USDOT Connected Vehicle Overview

RWM Stakeholder Meeting

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Overview

- NHTSA Decision
- Safety Pilot
- Policy-Architecture Issues
- Mobility Program
- Basic Safety Message (BSM)
ITS Research Program Components

Applications

- Safety
  - V2V
  - V2I
  - Safety Pilot
- Mobility
  - Real Time Data Capture & Management
  - Dynamic Mobility Applications
- Environment
  - AERIS
  - Road Weather Applications

Technology

- Harmonization of International Standards & Architecture
- Human Factors
- Systems Engineering
- Certification
- Test Environments

Policy

- Deployment Scenarios
- Financing & Investment Models
- Operations & Governance
- Institutional Issues
## Major Milestones

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<th>PROGRAM AREA</th>
<th>FOUNDATIONAL ANALYSIS</th>
<th>RESEARCH, DEVELOPMENT &amp; TESTING</th>
<th>PILOT IMPLEMENTATIONS</th>
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- **Safety V2V**
  - Safety Workshop
- **Safety Pilot**
- **Safety V2I**
  - V to V Apps Defined
  - Initial Aftermarket V to I Apps
  - V2I Apps Defined
  - Qualified Product Lists (QPLs)
  - Mobility and Environment Workshop
  - High-Priority Mobility Apps Announced
- **Data Capture**
  - Mobility Benefits
  - Compiled Data Environments
  - Apps Develop
  - Testbed Launch
  - Revised Architecture Released
  - Prototype Security Process
  - Prototype Certification Process
  - Prototype Governance Structure
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Safety Pilot - Objectives

- Generate empirical data for supporting 2013 and 2014 decisions
- Show capability of V2V and V2I applications in a real-world operating environment using multiple vehicle types
- Determine driver acceptance of vehicle-based safety warning systems
Safety Pilot - Objectives (cont)

- Assess options for accelerating the safety benefits through aftermarket and retrofit safety devices
- Extend the performance testing of the DSRC technology
- Collect lots of data and make it available for industry-wide use
- Let others leverage the live operating environment
Device Installation Examples
(Passenger vehicles - Drivers’ own vehicles)

Vehicle Awareness Device

Antenna

Aftermarket Safety Device with Data Acquisition System (DAS)

DAS sensors, OEM can bus
Antenna
DAS Antenna

Data Acquisition from:
Aftermarket device
Radar or ranging device(s)
4 cameras, microphone
OEM CAN bus data
Vehicle motion
Cell & GPS antennas
Commercial Vehicle Fleets
(3 Integrated Trucks, 16 Retrofits, ~50 VADs)

Con-way Freight
- Less-than-truckload carrier (daytime pickup/delivery, nighttime line-haul)
- UMTRI/DOT partner in past projects

Sysco Detroit LLC
- Food-service products for restaurants, schools, etc.
- Mix of tractors, trailers
Transit Vehicle Fleets
(3 Integrated Buses, ~100 Vehicle Awareness Devices)

Ann Arbor Transit Authority
- Operates 67 buses
- Active in national programs

University of Michigan
- Operates 61 buses
- Model deployment area spans two separate campuses with high bus traffic between and within.
Policy Research Focus

- Determine if V2V is feasible to implement
  - Security Needs
    - Functional Requirements
    - Physical/Technical Requirements
    - Operational & Organizational Requirements
    - Financial Sustainability and Responsibility
The V2V/V2I system requires communications media for two critical purposes:

- Secure communications for distribution of certificates and revocation lists to make sure that entities on the system are legitimate users
- Trusted communications for delivering safety application data and messages (and, potentially, other applications and services)
Critical Questions

- Which communications media can support the needs for distributing security certificates? Choices include:
  - Existing Cellular Networks
  - Dedicated Short Range Communications (DSRC)
  - WiFi
  - Vehicle-Based Security Option

- What are advantages and limitations of each?

- How should the organizational functions of security certificate distribution and management be structured?
  - Who should be responsible for them and how should they be funded initially and over time?
Supportable Operationally – Certificate Management

- Develop Certificate Management Organizational/Operational Models:
  - Roles and responsibilities
  - Organizational models

- Project Schedule:
  - Options due in winter 2011
  - Public meeting in April 2011 (for organizational analysis and network options – interim analysis for both projects)
  - Prototype testing: June 2012
  - Test Results and Evaluation of Approach: Jan 2013
  - Final Report: July 2013
Supportable Operationally – Financial Models

- All security network options require financing for operational support
  - **All public** – politically feasible?
  - **Public/private partnership** – what type of framework?
  - **All private** – where’s the value?
    - Data
    - Transactions
    - Spectrum
    - Other
Mobility Program

Real-time Data Capture and Management

- Vehicle Status Data
- Weather Data
- Truck Data
- Transit Data
- Infrastructure Status Data
- Location Data

Dynamic Mobility Applications

- Reduce Speed 35 MPH
- Transit Signal Priority
- Weather Application
- Real-Time Travel Info
- Fleet Management/Dynamic Route Guidance
- Signal Phase & Timing Adjusts Real-Time Conditions
- Safety Alerts and Warnings

Data Environment
Data Capture and Management: Near-term Data Products

- Saxton Lab (Virginia) Real-Time Data Feed
- V2V/V2I Test Bed (MI) Archived, Simulated and Real-Time Data Feed
- Weather IMO
- World Congress Demo
- Related Demonstration Data
- DMA Application Data/Other Tests

Available Now: 10/10

Coming Soon: 10/11

Future Research Data: 03/12
Data Capture and Management – Key Issue

- Assessment of Data Elements in the SAE J2735 - Basic Safety Message
  - What can we do with the Data if delivered only via DSRC (Density of roadside locations to be effective)?
  - What can we do if the data is delivered via other communication media?
  - Are there other critical data elements?
- Do we need to modify the SAE J2735 Probe Data Message Process and do we need to develop a performance criteria standard?
High-Priority Dynamic Mobility Applications

- High priority mobility applications identified (many also have safety impact)
  - Coordinated Adaptive Cruise Control
  - Speed Harmonization
  - Queue Warning

- Intelligent Traffic Signal System
- Transit Signal Priority
- Mobile Accessible Pedestrian Signal System

- Emergency Communications and Evacuation
- Incident Scene Pre-Arrival Staging Guidance for Emergency Responders
- Incidents Scene Work Zone Alerts for Drivers and Workers
High-Priority Dynamic Mobility Applications (2 of 2)

- Next Generation Integrated Corridor Management
- Transit Connection Protection
- Dynamic Transit Operations
- Dynamic Ridesharing
- Freight Traveler Information
- Traveler Information
Basic Safety Message (BSM) Fundamentals

- Connected V2V safety applications are built around the BSM, which has two parts
  - BSM Part 1:
    - Contains the core data elements (vehicle size, position, speed, heading acceleration, brake system status)
    - Transmitted approximately 10x per second
  - BSM Part 2:
    - Added to part 1 depending upon events (e.g., ABS activated)
    - Contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies)
    - Transmitted less frequently
  - No on-vehicle BSM storage of BSM data
  - The BSM is transmitted over DSRC (range ~1,000 meters)

- The BSM is tailored for low latency, localized broadcast required by V2V safety applications
Mobility Programs: BSM Assessment Activity

- Assess the extent to which the BSM supports or enables mobility applications
  - To what degree is a DSRC-based BSM Part 1 message critical to realizing transformative benefits from mobility applications?
  - What key elements of BSM Part 2 or other vehicle-based data might be needed? Where and how often?
  - Can other messages tailored for cellular communication augment a DSRC-based BSM?
  - As we add data from mobile devices and fixed sensors, how much improvement do we see in application effectiveness?
Role of BSM Part 1 Via DSRC In Support of Mobility Applications

- BSM Part 1 via DSRC provides the vehicle data needed to support a few mobility applications that require low latency and localized broadcast exchange
  - Cooperative Adaptive Cruise Control
  - Queue Warning

- These applications will likely be successful wherever DSRC-capable roadside infrastructure (RSEs) is deployed
  - Key intersections
  - Major interchanges
Key Elements of BSM Part 2 Needed for Mobility Applications

- BSM Parts 1 and 2 via DSRC provides the vehicle data needed to support some localized mobility applications

<table>
<thead>
<tr>
<th>MOBILITY APPLICATIONS (where roadside units deployed)</th>
<th>KEY PART 2 DATA ELEMENTS TO SUPPLEMENT PART 1 DATA</th>
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<tr>
<td>▪ Cooperative Adaptive Cruise Control</td>
<td>▪ Weather Data (with examples)</td>
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<tr>
<td>▪ Speed Harmonization</td>
<td>▫ Ambient Temperature</td>
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<td>▪ Queue Warning</td>
<td>▫ Ambient Air Pressure</td>
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<td>▪ Transit Signal Priority</td>
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<td>▪ Incident Scene Work Alerts</td>
<td>▫ Wiper Status</td>
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<td>▪ Vehicle Data (with examples)</td>
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<td>▫ Antilock Brake System Status</td>
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- HOWEVER: DSRC link burdened by redundant Part 2 elements
Using Cellular Messages to Augment BSM for Mobility Applications

- Most mobility applications do not require BSMs 10 times per second
- Many applications require data captured over a wide area, not just localized data near a roadside unit (storage and/or wide-area communications needed)
- Possible Approach:
  - Vehicles transmit BSM Part 1 plus key Part 2 elements less frequently
  - Transmit via DSRC when available, Cellular otherwise

- Augmenting BSM with key Part 2 elements via Cellular provides the vehicle data needed to support nearly all mobility applications

- Cooperative Adaptive Cruise Control
- Speed Harmonization
- Queue Warning
- Intelligent Traffic Signal System
- Transit Signal Priority
- Mobile Accessible Pedestrian Signal System
- Emergency Communications and Evacuation
- Incident Scene Pre-Arrival Staging Guidance for Emergency Responders
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Data Question

Even more mobility and weather applications

*Basic Safety Message*

1 & 2+, at a regular interval, via cellular

*Basic Safety Message 1 & 2 via DSRC,*

at a regular interval

More mobility and weather applications

Mobility and weather applications
Summary of Initial Assessment: BSM and Mobility Applications

- The Mobility Program (DCM/DMA) is currently engaged in a research program intended to identify:
  - Key Part 2 and other vehicle-based data elements required by high-priority mobility applications
    - Required frequency and latency
    - Likelihood of OEMs to share these data
  - Need to store data on vehicles
  - Targeted use of triggers to reduce data redundancy
  - In conjunction with the safety program, identify business and financial models to support deployment
  - Examine vehicle data needs in light of additional data from mobile devices and fixed sensors
Mobility Program:
Schedule of BSM-Related Next Steps

- Updates to BSM Role Assessment Research
  - May 2012: Application ConOps Update
  - September 2012: BSM Data Analysis Update
  - May 2013: Impacts Assessment – Benefit/Cost Update

- Stakeholder Engagement
  - OEM Engagement – through VIIC
  - AASHTO Engagement – through Pooled Fund Study

- BSM Data Analysis
  - Safety Pilot Model Deployment
  - Mobility-related Technology Testing