Raising Awareness of Emergency Vehicles in Traffic Using Connected Vehicle Technologies

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University of Arizona
connected vehicles

- Purpose:
  - Safety
  - Mobility
  - Environment

- Basic Safety Message (BSM)
  - Temporary ID (ensure privacy)
  - Position (GPS)
  - Motion
    - Speed
    - Heading
    - Steering Wheel Angle
    - Acceleration
  - Brakes
  - Vehicle Size
  - Mode (vehicle, transit, truck, EV,...)

DSRC
5.9 GHz Wireless

Basic Safety Message
(SAE J2735 BSM)
Broadcast 10 times/second
(10 HZ)
Official Connected Vehicle Definition

• **Definition:** “Connected Vehicle” (USDOT)

“The U.S. DOT defines a **Connected Vehicle** as one that can transmit and receive Basic Safety Messages (BSMs) following the WAVE protocol, established in Standard IEEE 802.11p which uses the ITS band of 5.9 GHz (5.85 – 5.925 GHz).”
The Connected Vehicle System

- 1999 FCC Allocated 75 MHz for Intelligent Transportation Systems
- Development of Communication Standards
  - IEEE 1609 WAVE Communications
  - SAE J2735 Message Set and J2945/x Performance Requirements
- USDOT/FHWA Research and Development of Applications (54): Safety, Mobility, and Environment
  - Collision Avoidance Metric Partnership (CAMP)
- 2017 NHTSA Notice of Proposed Rulemaking
  - Mandate that all light duty vehicles be equipped with DSRC starting in 2021 (approx.)
  - Mandate future wireless (e.g. 5G) required to be compatible (interoperate)
- 2017 Cadillac CTS – first commercially available vehicle with DSRC
- V2I Deployment Coalition – States/Local Agencies working towards deployment
  - SPaT Challenge
Connected Vehicles and Infrastructure Systems

Vehicle(s)...
  +
Connected Vehicle Equipment

On Board Unit (OBU)
After Market Safety Device (ASD)

Connected Vehicle Infrastructure Equipment
Road Side Unit (RSU)

DSRC 5.9 GHz Radio
- BSM/SRM
- Signal Phase and Timing (SPaT)
- MAP

Cooperative Applications:
- Transit Priority
- Truck Priority
- Emergency Vehicle Priority

MAP Data
Digital Description of Roadway

(D. Kelley, 2012)
Latency vs. Communications Technologies For IntelliDrive<sup>SM</sup>

### Active Safety Latency Requirements (secs)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Signal Violation Warning</td>
<td>0.1</td>
</tr>
<tr>
<td>Curve Speed Warning</td>
<td>1.0</td>
</tr>
<tr>
<td>Emergency Electronic Brake Lights</td>
<td>0.1</td>
</tr>
<tr>
<td>Pre-Crash Sensing</td>
<td>0.02</td>
</tr>
<tr>
<td>Cooperative Forward Collision Warning</td>
<td>0.1</td>
</tr>
<tr>
<td>Left Turn Assistant</td>
<td>0.1</td>
</tr>
<tr>
<td>Lane Change Warning</td>
<td>0.1</td>
</tr>
<tr>
<td>Stop Sign Movement Assistance</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Communications Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Latency Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>WiFi 802.11</td>
<td>(3 - 5 secs)</td>
</tr>
<tr>
<td>Terrestrial Digital Radio &amp;</td>
<td>(10 - 20 secs)</td>
</tr>
<tr>
<td>Satellite Digital Audio Radio</td>
<td></td>
</tr>
<tr>
<td>Bluetooth</td>
<td>(3 - 4 secs)</td>
</tr>
<tr>
<td>Cellular</td>
<td>(1.5 - 3.5 secs)</td>
</tr>
<tr>
<td>WMX</td>
<td>(1.5 - 3.5 secs)</td>
</tr>
<tr>
<td>Two-Way Satellite</td>
<td>(60+ secs)</td>
</tr>
<tr>
<td>5.9 GHz DSRC</td>
<td>(.0002 secs)</td>
</tr>
</tbody>
</table>

Note: Y-axis not to scale for illustration purposes.

Data source: Vehicle Safety Communications Project – Final Report

March 25, 2016
WAVE Communications

Connected Vehicles
Technology, Equipment and Standards

DSRC Roadside Unit (RSU)
Specifications Document v4.1
(USDOT October 31, 2016)
Aware and Alert!

DHS Proposals: **EVAAlert** and **EVAware**

- Submitted in July 2017
- Oral Presentation in August 2017
- Notice of Selection in September 2017
- But, no funding available........
EVAware – V2V and V2I

On Board Unit (OBU)

Emergency Vehicle Alert (SAE J2735)

Road Side Unit (RSU)

Extend the Range
Urban Canyons

Channel 184 – Public Service Emergency

On Board Unit (OBU)
**EVAAlert – V2V and V2I**

- **On Board Unit (OBU)**
- **Emergency Vehicle Alert (SAE J2735)**
- **Road Side Unit (RSU)**
- **Extend the Range**
  Urban Canyons

**Channels**
- **Channel 184**
  Public Service Emergency
- **Channel 172**
  Safety of Life
Basic Mobility Applications... (not vehicle safety)

• What traffic signal applications could be built using BSM/MAP/SPaT data?
  • **Priority for Special Modes of Vehicles**
    • **Emergency Vehicles**, Transit, Trucks, Pedestrians
  • **Performance Observation**
    • Travel Time, Delay, Stop, Arrival on Red, Arrival on Green, Queue Length,.....
    • By Movement (e.g. thru, left turn, right turn)
    • By Mode (vehicles, transit, trucks, pedestrians, bicycles,...)
  • **Basic Traffic Control**
    • Phase Call, Phase Extend, Dilemma Zone Protection
  • **Adaptive Traffic Control**
    • Dynamic Phase Time (Green Allocation)
    • Optimal Signal Timing
Other v2i Applications

- School Zone Alert!
- Construction Zone Alert!
- Intelligent Traffic Signal System
- Emergency Vehicle Alert!
- Incident Ahead Alert!

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Arizona Connected Vehicle Test Bed
Anthem, AZ

DSRC Installations:
11 Signalized Intersection
6 Freeway Interchanges
10 Freeway Locations
Approx. 25,000 Residents
Approx. 10,000 Vehicles

1 2017 Expansion Project (ADOT)
Advantages of DSRC

- Dedicated Spectrum – 75 MHz
  - 10 MHz Channel for Public Service/Emergency
  - 10 MHz Dedicated for Safety of Life
  - 4 Service Channels
- FCC Registration
  - Agency Registration of roadside units
  - Vendor Registration of vehicle units
- Integrated into Vehicle Systems
  - EV – Lights and Siren System/Silent Running
  - Commercial Vehicles (OEM)
- Standards/Interoperability
  - Multiple Vendors and Multiple OEMs
- Key Component is Integrated Connected Vehicle System
  - Safety Applications (e.g. V2V Safety, Work Zones)
  - Mobility Applications (e.g. EV Signal Priority)
- No subscription fees
- **No sharing communications media** (e.g. Hurricane Rita – Harris County, TX 2005)
- No Smartphone or tablet device (distracted drivers)
V2I Deployment Coalition: SPaT Challenge
The “Impact” of Connected Vehicles/MMITSS

- MMITSS Project Discussion/Plan
- MMITSS Project to Start 2017
- MMITSS Project Active
Questions?  
Ideas?  
Suggestions?

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