Connected Vehicle Applications for ATMS and Commercial Vehicles

Jesus Martinez, SwRI

ITS NJ Annual Meeting - October 14, 2014
Presentation Overview

- SunGuide ATMS Connected Vehicle Integration
- CV Development Activities
- FDOT Connected Vehicle Test
- US Safety Pilot – RSD
- CVII Project with NYSDOT
- Questions
Connected (Cooperative) Vehicles

- Connected Vehicle = DSRC
  - Connected Vehicle Systems/Applications are transport layer agnostic
  - Communications medium based on application needs
  - Cellular, WiFi, 900MHz, DSRC, Bluetooth, WiMax
    - Latency
    - Bandwidth
    - Range

- Connected Vehicle = Coordinated vehicles and infrastructure
  - Increase safety (80% of all accidents due to human error)
  - Improve mobility
  - Support environmentally friendly transportation
DSRC Roadside Equipment
Modular system integrating many technologies
Connected Vehicle Subsystem

- Standard SunGuide Architecture
  - Generic subsystem
  - Protocol-specific driver
- Protocol support: SAE J2735
- Message types
  - Basic Safety Message
  - Probe Vehicle Data Message
  - Traveler Advisory Message
**SAE J2735**

- **Messages**
  - BasicSafetyMessage
  - CommonSafetyRequest
  - EmergencyVehicleAlert
  - IntersectionCollisionAvoidance
  - MapData
  - NMEACorrections
  - ProbeDataManagement
  - ProbeVehicleData
  - RoadSideAlert
  - RTCMCorrections
  - SignalRequest
  - SignalStatusMessage
  - SPaT
  - TravelerInformation
SAE J2735 - BasicSafetyMessage

- BSM – 10Hz
  - Part-I: required/38 bytes
    - Vehicle TempID (changes every ~5 minutes)
    - Timestamp (milliseconds within the minute)
    - Position (latitude, longitude, elevation, accuracy)
    - Motion (speed, heading, steering wheel angle, 4-way acceleration)
    - Brakes (brakes applied, traction control, ABS, stability control, brake boost, auxiliary brakes)
    - Vehicle Size (length, width)
  - Part-II: optional/variable size and rate
    - Path History
    - Path Prediction
    - Events (hazard lights, ABS, hard braking, wipers on, air bag deployed, etc.)
SunGuide RSE Configuration

- Dynamic configuration of RSEs
  - Add, modify, delete without restarting
- Update multiple devices at a time
- Configure detection zones
  - Geographic bounding area
  - Heading limits
Traffic Speed Monitoring

- BSM and Probe messages generate traffic speed info for TSS links
- Standard SunGuide TSS functionality available
- Additional CV link information
  - Most severe link by RSE
  - TAMs by RSE

![Connected Vehicle Roadside Equipment Status]

<table>
<thead>
<tr>
<th>Name</th>
<th>Op Status</th>
<th>Speed</th>
<th>No. TAMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>nonSyncRse</td>
<td>Out Of Service</td>
<td>0 (thresholds unavailable)</td>
<td>0</td>
</tr>
<tr>
<td>rseDataTest</td>
<td>Active</td>
<td>44 (4 below alarm)</td>
<td>0</td>
</tr>
<tr>
<td>testRse</td>
<td>Out Of Service</td>
<td>Unavailable</td>
<td>0</td>
</tr>
<tr>
<td>testRse2</td>
<td>Active</td>
<td>44 (4 above recovery)</td>
<td>0</td>
</tr>
</tbody>
</table>
Traveler Advisory Messages

- Manually created and issued by operators, or
- Automatically generated by event response plans
  - Administrator defined message format
  - Automatic presentation region along roadway
- Supports multiple presentation regions
Traveler Advisory Message (TAM)

- Messages meant specifically to driver
  - Contains area to display message
- Allows more directed messages
CV Application Development Activities

- **Vehicle Probe Data**
- **Signal Phase & Timing / MAP**
- **Signal Prioritization**
- **Signal Preemption**
- **Green Speed**
- **Wireless Roadside Inspection**
- **Unsafe-to-pass / Unsafe-to-merge**
- **Blind Spot Warning**
CV Application Development Activities Cont’d

- Roadside Alerts
- Railroad Grade Crossing
- Traveler Information
  - curve speed warning
  - dynamic/variable text
  - static signage (MUTCD based)
- Emergency Vehicle Alert
- Overheight Detection/Alert
- Wrong Way Driver Detection/Alert
CV Application
Development Activities Cont’d

- Cooperative ACC
- Emergency Electronic Brake Lights
- Forward Collision Warning
- Mayday Message / Relay
Sample V2V Demo Video – Collision Warning

Active Safety Alert
A monitoring system will be integrated with existing railroad grade crossing warning equipment that would begin emitting the SAE 2735 Roadside Alert message once activated and stop when deactivated. The vehicle would process the Roadside Alert message and determine if the direction / location / extent is appropriate (e.g. trucks traveling away from the crossing that receive the message would not display the warning).
FDOT Connected Vehicle Testing

- FDOT Conducted CV Testing on August 29, 2014
- Composed of five different scenarios:
  - Wrong Way Driving Detection
  - Emergency Vehicle Alerts
  - Emergency Braking
  - Overheight Vehicle Detection
  - Mayday Message
Special build of the SunGuide software deployed at TERL
Supports Vehicle to Infrastructure Applications
Wrong Way Driver Detection and Alert
Wrong Way Driver Detection and Alert
Wrong Way Driver Detection and Alert

CAUTION!
Watch For Wrong Way Vehicle

WRONG WAY
Wrong Way Driver Detection and Alert

CAUTION!
Watch For Wrong Way Vehicle

Alert: Wrong-Way Driver
Vehicle traveling NNE with a speed of 44 MPH reported at 8/4/2014 9:30:00 AM

Locate on Map  Acknowledge

WRONG WAY

Wrong Way
USDOT Safety Pilot Model Deployment Project Background

- USDOT Safety Pilot Model Deployment
- August 2012 → February 2014
- Vehicles & Devices Deployed
  - 2362 VADs
  - 289 ASDs
  - 64 Integrated Light Vehicles
  - 19 Integrated / Retrofit Heavy Vehicles
  - 3 Retrofit Transit Vehicles
  - 26 RSEs

Objective: Demonstrate real-world, connected vehicle safety capabilities and provide robust technical data to support the benefits assessment required for NHTSA’s agency decision in 2013.

http://www.its.dot.gov/safety_pilot/
CV Retrofit Safety Device Kits


- Kits send and receive BSM, and include V2V and V2I Safety Applications (using 5.9 GHz DSRC communications). These include:
  - **V2V**
    - Forward Collision Warning (FCW)
    - Emergency Electronic Brake Lights (EEBL)
  - **V2I**
    - Curve Speed Warning (CSW)
Retrofit Safety Device Technical Approach: OBE Architecture

- Base Platform: Cohda Wireless MK2
- Human Machine Interface
- Wireless Access Point
- 1 GPS & 2 DSRC Antennas
- J1939 Interface
- Vehicle Power / Ignition Interface
COMMERCIAL VEHICLE Infrastructure Integration (CVII) Program

Purpose

• NYSDOT Lead
• Develop and test Connected Vehicle technologies that will enhance Commercial Vehicle security, mobility, and safety.
  • Wireless Roadside Inspection
  • Traveler Advisories
  • Probe Data
  • Driver Credential Identification
  • Maintenance to Commercial Vehicle Communications
  • Safe-to-Merge, Safe-to-Pass, Blindspot Warning, Tailgate Warning
  • Railroad Grade Crossing Warning
CVII Corridors - NYC/Long Island

CVII Business Plan (One to Five Years)

Pending Integrated E-Screening/Virtual Weigh Station
1. Newburgh Beacon Bridge
2. I-87 Northbound - Newburgh/Exit 17 Interchange
3. I-84 Westbound - Wallkill Rest Area

Proposed Integrated E-Screening/Virtual Weigh Station
1. I-84 Eastbound - Wawayanda Rest Area
2. I-87 Southbound - Yonkers Toll Plaza
3. George Washington Bridge
4. Verrazano-Narrows Bridge

NYS IntelliDrive/CVII Corridors & Proposed Expansions
- Existing CVII Corridors (Completed 2008)
- Pending CVII Corridors (Completion 2010 - 2011)
- Proposed CVII Corridors - Near Future

NYSDOT - Office of Modal Safety and Security - October 2010
Early Connected Vehicle Research
Questions?

Jesus Martinez
Southwest Research Institute
jamartinez@swri.org