promote CA cities as field test opportunities