5.9 GHz “Safety Band” Transportation Communications—Incorporating Secure 5G

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AUGUST 12, 2020
Many Types and Uses of Communications for Transportation

- Center-to-Center Communications
- Center to Field Communications
- Back Office Communications

Machine-to-Machine communications:
- Vehicle-to-Vehicle (V2V) Crash Avoidance
- Vehicle-to-Infrastructure (V2I, i.e., Signal Priority, Weather, Emergency Response, etc.)
- Vehicle-to-Everything (V2X), i.e., portable devices for pedestrians (vehicle-to-pedestrian, V2P) or vulnerable road users.

- 2G / 3G / 4G
- Fiber
- Internet
- Satellite

- Tailored Broadcast Wi-Fi
- Tailored Broadcast Cellular
V2X: Game Changing Capabilities

• Cooperative automated vehicle maneuvering
• Notify Automated vehicles of approaching police and emergency vehicles
• Send wireless notifications of traffic signal and other roadside messages to enhance situational awareness for automated vehicles
• And other new and innovative features and applications
**Dedicated Band Plan—5.9 GHz Safety Band Spectrum in Use Today**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Channel</th>
<th>Service 1</th>
<th>Service 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.850 GHz</td>
<td>CH 172</td>
<td>Service</td>
<td>10 MHz</td>
</tr>
<tr>
<td></td>
<td>reserve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 MHz</td>
<td>CH 173</td>
<td>Service</td>
<td>10 MHz</td>
</tr>
<tr>
<td>5850-5855</td>
<td>CH 174</td>
<td>Service</td>
<td>10 MHz</td>
</tr>
<tr>
<td></td>
<td>CH 176</td>
<td>Service</td>
<td>10 MHz</td>
</tr>
<tr>
<td></td>
<td>CH 178</td>
<td>Service</td>
<td>10 MHz</td>
</tr>
<tr>
<td>5.925 GHz</td>
<td>CH 180</td>
<td>Service</td>
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</tr>
<tr>
<td></td>
<td>CH 182</td>
<td>Service</td>
<td>10 MHz</td>
</tr>
<tr>
<td></td>
<td>CH 184</td>
<td>Service</td>
<td>10 MHz</td>
</tr>
</tbody>
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**Critical Spectrum Requirements**

<table>
<thead>
<tr>
<th>Tailored Communications</th>
<th>Interoperability</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low Latency</td>
<td>• All makes and models of devices can “hear” each other</td>
<td>• V2X messages are trusted and authenticatable</td>
</tr>
<tr>
<td>• Non-Networked—no association time</td>
<td></td>
<td></td>
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<tr>
<td>• Channel Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Information Age / Interpacket Gap</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• &lt; 90% Packet Completion Rate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Test is Key to Tailoring

Graphics Source:
Crash Avoidance Metrics Partners LLC (CAMP)
Vehicle Safety Communications 8 (VSC8)
Consortium & U.S. DOT
Moving Toward Zero-Trust

- Highly Tailored Form of Security
  - IEEE 1609.2 Credentials—very low overhead to support authentication from nearby vehicles, infrastructure, and devices up to 10x per second
  - Service Specific Permissions
  - Security Credential Management System (SCMS)

- Misbehavior Detection
  - Local—devices detect malicious behavior (i.e., spoofing) or failing devices and do not authenticate messages and report problem certificates to local devices
  - Global—devices report to SCMS which can revoke certificates

- Strong Privacy Protection
  - Randomization of credentials
  - Change-out at a minimum of 5 minutes / refresh batches every few weeks or months
Key Performance Metrics Questions

Testing will examine critical, edge use cases involving 250 devices on a test track with vehicles moving at high speeds and will address the following questions:

- Does LTE-C-V2X conclusively support crash-imminent safety applications in non-network connected V2V mode?

- What is required to prevent interference:
  - Within and between LTE-C-V2X channels?
  - Between LTE-C-V2X and DSRC devices operating on the same channel?
  - Between LTE-C-V2X and DSRC channels?

- Are there LTE-C-V2X performance gaps in high device density scenarios?

- At what level is interoperability possible between LTE-C-V2X and DSRC or among devices from different LTE-CV2X vendors?

- Are the laboratory results able to be validated through field-testing?
Background: What are V2X Communications?

- Vehicle-to-Everything (V2X) technology is direct, device-to-device wireless messaging between vehicles, infrastructure and mobile devices—and uses 75 MHz of spectrum located at 5.9 GHz (termed the Safety Band) to support safety communications.
- Direct communications between devices (no cell tower needed).
- Machine-to-Machine communications:
  - Vehicle-to-Vehicle or V2V
  - Vehicle-to-Infrastructure or V2I
  - Vehicle-to-Everything (V2X) i.e., portable devices for pedestrians (vehicle-to-pedestrian, V2P) or vulnerable road users.
Infrastructure and Vehicle Density

Image: NYC DOT

Image: LA DOT