DSRC - Technology, Challenges, and Evolution

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The Connected Vehicle Environment

- Supports vehicular safety applications through communications
- Vehicle to vehicle (V2V)
- Vehicle to Infrastructure (V2I)
- Dedicated Short Range Communications (DSRC)
  - 75 MHz at 5.9 GHz
  - IEEE 802.11p
  - IEEE 1609

US-DOT ITS JPO Connected Vehicle Timeline

Goal: Deploy Stable, Interoperable, Reliable Systems

- 2011: Defined V2V Apps
- 2012: Defined Safety (V2I), Mobility (V2V & V2I), AERIS and Weather Apps
- 2013: NHTSA Decision Light Vehicles
- 2014: NHTSA Decision Heavy Vehicles
- 2015: FHWA Deployment Guidelines
- 2016: Pilots/Early Deployments

Application Development
Initial DSRC Safety Applications

- **V2V Safety Applications**
  - Emergency electronic brake light (EEBL)
  - Cooperative forward collision warning (CFCW)
  - Intersection collision warning (ICW)

- **V2I Safety Applications**
  - Traffic signal violation warning (TSVW)
  - Curve speed warning (CSW)

- Many other DSRC safety, mobility, and sustainability applications have been defined
Electronic Emergency Brake Light

Crash Avoidance through timely and accurate information

“See around corners”

Detect hard braking multiple cars ahead

Client-based apps on-board each vehicle are enabled by data from DSRC broadcasts from all the other vehicles

Image Source: oneighturbo.com
DSRC Security and Privacy

- DSRC messages need to be trusted

- Security needs to preserve the privacy of vehicles
  - Messages need to be anonymous
  - Prevents the system from tracking of individual vehicles

- IEEE 1609.2 defines the security system based on public key infrastructure (PKI)
  - Security certificates are used to sign all messages
  - Vehicles can authenticate messages with valid certificates
  - Messages without a valid certificate are ignored
  - Removes misbehaving vehicles through a published certificate revocation list (CRL)

- System preserves the privacy of vehicles by design
  - Each vehicle has multiple certificates that are only used for a short period of time
  - If a certificate is misused it is put on the CRL
Multiple waves of field tests performed by industry, government and academia: System improves safety and can save lives, improves mobility, and increase environmental sustainability.

**Typical DSRC Results in NLOS Conditions**

<table>
<thead>
<tr>
<th>Range (m)</th>
<th>Packet Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>0.85</td>
</tr>
<tr>
<td>100</td>
<td>0.8</td>
</tr>
<tr>
<td>200</td>
<td>0.7</td>
</tr>
<tr>
<td>400</td>
<td>0.4</td>
</tr>
<tr>
<td>800</td>
<td>0.2</td>
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</tbody>
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*Image Source: its.dot.gov*
Connected Vehicle Market Model

Dynamic Structure Supports Studies of Market Penetration and Costs

US DOT Volpe study projected $42B in total benefits at full deployment from just 4 Safety Apps.

Image Source: Metriken
New RF technologies are continually being developed
- These may be used in future connected vehicle RF (CV-RF) technologies

Backward Compatibility
- Safety applications require compatibility with future versions of DSRC
- Initial DSRC will be supporting safety apps on vehicles for decades
- Broadcast nature of DSRC limits ability for compatibility with future CV-RF
- Future generations of CV-RF may need to support multiple RF technologies

Steps for future-proofing DSRC
- Need to develop additional requirements in 802.11p to ease evolution
- Synchronization, channel switching improvements
Expanded DSRC Opportunities

- Pedestrian and cyclists’ safety can be enhanced by incorporating 5.9 GHz DSRC into cellphones and mobile devices
  - Significantly expands potential market for DSRC chips and DSRC applications
  - Slightly increases cell phone costs, which could be offset with expanded benefits from applications beyond safety
- Cellular-based backhaul may be needed for safety and other applications
  - Strategic implications on wireless carrier businesses
- Impact of additional congestion on DSRC system performance
Path Forward

- DSRC raises many strategic, deployment, and operational issues:
  - DOTs, transportation authorities, telecommunications carriers, and automotive suppliers and OEMs
  - Venues, timing, costs, market uptake, risks, effectiveness
- NHTSA 2013, 2014 and 2015 decisions and impacts on New Jersey’s unique transportation environment
- Planning for DSRC Infrastructure construction and operations in New Jersey and Multi-state area
- Testing DSRC in New Jersey and Multi-state area
- Expand Safety, Mobility, and Sustainability Apps
Thank you!