Office of the Assistant Secretary for Research and Technology

Overview of the USDOT Connected Vehicle and Real-Time Data Capture and Management Programs

27 March 2014
Overview of the USDOT Connected Vehicle Program
Connected Vehicle Program

ITS Research = Multimodal and Connected

Drivers/Operators

Vehicles and Fleets

Connectivity

Wireless Devices

Infrastructure
# ITS Research Program Components

<table>
<thead>
<tr>
<th>Applications</th>
<th>Safety</th>
<th>Mobility</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V2V</td>
<td>V2I</td>
<td>AERIS</td>
</tr>
<tr>
<td></td>
<td>Safety Pilot</td>
<td>Real Time Data Capture &amp; Management</td>
<td>Road Weather Applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dynamic Mobility Applications</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonization of International Standards &amp; Architecture</td>
</tr>
<tr>
<td>Human Factors</td>
</tr>
<tr>
<td>Systems Engineering</td>
</tr>
<tr>
<td>Certification</td>
</tr>
<tr>
<td>Test Environments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deployment Scenarios</td>
</tr>
<tr>
<td>Financing &amp; Investment Models</td>
</tr>
<tr>
<td>Operations &amp; Governance</td>
</tr>
<tr>
<td>Institutional Issues</td>
</tr>
</tbody>
</table>
Connected Vehicle Applications

- Safety Applications
  - V2V
  - V2I
- Dynamic Mobility Applications
  - Traffic signal control
  - Flow optimization
  - Emergency response
  - Freight movement
  - Real-time options on all roads, transit, and parking along your route
- Applications for the Environment Real-Time Information Synthesis (AERIS)
- Road Weather Research
Safety Applications

**V2V**
- Forward Collision Warning (FCW)
- Emergency Electronic Brake Light (EEBL)
- Blind Spot/Lane Change Warning (BSW/LCW)
- Do Not Pass Warning (DNPW)
- Intersection Movement Assist (IMA)
- Left Turn Assist (LTA)

**V2I**
- Curve Speed Warning (CSW)
- Red Light Violation Warning (RLVW)
- Spot Weather Information Warning (SWIW)
- Reduced Speed Zone Warning (RSZW)
- Stop Sign Gap Assist (SSGA)
- Smart Roadside
- Transit Pedestrian Warning
V2I Safety Applications

Curve Speed Warning

Driver Vehicle Interface (DVI) Example

Red Light Violation Warning

Driver Infrastructure Interface (DII) (dynamic signal)

Driver Vehicle Interface (DVI) Example (static alert message)

Stop Sign Gap Assist

Driver Infrastructure Interface (DII) Example

Smart Roadside

Pedestrian Warning Application for Transit Vehicles

Option 1: This option includes sending an alert when the crosswalk signal has been activated.

Option 2: This option includes the use of a pedestrian detection system if the presence of a pedestrian is in the crosswalk.

Image Source: Thinkstock/USDOT
## Dynamic Mobility Application Bundles

<table>
<thead>
<tr>
<th>Application Bundle</th>
<th>Description</th>
<th>Team Member</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMITSS:</td>
<td>Multimodal Intelligent Traffic Signal System</td>
<td>Ben McKeever</td>
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<tr>
<td>INFLO:</td>
<td>Intelligent Network Flow Optimization</td>
<td>Osman Altan</td>
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<tr>
<td>Enable ATIS:</td>
<td>Enable Advanced Traveler Information Systems</td>
<td>Bob Rupert</td>
</tr>
<tr>
<td>IDTO:</td>
<td>Integrated Dynamic Transit Operations</td>
<td>Ron Boenau</td>
</tr>
<tr>
<td>FRATIS:</td>
<td>Freight Advanced Traveler Information Systems</td>
<td>Randy Butler</td>
</tr>
</tbody>
</table>
Environmental Applications

- **Eco-Signal Operations**
  - Eco-Approach and Departure at Signalized Intersections*, DSRC
  - Eco-Traffic Signal Timing*
  - Eco-Traffic Signal Priority*, DSRC

- **Dynamic Eco-Lanes**
  - Dynamic Eco-Lanes Management*
  - Eco-Speed Harmonization*
  - Eco-Cooperative Adaptive Cruise Control*, DSRC
  - Eco-Ramp Metering*

- **Dynamic Low Emissions Zones**
  - Dynamic Emissions Pricing*

**Notes**

* Denotes Application requiring V2I Communication

DSRC Denotes Applications Requiring Dedicated Short Range Communications (DSRC) or Other Low Latency Communications

- **Support for Alternative Fuel Vehicle Operations**
  - Engine Performance Optimization
  - Alternative Fuel Vehicle (AFV) Charging / Fueling*

- **Eco-Traveler Information**
  - Dynamic Eco-Routing*
  - Eco-Smart Parking*
  - Connected Eco-Driving DSRC
  - Multi-Modal Traveler Information*

- **Eco-Integrated Corridor Management (Eco-ICM)**
  - Eco-ICM Decision Support System
  - Applications from the Other Transformative Concepts
Road Weather CV Applications

- Road Weather Research
  - Defined 6 applications to address safety and mobility impacts of weather
  - Vehicle as Road Weather probe: developed software to turn vehicle data into weather and road condition observations
  - Working with 3 State DOTs to test and evaluate 2 applications that use these mobile observations
- Enhanced Maintenance Decision Support
- Information for Maintenance and Fleet Management Systems
- Weather-Responsive Traffic Management
- Variable Speed Limits
- Signal Timing Optimization
- Motorist Advisories and Warnings
- Information for Freight Carriers
- Information and Routing Support for Emergency Responders
The Path To Deployment

- Defined V2V Apps
- Defined Safety (V2I), Mobility (V2V & V2I), AERIS and Weather Apps
- Application Development
- NHTSA Decision Light Vehicles
- NHTSA Decision Heavy Vehicles
- FHWA Deployment Guidelines
- Pilots/Early Deployments

U.S. Department of Transportation
ITS Joint Program Office
Infrastructure Deployment Planning

- 2015 FHWA Deployment Guidance
- National Cooperative Highway Research Program (2013 completion)
  - Benefit Cost Analysis for state and local DOTs, including funding options
  - DSRC deployment guidance for state DOTs
- National Connected Vehicle Field Infrastructure Footprint Analysis (AASHTO led, 2014 completion)
- Standardized interfaces
- Certification processes for equipment and systems
- Nationwide Security Credential Management System (SCMS)
- USDOT is working with state and local DOTs and private industry to plan for deployment
Exploratory Research

- Vehicle to Motorcycle
- Vehicle to Pedestrian
- Vehicle Automation
  - Can proceed independently of connectivity to a point
  - Greatly enhanced with connectivity to other vehicles and infrastructure
- Benefits of Connectivity
  - Increases availability, speed, and reliability of information
  - Enables coordination of automated traffic streams

The full potential benefits of road vehicle automation can only be achieved through a connected environment.

Source: Continental Automotive Group
Any Questions about the Connected Vehicle Program?
Overview of the USDOT Real-Time Data Capture and Management (DCM) Program
DCM Program Vision and Objectives

- **Vision**
  - Active acquisition and systematic provision of integrated, multi-source data to enhance current operational practices and transform future surface transportation systems management

- **Objectives**
  - Enable systematic data capture from connected vehicles (automobiles, transit, trucks), mobile devices, and infrastructure
  - Develop data environments that enable integration of data from multiple sources for use in transportation management and performance measurement
  - Reduce costs of data management and eliminate technical and institutional barriers to the capture, management, and sharing of data
  - Determine required infrastructure for transformative applications implementation, along with associated costs and benefits
# Data Capture and Management Program Phase 2: Research, Development and Testing

<table>
<thead>
<tr>
<th>Program Tracks</th>
<th>FY2011</th>
<th>FY2012</th>
<th>FY2013</th>
<th>FY2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Track 1: Stakeholder Engagement</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Track 2: Program Planning and Coordination</td>
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<td>Track 6: Applications Development and Testing</td>
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<tr>
<td>Track 7: Demonstrations</td>
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<tr>
<td>Track 8: Evaluation and Performance Measures</td>
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<td></td>
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<tr>
<td>Track 9: Communication and Technology Transfer</td>
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</tbody>
</table>

### Track 1: Stakeholder Engagement
- [ ] Stakeholder Engagement
- [ ] Workshops
- [ ] Meetings

### Track 2: Program Planning and Coordination
- [ ] Program Plan Update
- [ ] Program Priorities
- [ ] FY11 EDWs
- [ ] FY12 EDWs
- [ ] FY13 EDWs
- [ ] FY14 EDWs

### Track 3: Fundamental Research and Development
- [ ] Task Data Sets
- [ ] Additional Data Environments for the RDE
- [ ] Workshops
- [ ] Prototype Data Environment DB

### Track 4: Institutional and Policy Integration
- [ ] Institutional and Policy issues Assessment / White Paper
- [ ] Establish Policy and Governance Processes
- [ ] Implement and Test IPR Processes

### Track 5: Standards Development and Testing
- [ ] Standards Coordination Plan Development
- [ ] Develop and Enhance Needed Standards / International Coordination

### Track 6: Applications Development and Testing
- [ ] Assess needs of TMA Applications from Concept Development
- [ ] CAMIP Advanced Messaging Prototype

### Track 7: Demonstrations
- [ ] Data Mgr. Prototype
- [ ] Build RDE
- [ ] Maintain and Enhance Research Data Exchange (RDE)

### Track 8: Evaluation and Performance Measures
- [ ] Performance Evaluation Plan
- [ ] FY11 EDWs
- [ ] FY12 EDWs
- [ ] FY13 EDWs
- [ ] FY14 EDWs

### Track 9: Communication and Technology Transfer
- [ ] Conduct Communication/Technology Transfer activities (Mob. App. Dev. Env., documented apps, fact sheets, calls for participation, workshops, etc.)

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**Legend:**
- [ ] Deliverables
- [ ] Stakeholder meetings/workshops
- [ ] Joint Activity with Dynamic Mobility Applications program

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**Image Source:** Thinkstock/USDOT

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**Version:** 6.0, 12/10/2013

**U.S. Department of Transportation**

**ITS Joint Program Office**

**Page:** 19
DCM Roadmap Tracks

1. Stakeholder Engagement
2. Coordinated Research and Development
   - Program Planning and Coordination
   - Fundamental Research and Development
   - Institutional and Policy Issues
   - Standards
3. Applications Development and Testing
4. Demonstrations
5. Evaluation and Performance Measures
6. Communications and Technology Transfer
Track 1: Stakeholder Engagement

- Webinars and Workshops
  - RDE Workshops
  - DCM Workshops
  - TRB Poster Session and Informal Demos
  - Feedback Forms on the RDE
Track 2: Coordinated Research & Development

- Innovation Scan
- Data Business Plan
- Basic Safety Message Assessment (feedback to NHTSA)
- Probe message coordination with EU and Japan
- Privacy Protection Study
- Communications Congestion Study
Track 2: Big Data Analytics Study

- **Challenges**
  - A data explosion is imminent as connected vehicle research evolves to deployment phase
  - 10-27 petabytes of Basic Safety Messages may be generated per second just with vehicle-to-vehicle communications
  - Will data communications swamp available channels?

- **Opportunities**
  - Use large amount of data collected from connected vehicles for better traffic management through enhanced situation assessment and prediction
    - Improve accuracy and speed of decision-making, thereby facilitating proactive management
    - Affords the capability to determine the causality of transportation problems, such as crashes, bottlenecks, delays, etc.
    - Provides comprehensive and accurate view of transportation systems
Track 2: BSM Data Emulator

- Represent and model V2I messaging variants including international probe messages

- Model messaging variants that utilize DSRC, cellular or both

- Emulate alternative strategies for in-vehicle data capture, storage and transmission timing

- Simulate latency and data loss by messaging variant and communications media
Track 2: Policy Considerations

- Privacy Concerns for Shared Data:
  - Ensuring no personally identifiable information in data sets
  - Managing location information (e.g., stripping off first and last ends of location data) to prevent re-identification
  - Protection of proprietary information for data on commercial trips

- Open Data Policies:
  - Formal documentation of ownership and granting of rights to share data
  - An open data policy for data collected with Federal mobility program funds based on stakeholders input
  - Data sharing under widely accepted and used license: the Creative Commons Attribution-ShareAlike 3.0 Unported license
Track 3: Applications Development and Testing

- Data Analysis and Tools Development
- Advanced Messaging Prototype
- Advanced Data Capture Field Testing
- Advanced Vehicle & Device Data Capture Testing
- International Probe Data & Mobile Devices
Track 4: Research Data Exchange

- What is included in the RDE
  - Real-time and Archived Data
  - Probe Data from Field Tests
  - Data from Research Projects including simulations
  - Advanced Search Capabilities
  - FAQs
  - External Links
  - Contact Information
  - Standard Metadata documentation
Track 4: Operational Data Environment

- Establish a prototype ODE to demonstrate the feasibility of real-time data integration and aggregation for implementing connected vehicle applications.
- Emulate a connected vehicle application in an operational setting.
- Assess the technical difficulties and risks associated with ODEs.
- Develop and test procedures for collecting, validating, and distributing connected vehicle data using anticipated messages.
- Step towards cloud computing.
# Track 5: Evaluation & Performance Measures

- **DCM Program Evaluation**
  - Assess the overall impacts of the DCM program
  - Assess contributions of DCM projects to program goals

<table>
<thead>
<tr>
<th>Logic Model</th>
<th>Drivers</th>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Anticipated Short Term Outcomes</th>
<th>Anticipated Intermediate Outcomes</th>
<th>Anticipated Long Term Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>External Causes</td>
<td>DCM Program Resources</td>
<td>DCM Projects</td>
<td>DCM Products and Services</td>
<td>Outcomes Expected within 6 Months</td>
<td>Outcomes Expected Between 6-12 Months</td>
<td>Outcomes Expected Beyond 12 Months</td>
</tr>
<tr>
<td>Examples for Consideration</td>
<td>- Sanitary authority</td>
<td>- ITS-JPO staff</td>
<td>- Data environment R&amp;D</td>
<td>- RDE website</td>
<td>- Improved data environment, to include data capture and data management</td>
<td>- Integration of DCM data as part of broader Connected Vehicle program</td>
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<td></td>
<td>- Legislative policy</td>
<td>- Other ITS-JPO programs</td>
<td>- Joint activities (e.g., DMA)</td>
<td>- Guidelines (e.g., data, metadata, access security, governance, etc.)</td>
<td>- Increased stakeholder engagement and buy-in</td>
<td>- Increased RDE website usability ratings</td>
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<tr>
<td></td>
<td>- Economic trends</td>
<td>- Modal partners</td>
<td>- Institutional activities</td>
<td>- Applications developed using DCM data</td>
<td>- Increased customer satisfaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Policies, mandates, and standards</td>
<td>- Data systems</td>
<td>- Standards development</td>
<td>- Program cost avoidance and reduction</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>- International cooperative agreements</td>
<td>- Data management practices</td>
<td>- Stakeholder coordination</td>
<td>- Stakeholder engagement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Budget</td>
<td>- Outreach</td>
<td>- Data sets available on RDE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Infrastructure</td>
<td>- International activities</td>
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The left side of the logic model answers the question “How?” through drivers, inputs, activities and outputs. The right side of the logic model answers the question “Why?” through short term, intermediate, and long term outcomes.
Track 6: Communication & Technology Transfer

- Public dissemination of information about the data collection and provision aspects of connected vehicle applications will include:
  - Documented applications
  - Fact sheets
  - Web pages
  - Flyers

Research Data Exchange

The Research Data Exchange (RDE) is a web-based resource that collects, manages, and provides access to multi-source and multi-modal transportation data to support the development and testing of ITS and connected vehicle applications. This data sharing capability allows researchers, application developers, and others to significantly reduce the cost and time required to collect and compile data for analyzing or conducting research for connected vehicle related ITS applications.

The RDE currently has ITS and connected vehicle data from 11 locations to support the analysis and development of connected vehicle applications. The RDE is continuously evolving and has recently launched Release 2 with new features and data. Data accessible through the RDE is quality-checked, well-documented, and freely available to the public.

The RDE provides access to connected vehicle and passenger related data involving transit vehicles, maintenance vehicles, probe vehicles, traffic monitoring and reporting devices, incident detection systems, traffic signals, and weather and other type of ITS sensors. These types of data allow for a wide range of issues and factors to be used for analysis and research.

Data sets on the RDE contain various types of information including...
Summary of DCM Program Approach to Assessing Innovations and Enabling Deployment

- Objective 1: Assess Innovations
  - Scan for data capture and management innovations
    - Assess the potential of “Big Data” concepts and analytics
  - Collaborate in international research efforts (EU-Japan)
  - Identify and exploit innovations supporting deployment

- Objective 2: Enable Deployment of Operational Data Environments
  - Facilitate collaborative research by sharing connected vehicle data
    - Continually add data and features to the Research Data Exchange
  - Prototype real-time multi-source publish-subscribe data environments
    - Prototype Operational Data Environment
  - Create analytical tools to assess alternative messaging protocols
    - Release Open Source BSM Data Emulator Tool
Do You Have Any Questions about the DCM Program?