Georgia Connected Vehicles

Progress and Plans
Point-to-point communications

V2X is this:

OBU  PED  RSU

Not this:

OBU  PED  RSU

Infotainment vs. Safety Critical
V2X Spectrum in the US

- 5.9 GHz Spectrum is a free public resource
- Only DSRC can be deployed legally in US 5.9 GHz
- Channel switching (2 radios efficiently cover 7 channels)

### Seven 10-MHz Channels

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH 172</td>
<td>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>
<td>Safety &amp; Service</td>
</tr>
<tr>
<td>CH 184</td>
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</tbody>
</table>

Every channel used for safety apps:

- **Ch. 172**: BSM safety and small set of V2I safety apps
- **Ch. 174**: I→V safety and mobility, to avoid cross-channel interference to Ch. 172
- **Ch. 176**: VRU safety (PSM) D→V, and download from SCMS (I→V)
- **Ch. 178**: Control channel: WSA, and low-bandwidth safety (I→V)
- **Ch. 180**: Non-BSM V2V safety (e.g. C-ACC, sensor sharing), and mobility (I→V)
- **Ch. 182**: I→V safety and mobility
- **Ch. 184**: FCC designation for public safety. Ex: Preemption, Emergency Alert

Source: SAE J2945/0
To challenge state and local public sector transportation Infrastructure Owners and Operators (IOOs) to deploy DSRC infrastructure with SPaT (and MAP) broadcasts in at least one corridor or network (approximately 20 signalized intersections) in each state by January 2020.

20 intersections in 50 states by 2020!
Pilot Deployment Objectives

Primary goal: Develop back-end infrastructure, network components, and business processes to support broad vehicle to infrastructure applications that is broadcast-medium agnostic, scalable, and sustainable.

Secondary goal: Begin broad installation of available roadside units and on-board units to facilitate applications that improve safety and mobility.

Primary Application Spaces:
- Safety
- Mobility
- Freight
- Partnerships
Initial Deployment

Phase 1: Pilot – Active June 2018

• SR 141 (Peachtree) from SR 9 to I-285
• SR 8 (Ponce de Leon) from Peachtree to SR 42
• 54 traffic signals
• 12 ramp meters
• Signal Phasing and Timing (SPaT)
  • Red light warning
  • Pedestrian in signalized crosswalk (in development)
  • Phase termination/next signal phase
  • Green-band speed (Green light optimal speed)
Phase 1 SPaT/MAP Applications

- **Red light warning**: Safety for drivers – alerts of inability to safely clear intersection
- **Pedestrian in crosswalk**: Safety for drivers and pedestrians – turning vehicles have additional awareness of other users
- **Phase service remaining**: Efficiency for drivers – alert drivers for safe intersection passage or efficient stopping
- **Green speed for coordinated signals**: Efficiency for drivers – inform drivers of the optimal driving speed through coordinated signals to minimize stops

**ACTIVE RSUs IN METRO ATLANTA**

- SR 141 (Peachtree) – 39 intersections
- SR 8 (Ponce de Leon) – 15 intersections
- North Ave – 22 intersections (Renew)
GDOT CV Architecture

- CV Application resides on signal controller
- No additional hardware (outside of RSU) required
- Open access to third parties
- Conformity to national standards and open access
Deployment

MAXTIME CV

Connected Devices Status

<table>
<thead>
<tr>
<th>Device</th>
<th>Device Type</th>
<th>Peer ID</th>
<th>Connection Status</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>MaxTime</td>
<td>1</td>
<td>Connected</td>
</tr>
<tr>
<td>2</td>
<td>RSU 4.1 SPAT UDP</td>
<td>2</td>
<td>Connected</td>
</tr>
<tr>
<td>3</td>
<td>RSU 4.1 MAP UDP</td>
<td>3</td>
<td>Connected</td>
</tr>
<tr>
<td>4</td>
<td>RSU 4.1 TIM UDP</td>
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Deployment

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<td>4</td>
<td>RSU 4.1 TIM UDP</td>
<td>4</td>
<td>Connected</td>
</tr>
<tr>
<td>5</td>
<td>Generic RSU UDP</td>
<td>5</td>
<td>Connected</td>
</tr>
</tbody>
</table>
Phase service remaining

Intersection name

Debug information

Minimum speed required to clear green

Vehicle speed

SR141_Shadowlawn

Target Speed

10 MPH

33 MPH
Red light running warning
Validation and Testing

- Properly formatted, J2735-compliant messages
- Ingress lanes that include a ConnectsTo but that egress lane is not defined (or is not defined as an egress)
- Ingress lanes that do not include a ConnectsTo
- Ingress lanes that do not include a signal phase/approachId
- Incorrect or missing ingress/egress definitions for each approach
- Overlap/underlap of lanes and widths
- Incorrect 'ConnectsTo' lanes
- General layout and structure of lane paths/geometries
- Signal phases being reported as “dark” or “unavailable”
- Correctness of the time remaining values
- Inconsistency of the reported minTime and maxTime (ie. min greater than max)
- Unexpected changes in minTime and maxTime
- Accuracy of the reported phase vs the actual signal
- Transmit rate of each message type
Project Challenges

• Device interoperability
  • Controller to RSU
  • RSU to OBU
  • OBU to OBU
• MAP message creation and validation
• Protected/permissive left turns
• Application deployments
• Security credentialing
• Data
• Limited fleet
• Regional communications network
• Technology risk and Spectrum Uncertainty
Phase 2 Deployment

Scalable Deployment Strategy

- Communications
- ATC Signal Controller
- DSRC Radio

Broad deployment potential in Georgia
Phase 2 Deployment
Phase 2: RTOP – June 2020
GDOT Investment + USDOT ATCMTD Grant

- 1,600 traffic signals in metro Atlanta
- 185 ramp meter locations
- Regional deployment
  - Not a pilot program: a deliberate inter-agency deployment across the entire metro Atlanta region
Interoperable Ecosystem

Regional interoperability through standards-based, non-proprietary technology deployments
Phase 2 Deployment

Phase 2.1: RTOP – Fall 2019

- Additional 600 of FY 2019 to be installed by Fall 2019
- 305 RSUs operational as of July 2019
- Connectivity on every major arterial in metro Atlanta
- Open data stream to third parties also available

ADDITIONAL APPLICATIONS

- **Emergency vehicle preemption**
  - Preemption at select signals to improve emergency vehicle response time
- **Transit signal priority**
  - Priority requests to signal controllers for specific transit applications and routes
- **Freight signal priority**
  - Signal priority for freight vehicles that are operating in cooperative platooning mode
## Phase 2 Deployment

<table>
<thead>
<tr>
<th>Phase 2 Deployment Est.</th>
<th>FY 2019 (600)</th>
<th>FY 2020 (1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSU Equipment</td>
<td>$780,000</td>
<td>$1,300,000</td>
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<tr>
<td>RSU Deployment</td>
<td>$510,000</td>
<td>$850,000</td>
</tr>
<tr>
<td>RSU Configuration &amp; Support</td>
<td>$1,200,000</td>
<td>$2,000,000</td>
</tr>
<tr>
<td>ATCMTD OBUs (1000)</td>
<td>$1,000,000</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$2,490,000</strong></td>
<td><strong>$4,150,000</strong></td>
</tr>
</tbody>
</table>

- 1,600 Roadside units at $1,300 per device.
- RSU deployment at $850 per location.
- RSU configuration at $2,000 per device.
- OBU costs at $1,000 per device (optional).

Total: **$6,640,000**

654 RSUs to be operational by Fall 2019
CV, AV, & CAV
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