Connected Vehicles
-The Basics-

Jim Arnold
OST-R
Transportation Challenges

**Safety**
- 33,561 highway deaths in 2012
- 5,615,000 crashes in 2012
- Leading cause of death for ages 4, 11-27

**Mobility**
- 5.5 billion hours of travel delay
- $121 billion cost of urban congestion

**Environment**
- 2.9 billion gallons of wasted fuel
- 56 billion lbs. of additional CO₂
Fully Connected Vehicles

Vehicle Data:
- Latitude, Longitude, Speed,
- Brake Status, Turn Signal Status, Vehicle Length,
- Vehicle Width, Bumper Height

Infrastructure Data:
- Signal Phase and Timing,
- Drive 35 mph,
- 50 Parking Spaces Available
Connected Vehicle Communications Technology

- 5.9 GHz Dedicated Short-range Communications (DSRC)
- 4G and older 3G cellular networks provide high-bandwidth data communications
- Other wireless technologies such as Wi-Fi, satellite, and HD radio may have roles to play
DSRC Technology: How it Works

- Data is transmitted 10 times/sec (300m range)
- Privacy is built-in (vehicle location is NOT intended to be recorded or tracked)
- Wi-Fi radio adapted for vehicle environment
- Inexpensive to produce in quantity
- Original FCC spectrum allocation in 1999, revised in 2004 and 2006
Connected Vehicle Communications Technology: Benefits and Challenges

- Benefits of the DSRC communications technology:
  - Reduced price
  - Improved reliability → fewer false alarms
  - Increased performance → addresses more crash scenarios

- Challenges of the DSRC communications technology:
  - Both parties (vehicle/vehicle or vehicle/infrastructure) need to be equipped to gain benefit
  - Requires security infrastructure
Connected Vehicle Applications

Safety
- V2V
- V2I

Mobility
- Dynamic Mobility Applications

Environment
- AERIS
- Road Weather Applications
## Safety Applications: V2V

<table>
<thead>
<tr>
<th>V2V Safety Applications</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Forward Collision Warning</td>
<td>FCW</td>
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<tr>
<td>Emergency Electronic Brake Light</td>
<td>EEBL</td>
</tr>
<tr>
<td>Blind Spot/Lane Change Warning</td>
<td>BSW/LCW</td>
</tr>
<tr>
<td>Do Not Pass Warning</td>
<td>DNPW</td>
</tr>
<tr>
<td>Intersection Movement Assist</td>
<td>IMA</td>
</tr>
<tr>
<td>Left Turn Assist</td>
<td>LTA</td>
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</table>
Safety Applications: V2I

<table>
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<tr>
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<tr>
<td>Curve Speed Warning</td>
<td>CSW</td>
</tr>
<tr>
<td>Red Light Violation Warning</td>
<td>RLVW</td>
</tr>
<tr>
<td>Spot Weather Information Warning</td>
<td>SWIW</td>
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<tr>
<td>Reduced Speed Zone Warning</td>
<td>RSZW</td>
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<tr>
<td>Stop Sign Gap Assist</td>
<td>SSGA</td>
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<tr>
<td>Smart Roadside</td>
<td>SRI</td>
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<tr>
<td>Transit Pedestrian Warning</td>
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</tbody>
</table>
Connected Vehicle Applications: Mobility

Safety
- V2V
- V2I

Mobility
- Dynamic Mobility Applications

Environment
- AERIS
- Road Weather Applications
## Dynamic Mobility Applications

<table>
<thead>
<tr>
<th>Application</th>
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<tbody>
<tr>
<td>Multimodal Intelligent Traffic Signal System</td>
<td>MMITSS</td>
</tr>
<tr>
<td>Intelligent Network Flow Optimization</td>
<td>INFO</td>
</tr>
<tr>
<td>Response, Emergency Staging and Communications, Uniform Management, and Evacuation</td>
<td>R.E.S.C.U.M.E.</td>
</tr>
<tr>
<td>Enable Advanced Traveler Information Systems</td>
<td>Enable ATIS</td>
</tr>
<tr>
<td>Integrated Dynamic Transit Operations</td>
<td>IDTO</td>
</tr>
<tr>
<td>Freight Advanced Traveler Information Systems</td>
<td>FRATIS</td>
</tr>
</tbody>
</table>
Connected Vehicle Applications: Environment

- Safety
  - V2V
  - V2I

- Mobility
  - Dynamic Mobility Applications

- Environment
  - AERIS
  - Road Weather Applications
## Environment Applications: AERIS

<table>
<thead>
<tr>
<th>Cleaner Air Through Smarter Transportation</th>
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<tbody>
<tr>
<td>ECO-SIGNAL OPERATIONS</td>
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<tr>
<td>ECO-LANES</td>
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<tr>
<td>ECO-Traveler Information</td>
</tr>
<tr>
<td>ECO-INTEGRATED CORRIDOR MANAGEMENT</td>
</tr>
</tbody>
</table>
A system of specifications and requirements that allow the various components of V2I hardware, software and firmware to work together.

An agency will be able to select the capabilities and applications desired at a given installation.
- **Definition of General Services:**
  - Data Distribution
  - Security Credential Management
  - Infrastructure Management
- **Capabilities/Principles:**
  - Secure exchange of trusted data between users and applications without pre-existing relationship or entering into a permanent relationship
  - Assurance of privacy between users and from third parties
  - More efficient data collection from various sources and distribution to many users
Overview of USDOT Test Bed Resources

- Qualified Product List for RSE
  - 5 vendors
- Qualified Product List for Onboard Equipment (OBE)
  - Vehicle Awareness Devices
  - Aftermarket Safety Devices
- Portable RSE Trailers
- Network Listeners/Sniffers

- Test Bed Operations Staff
- Signal Phase and Timing (SPaT) Resources
  - Listeners
  - Interface standards from FHWA
- Security Credential Management System (SCMS)
  - 1609.2 certificate management system
Path to Deployment

- Defined V2V Apps
- Defined Safety (V2I), Mobility (V2V & V2I), AERIS and Weather Apps
- Application Development
- Pilots/Early Deployments

- 2011: Safety Pilot in 2013
- 2012
- 2013
- 2014
- 2015
- 2016

FHWA Deployment Guidelines
- NHTSA Decision to Move Forward with V2V communication for light vehicles
- NHTSA Decision for Heavy Vehicles
US DOT/NHTSA Decision on V2

- Announced on February 3\textsuperscript{rd}, 2014 for light vehicles; ANPRM issued on August 18, 2014
- Primary purpose: enable collision warnings to drivers prior to a crash
- Based on several years of research including the safety pilot model deployment – 3000 vehicle road test in Ann Arbor, Michigan
  - Report Released 8/20/2014
  - ANPRM Published 8/20/2014
- Security and privacy protections built into contemplated system
  - No exchanging or recording of personal information
  - No tracking of vehicle movements
- After circulating the research report for public comment, NHTSA will then begin working on a regulatory proposal to require V2V devices in new light vehicles in a future year
- Decision on heavy vehicles planned at end of 2014
To Learn More

Connected Vehicle 101 Workshops at ITS America State Chapter meetings:

• Sept 7 – Detroit, MI (ITS World Congress)
• Sept 30 – Anchorage, AK
• October 15 – Santa Clara, CA
• Nov 12 – Irving, TX

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