Moving Together Towards a Mass DSRC Deployment

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Outline

• What is DSRC?
• What can it do?
• Deployment Status
• Challenges & Opportunities
• Toyota’s vision on DSRC
Dedicated Short Range Communication

DSRC, a proven, stable and mature technology, helps transform the transportation system.
Example V2V Applications

- Different manufacturers
- Communicating on the same channel
- Exchanging standard Basic Safety Messages
- Enables multiple V2V safety applications

### Radar/Camera unlikely to address these two scenarios

<table>
<thead>
<tr>
<th>Item</th>
<th>Time</th>
<th>3D Position</th>
<th>Position Accuracy</th>
<th>Speed</th>
<th>Heading</th>
<th>Steering Wheel Angle</th>
<th>Acceleration</th>
<th>Brake Status</th>
<th>Vehicle Size</th>
<th>Event Flags</th>
<th>Path History</th>
<th>Path Prediction</th>
<th>Other optional fields</th>
</tr>
</thead>
</table>

**Control Channel**

- **Service Channels**
  - Ch 172
  - Ch 174
  - Ch 176
  - Ch 178
  - Ch 180
  - Ch 182
  - Ch 184

- **Service Channels**

**Radar/Camera unlikely to address these two scenarios**

Emergency Electronic Brake Lights (EEBL)

Forward Collision Warning (FCW)

Left Turn Assist (LTA)

Intersection Movement Assist (IMA)

Blind Spot / Lane Change Warning (BSW / LCW)

Do Not Pass Warning (DNPW)
Example V2I Applications

Curve Speed Warning

Smart Roadside

Red Light Violation Warning

Stop Sign Gap Assist

Pedestrian Warning Application for Transit Vehicles

Source: 2013 Team Fair of TEAM STL
# Channel Usage Plan

## US DSRC Spectrum

### Seven 10-MHz Channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 172</td>
<td>Safety &amp; Service (safety only)</td>
</tr>
<tr>
<td>CH 174</td>
<td>Safety &amp; Service</td>
</tr>
<tr>
<td>CH 176</td>
<td>Safety &amp; Service</td>
</tr>
<tr>
<td>CH 178</td>
<td>Control</td>
</tr>
<tr>
<td>CH 180</td>
<td>Safety &amp; Service</td>
</tr>
<tr>
<td>CH 182</td>
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<th>Channel</th>
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<tr>
<td>Ch. 172</td>
<td>BSM safety and small set of V2I safety apps</td>
</tr>
<tr>
<td>Ch. 174</td>
<td>I→V safety and mobility, to avoid cross-channel interference to Ch. 172</td>
</tr>
<tr>
<td>Ch. 176</td>
<td>VRU safety (PSM) D→V, and download from SCMS (I→V)</td>
</tr>
<tr>
<td>Ch. 178</td>
<td>Control channel: WSAs, and low-bandwidth safety (I→V)</td>
</tr>
<tr>
<td>Ch. 180</td>
<td>Non-BSM V2V safety (e.g. C-ACC, sensor sharing), and mobility (I→V)</td>
</tr>
<tr>
<td>Ch. 182</td>
<td>I→V safety and mobility</td>
</tr>
<tr>
<td>Ch. 184</td>
<td>FCC designation for public safety. Ex: Preemption, Emergency Alert</td>
</tr>
</tbody>
</table>

*SAE J2945/0*
DSRC Deployment

- Toyota and Lexus
  - Japan: started 2015, more than 100,000 cars equipped
  - US: starting 2021, across most of its lineup by mid-2020s

- GM
  - US: started March 2017 with Cadillac CTS
  - Recently announced: High volume Cadillac models by 2023

- VW announced deployment in EU starting 2019
  - Entire VW group (VW, Audi, …)
  - EU Car2Car Communications Consortium, representing 16 automakers, sets broad deployment target for 2019

- Government-industry collaboration propels numerous deployment projects
  - CV Pilot Deployments, Smart City, Pool Fund Study, SPaT Challenge etc.
Challenges and Opportunities

- Building Momentum for mass deployment
- Budget for infrastructure
- Security Credential Management System
- Preserving Spectrum
- Business model

Opportunities
- Mitigated traffic accidents
  - 1000 + lives saved annually
- Higher traffic throughput
- Less air pollution
- 1000 + lives saved annually

Challenges
Our Commitment to DSRC

Toyota and Lexus to Launch Technology to Connect Vehicles and Infrastructure in the U.S. in 2021

- Most of the lineups will be equipped by mid-2020s
- Increased road safety and efficiency
- Accelerates adoption of V2X capability
- Encourage all automakers to adopt 5.9GHz DSRC
Toyota’s Experience in Japan

**V2I**

**Vehicle-to-Infrastructure Communication**

- **Right-turn Collision Caution**
  Alerts the driver to potentially unseen oncoming vehicles and pedestrians to prevent collisions.
  * This system is equivalent to “Left-Turn Assist” in countries that drive on the right.

- **Red Light Caution**
  Notifies the driver of the signal ahead to avoid running a red light.

- **Signal Change Advisory**
  Provides a signal change timer to help smooth starting.

**V2V**

**Vehicle-to-Vehicle Communication**

- **Communicating Radar Cruise Control**
  Integrates Radar Cruise Control and V2V information from the vehicle ahead to help follow it smoothly.

- **Emergency Vehicle Notification**
  Informs the driver of the emergency vehicle nearby to aid swift location.

- **Crossing Collision Prevention**
  Alerts the driver to potentially unseen intersecting vehicles from the left or right to prevent collisions.
  * Available on LS only
Right Turn Collision Caution (in Japan)

Equivalent to left turn assist in US

Driver’s view inside the vehicle

Animation for illustration purpose only, Actual design may differ
From Alerts to Automation

• V2X provides warnings to drivers, and in the future will be used for higher levels of automation.
More automated driving systems...

- Wheel-hub sensor that detects revolutions to help measure the vehicle's motion
- Orientation sensors measure the car's attitude and balance
- Computers read data and regulate vehicle behavior
- GPS provides a coarse measure of the vehicle's position
- Lasers sense 360 degrees around the vehicle for objects and localization
- Radars measure the speed and range to vehicles across and ahead
- Cameras help read traffic light signals and aid in scene understanding
- A version of test vehicle
Cooperative Automation for Greater Benefits

Automated Vehicle
Operates in isolation from other vehicles using internal sensors

What the vehicle can SEE

Cooperative Automated Vehicle
Leverages autonomous and connected vehicle capabilities

Connected Vehicle
Communicates with nearby vehicles and infrastructure

e.g., BSMs, sensor data
Our Approach to DSRC Deployment (1)

- Consensus: rely on specifications and protocols standardized with industry consensus

- **IEEE 802.11 WG**
  - lower layer (PHY and MAC) standards

- **IEEE 1609 WG**
  - Security; Networking Service; Multi-channel operation

- **SAE DSRC TC**
  - Data dictionary; Message transmission requirements
Our Approach to DSRC Deployment (1)

We emphasize privacy and security

- No personal identifiable information sent
- Authentication protects data integrity, validates transmission authority
- Encryption keeps data secret
Our Approach to DSRC Deployment (2)

• Support
  – Preservation of 5.9GHz ITS spectrum
  – Voluntary deployment now
  – Eventual mandate of V2V technology
Our Approach to DSRC Deployment (3)

- Collaboration:
  - Toyota Motor North America is a member of OmniAir
  - Helps insure interoperability between OBU and infrastructure, and among OBUs
  - Embracing work with different stakeholders
Our Approach to DSRC Deployment (3)

• Encourage:
  – Automakers to introduce DSRC to their vehicles
  – Road operators to install DSRC infrastructures
  – Car/fleet owners to install after market devices to existing vehicles
“We believe that greater DSRC adoption by all automakers will not only help drivers get to their destinations more safely and efficiently, but also help lay the foundation for future connected and automated driving systems”

- James Lentz, Chief Executive Officer
  Toyota Motor North America
Thank you

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