



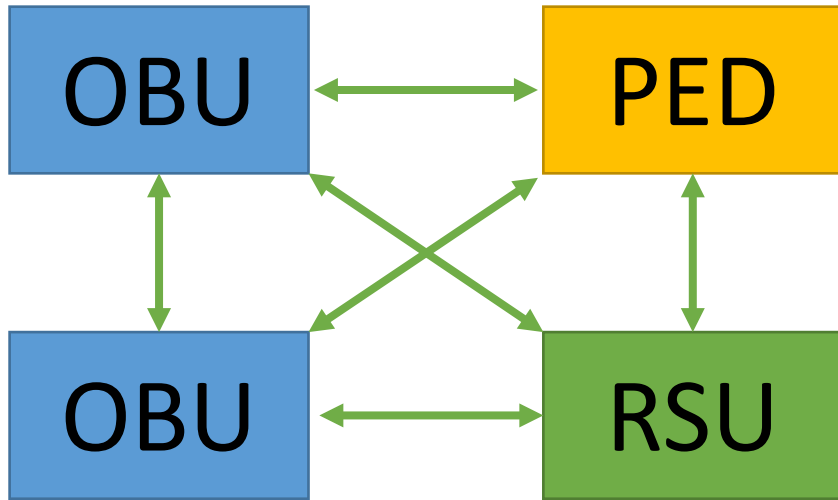
Georgia Connected Vehicles

Progress and Plans

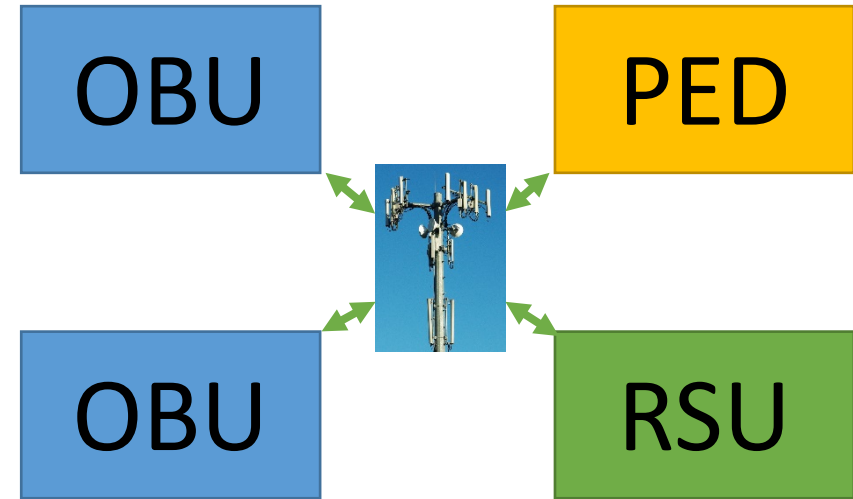


Point – to – point communications

V2X is this:



Not this:

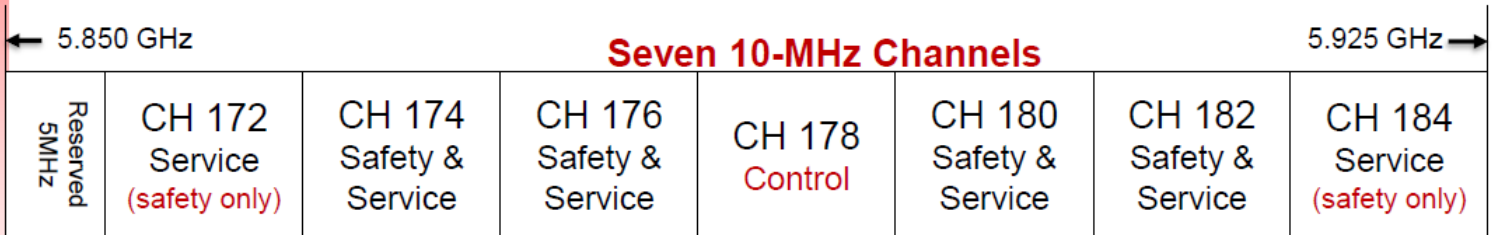


Infotainment vs. Safety Critical

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)



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: WSAs, 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

BSM = Basic Safety Message VRU = Vulnerable Road User PSM = Personal Safety Message
WSA = WAVE Service Advertisement SCMS: Security Confidential Management System

AASHTO SPaT Challenge

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!



26
States Committed

450+
Signals Operating

3,800+
Signals Planned

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:



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

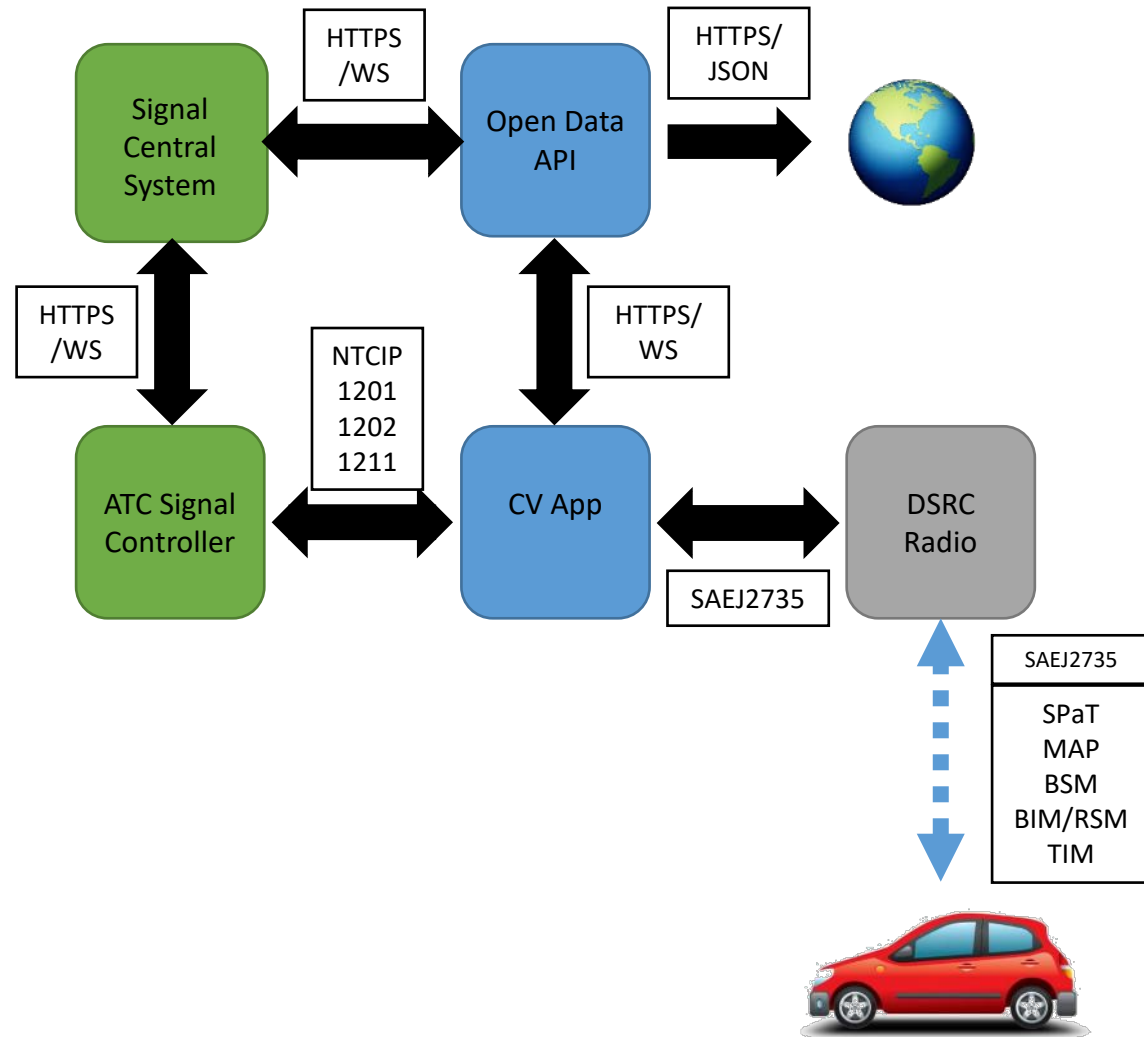
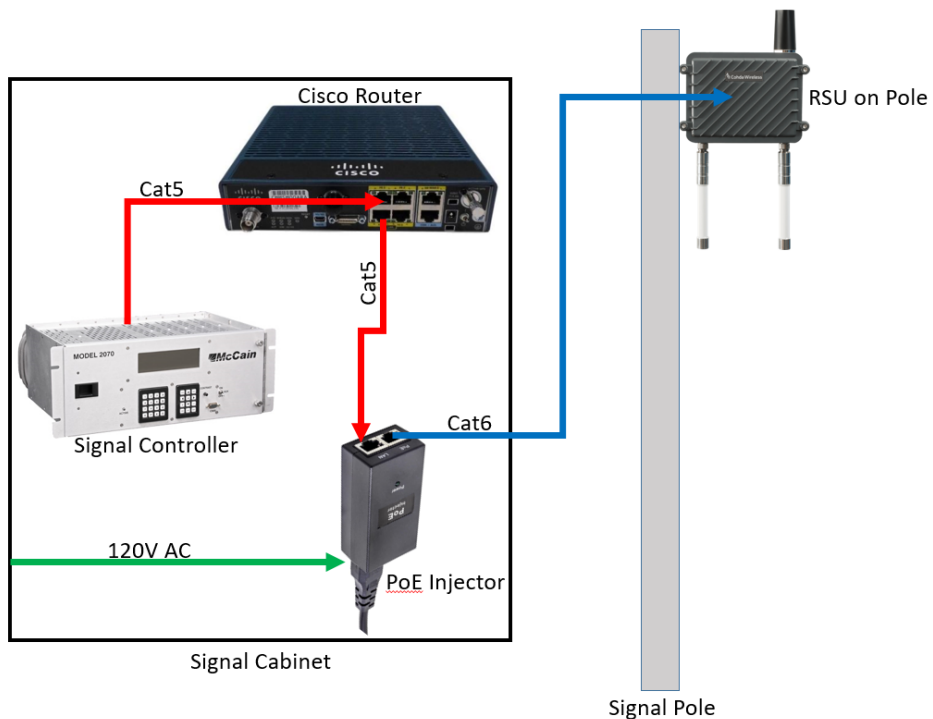
ACTIVE RSUs IN METRO ATLANTA

- 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

🔍 Search
🏠 Home
🚗 Status ^
Connected Devices
SPaT Message

Connected Devices Status

Show All Devices

Device	Device Type	Peer ID	Connection Status
1	MaxTime	1	Connected
2	RSU 4.1 SPAT UDP	2	Connected
3	RSU 4.1 MAP UDP	3	Connected
4	RSU 4.1 TIM UDP	4	Connected

Deployment



MAXTIME CV

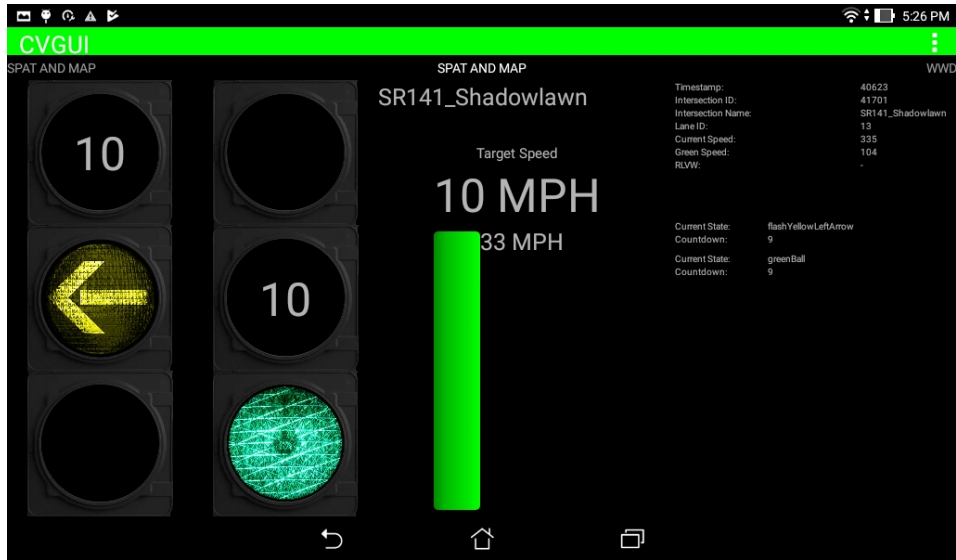
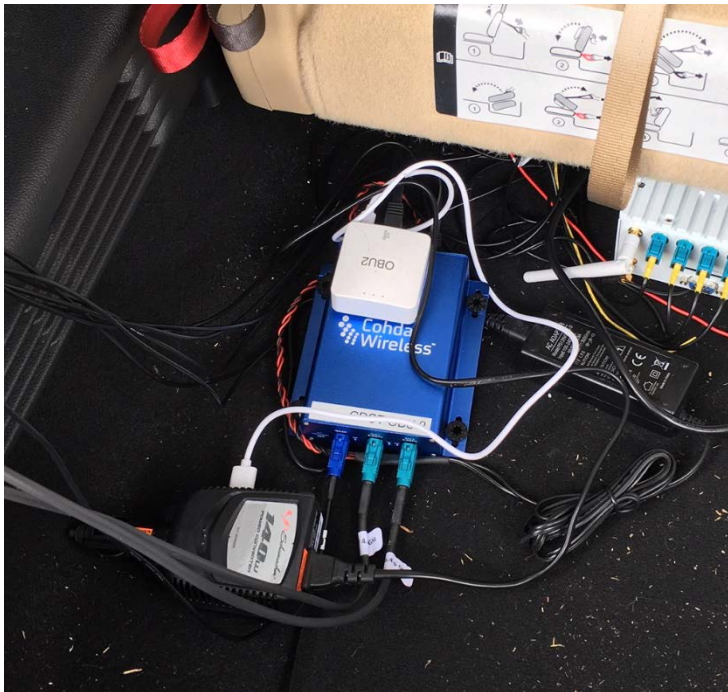
🔍 Search
🏠 Home
🚗 Status ^
Connected Devices
SPaT Message

Connected Devices Status

Show All Devices

Device	Device Type	Peer ID	Connection Status
1	MaxTime	1	Connected
2	RSU 4.1 SPAT UDP	2	Connected
3	RSU 4.1 MAP UDP	3	Connected
4	RSU 4.1 TIM UDP	4	Connected

Deployment



SOUTHWEST RESEARCH INSTITUTE

MAXTIME CV

- Search
- Home
- Status

Connected Devices

SPaT Message

MAP Message

Connected Devices Status

Show All Devices

Device	Device Type	Peer ID	Connection Status
1	MaxTime	1	Connected
2	RSU 4.1 SPAT UDP	2	Connected
3	RSU 4.1 MAP UDP	3	Connected
4	RSU 4.1 TIM UDP	4	Connected
5	Generic RSU UDP	5	Connected

CVGUI

SPAT AND MAP

SR141_Shadowlawn

Target Speed
10 MPH



33 MPH

Timestamp: 40623
Intersection ID: 41701
Intersection Name: SR141_Shadowlawn
Lane ID: 13
Current Speed: 335
Green Speed: 104
RLW: -

Current State: flashYellowLeftArrow
Countdown: 9

Current State: greenBall
Countdown: 9

WWD



The screenshot displays the CVGUI interface for the SR141_Shadowlawn intersection. The interface is divided into several sections:

- Header:** A green bar at the top contains the text "CVGUI" on the left and "5:26 PM" on the right.
- Intersection Name:** The text "SR141_Shadowlawn" is displayed in the center.
- Traffic Lights:** On the left, there are two vertical columns of traffic light indicators. The top light in both columns shows the number "10". The middle light in the right column shows a yellow left-pointing arrow. The bottom light in the right column shows a green circular light.
- Speed Information:** In the center, the text "Target Speed" is above "10 MPH". Below this, a green vertical bar is labeled "33 MPH".
- Debug Information:** On the right side, there is a table of data:

Timestamp:	40623
Intersection ID:	41701
Intersection Name:	SR141_Shadowlawn
Lane ID:	13
Current Speed:	335
Green Speed:	104
RLWV:	-
Current State:	flashYellowLeftArrow
Countdown:	9
Current State:	greenBall
Countdown:	9

Annotations with yellow arrows point to specific elements:

- "Phase service remaining" points to the "10" in the top-left traffic light.
- "Intersection name" points to "SR141_Shadowlawn".
- "Debug information" points to the right-side data table.
- "Minimum speed required to clear green" points to the "10 MPH" target speed.
- "Vehicle speed" points to the "33 MPH" value next to the green bar.

CVGUI

APPLICABLE AND VISIBLE

SPAT AND MAP

SR141_SR237

SPAT AND MAP

Timestamp:	2383
Intersection ID:	46538
Intersection Name:	SR141_SR237
Lane ID:	22
Current Speed:	335
Green Speed:	-
RLW:	1

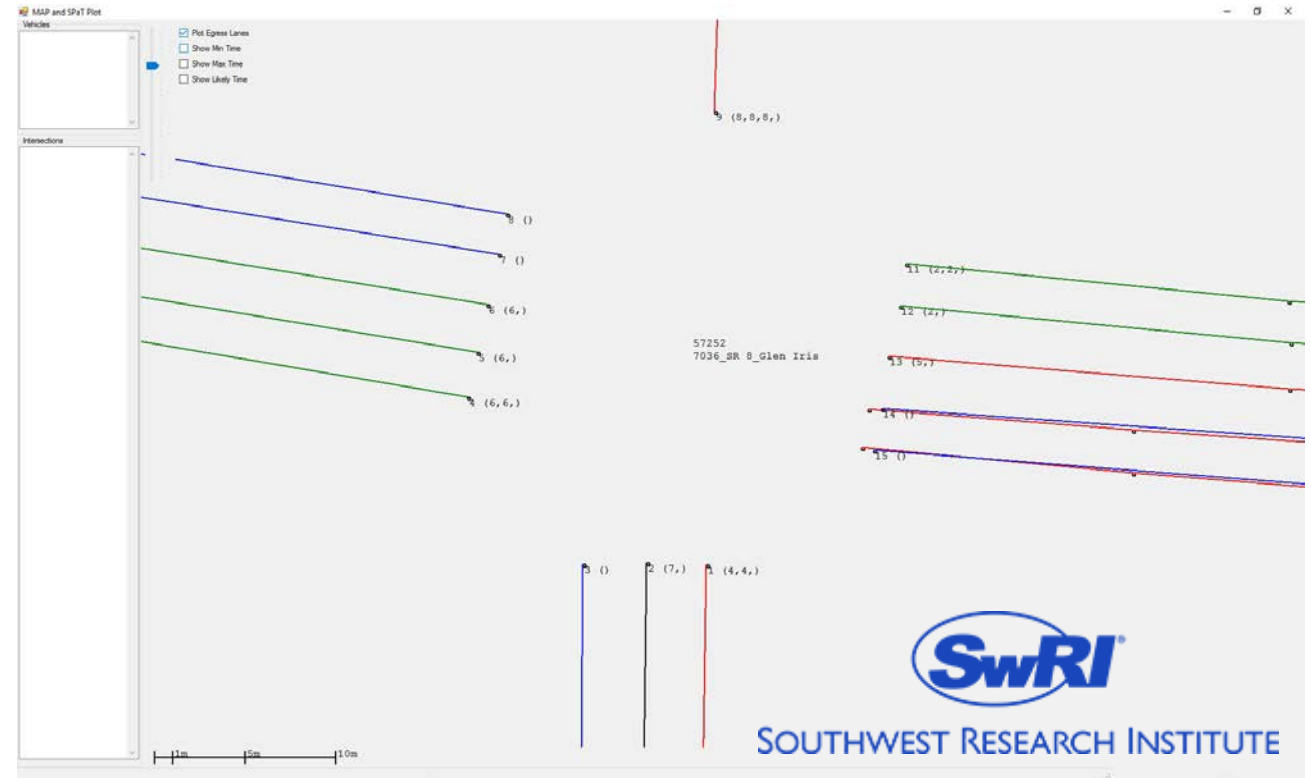
Current State: redBall
Countdown: 14

15

Red light running warning

Validation and Testing

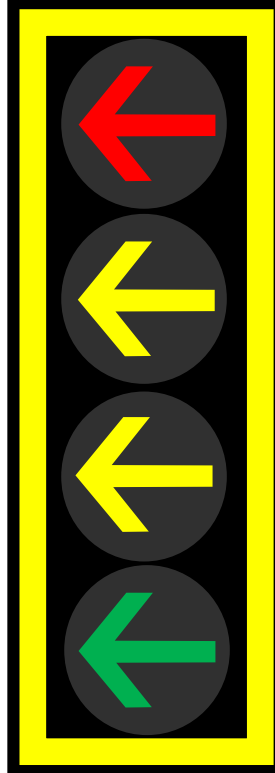
- Properly formatted, J2735-compliant messages
- Ingress lanes that include a ConnectsTo but that egress lane is not defined (or is not defined as an egress)
- Ingress lanes that do not include a ConnectsTo
- Ingress lanes that do not include a signal phase/approachId
- Incorrect or missing ingress/egress 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



2019-05-29 20:57:38.1	72	82	23
2019-05-29 20:57:38.3	72	82	32
2019-05-29 20:57:38.3	72	82	26
2019-05-29 20:57:38.8	72	81	26
2019-05-29 20:57:39.2	72	81	23
2019-05-29 20:57:39.6	72	82	4

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



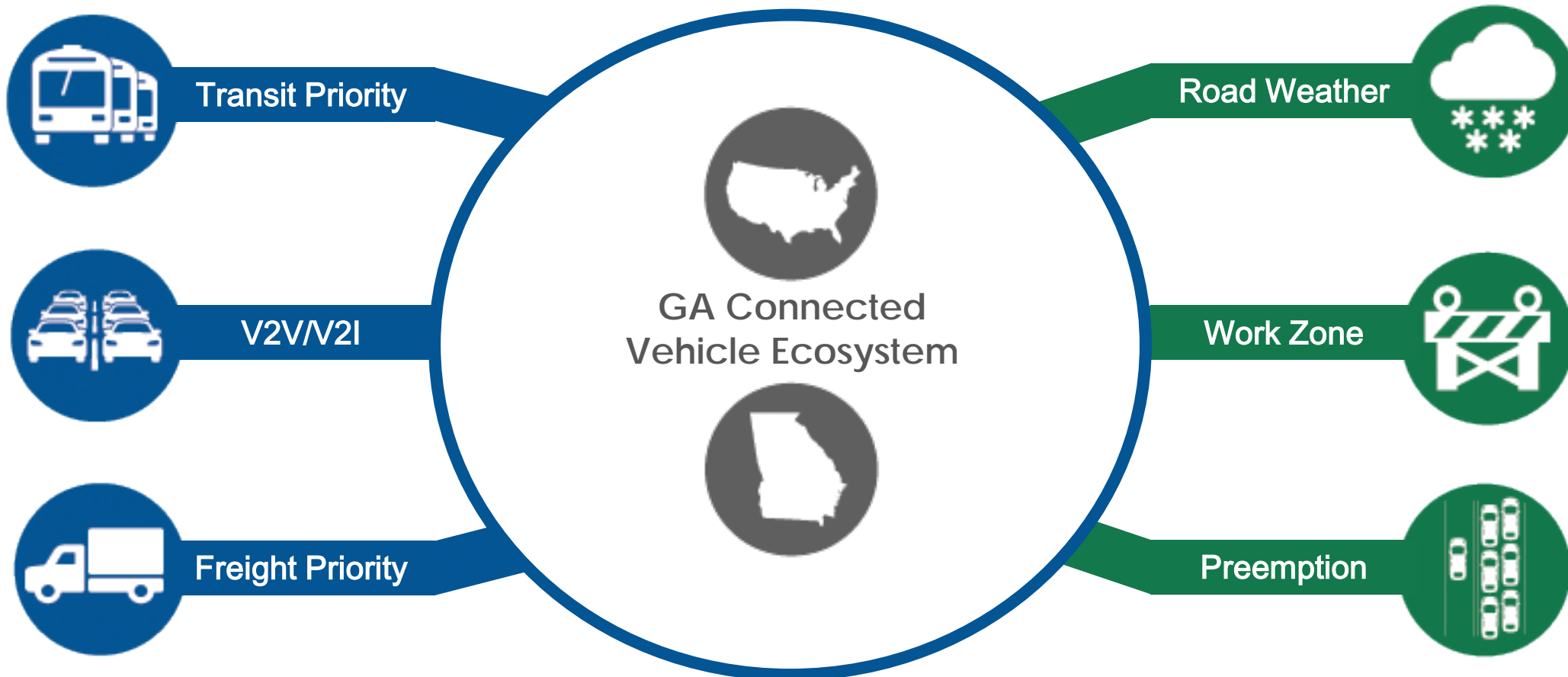
Phase 2 Deployment

Scalable
Deployment
Strategy

- Communications
- ATC Signal Controller
- DSRC Radio

**Broad deployment
potential in
Georgia**

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

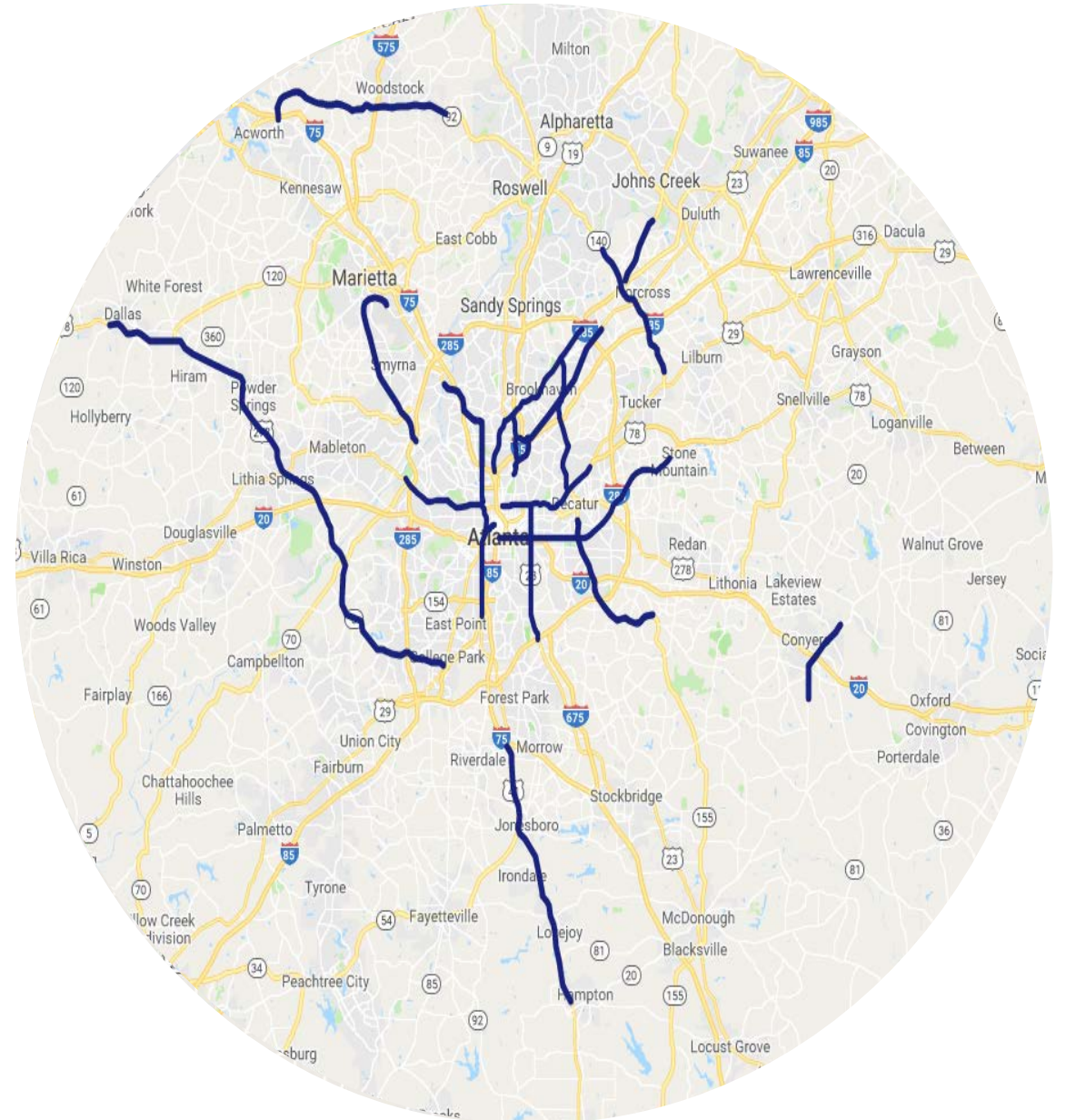


Priority requests to signal
controllers for specific transit
applications and routes

Freight signal priority



Signal priority for freight vehicles
that are operating in cooperative
platooning mode





Phase 2 Deployment

Phase 2 Deployment Est.	FY 2019 (600)	FY 2020 (1000)
RSU Equipment	\$780,000	\$1,300,000
RSU Deployment	\$510,000	\$850,000
RSU Configuration & Support	\$1,200,000	\$2,000,000
ATCMTD OBUs (1000)	-	\$1,000,000
TOTAL	\$2,490,000	\$4,150,000

<ul style="list-style-type: none"> •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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