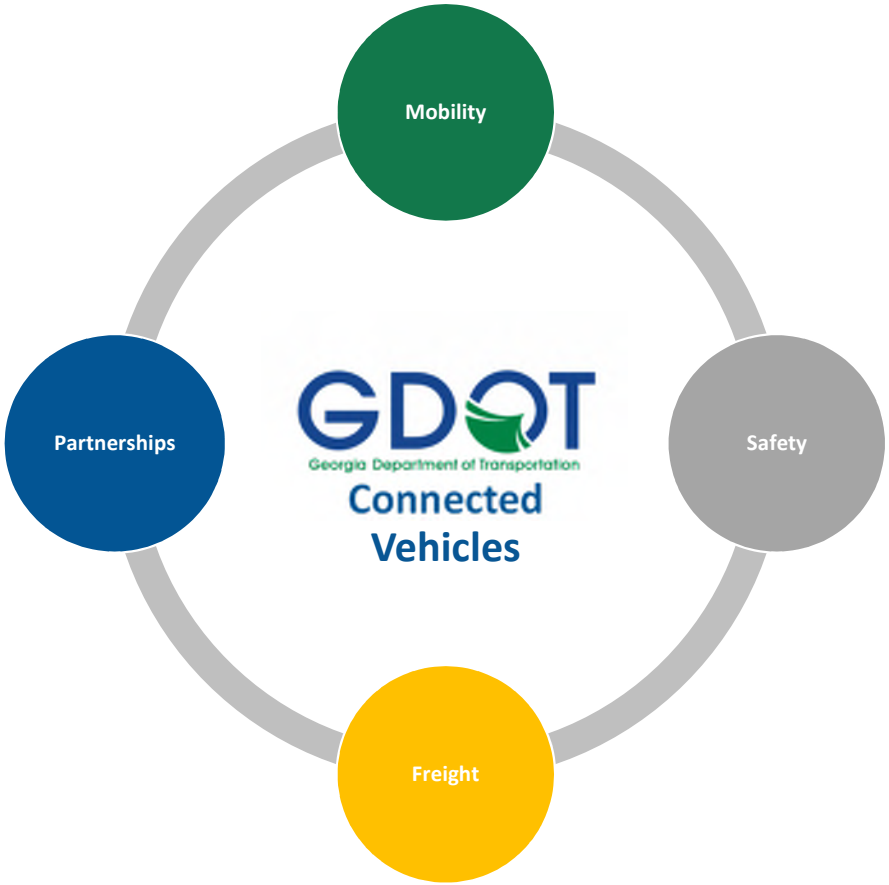
Georgia Department of Transportation

# Statewide Connected Vehicles

## Deployment Experience and Future Plans



GDOT
Georgia Department of Transportation



5GE

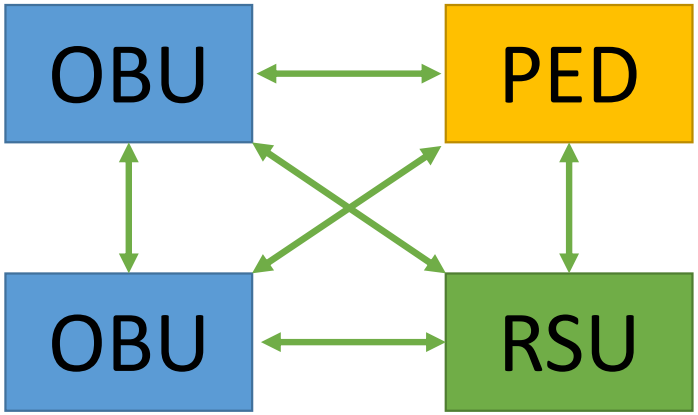
5G NR

5GNR

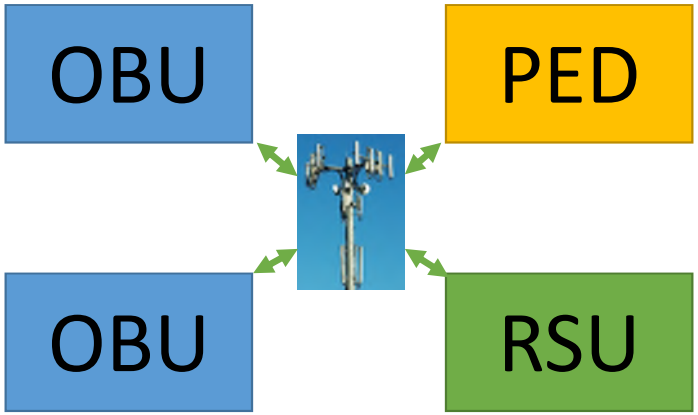
QUALCOMM OMNIAIR® CONSORTIUM

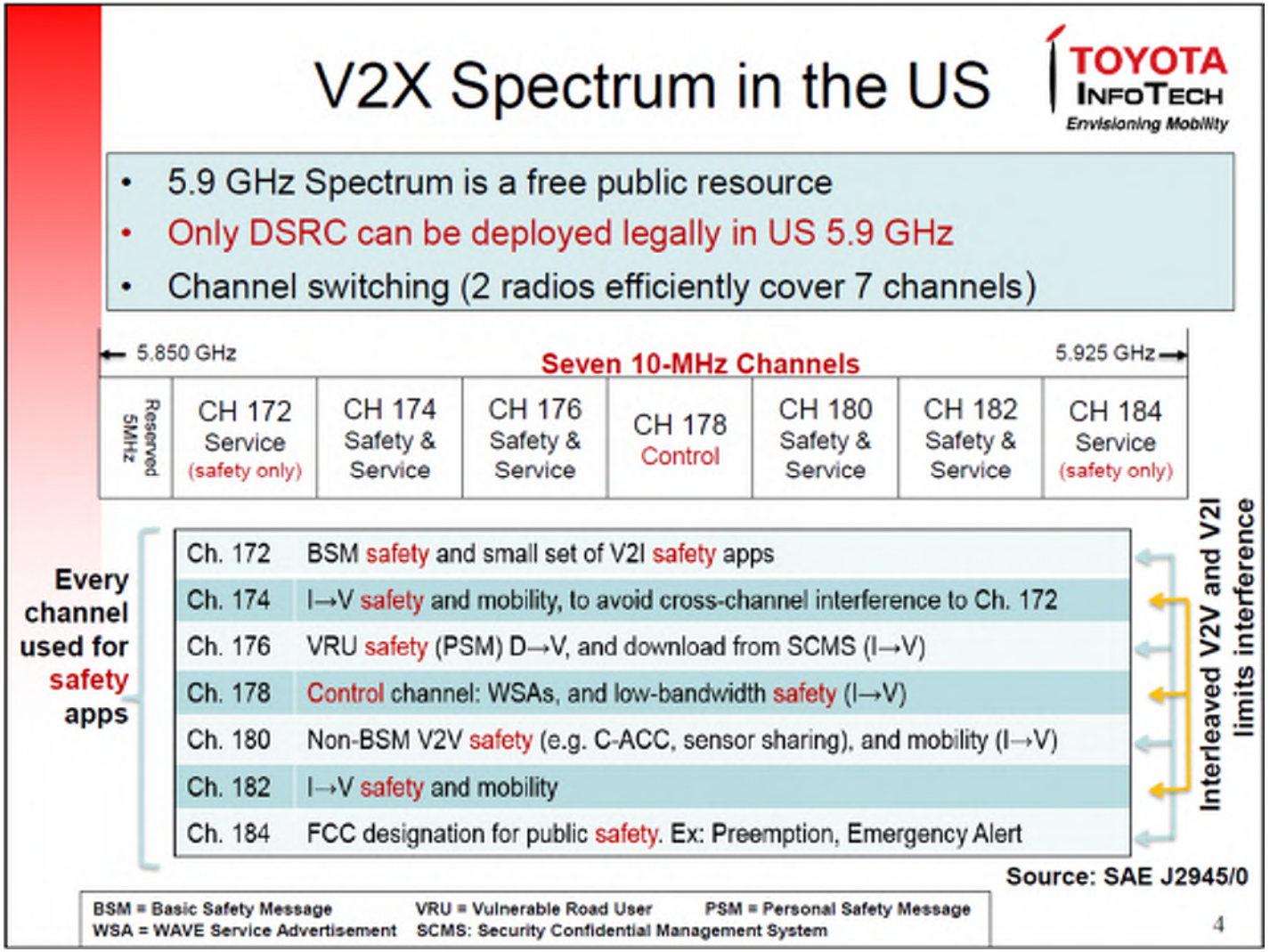
# Point – to – point communications

## V2X is this:




## Not this:






Source: Toyota InfoTech

# 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

**250+**
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 roadside units and equipped vehicles to facilitate applications that improve safety and mobility.

**Primary Application Spaces:**

# Active Deployments

## 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 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 |

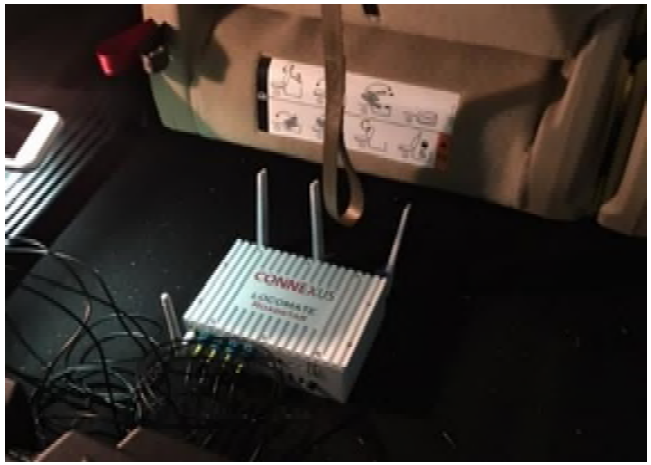
## ACTIVE DSRC IN METRO ATLANTA

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

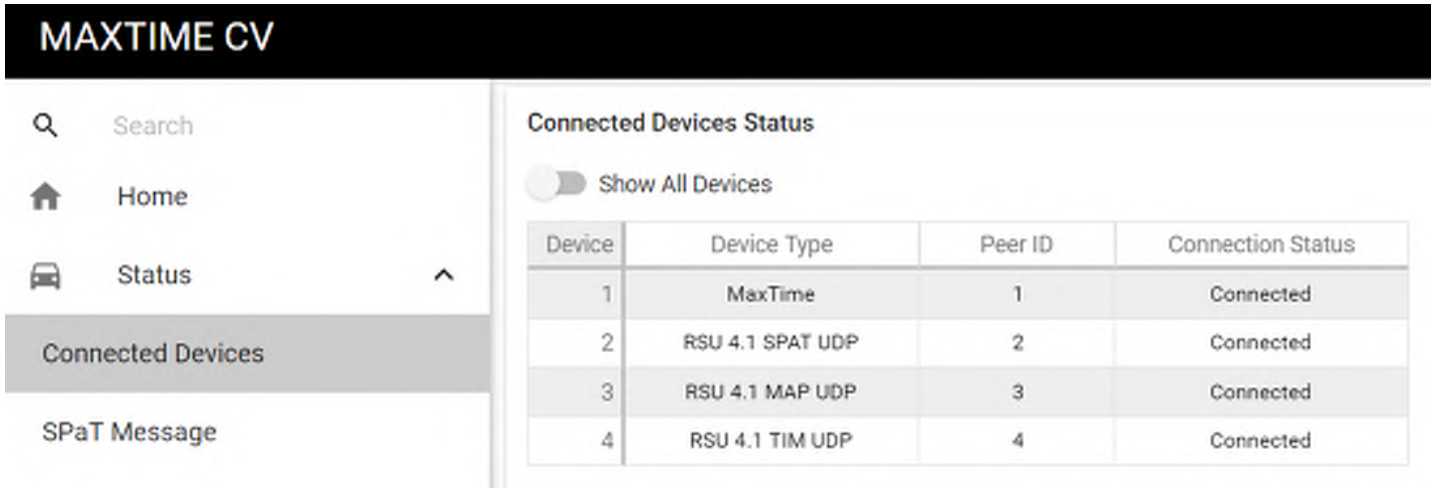
Real-time signal phasing and timing information → Aggregated data analytics for increased route efficiency → Increased awareness improving safety and mobility

# Deployment


NORTH
29
78
278
8
Piedmont




3600
SOS


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

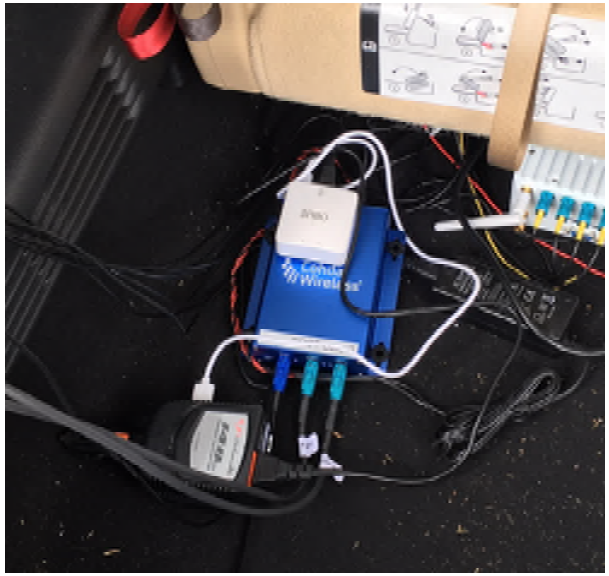
SPaT Message

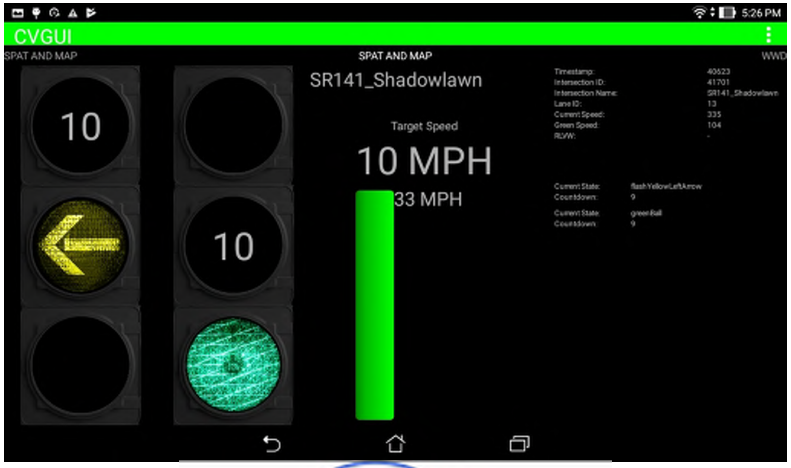
Connected Devices Status

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




SwRI
SOUTHWEST RESEARCH INSTITUTE

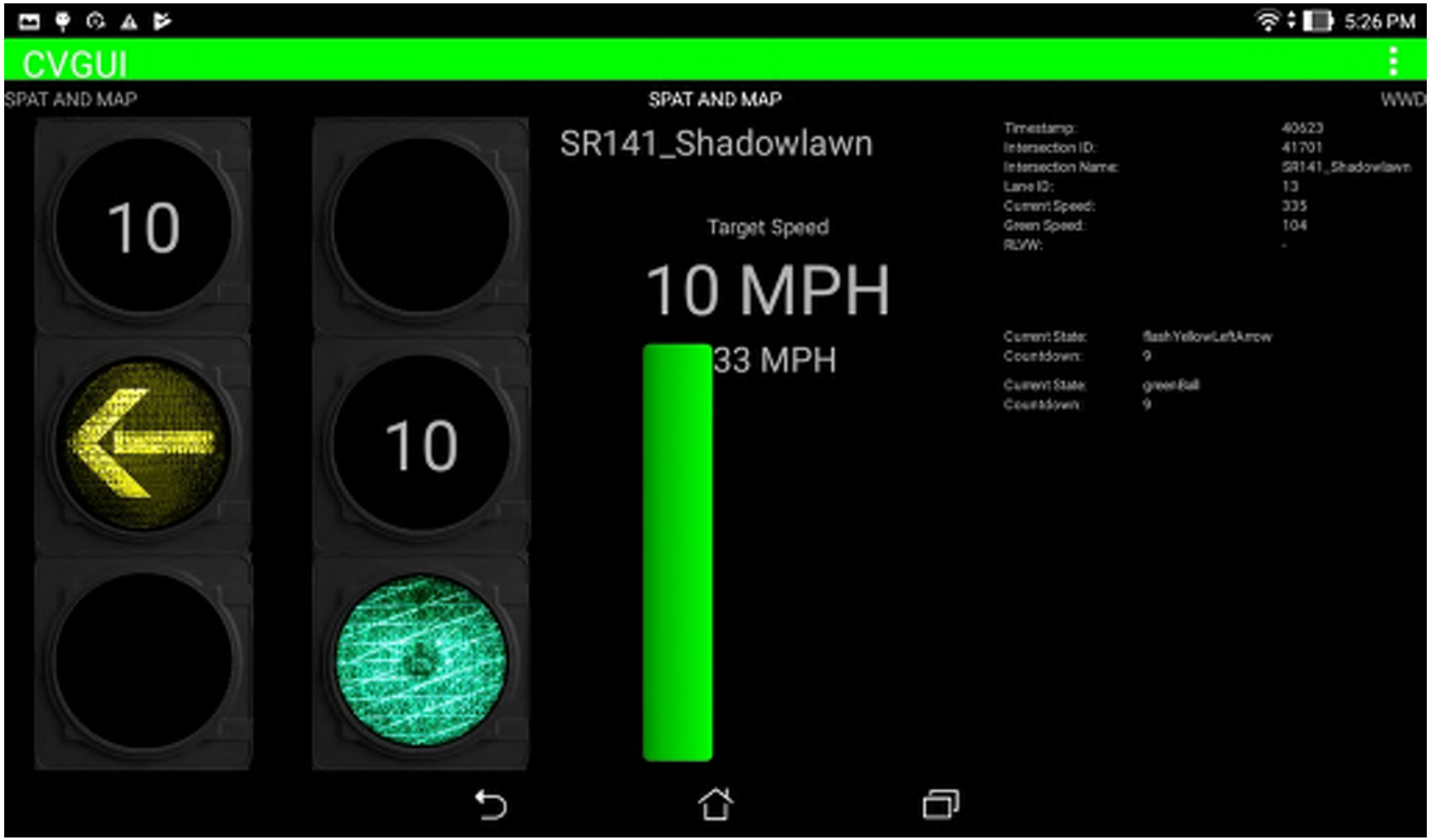
## MAXTIME CV

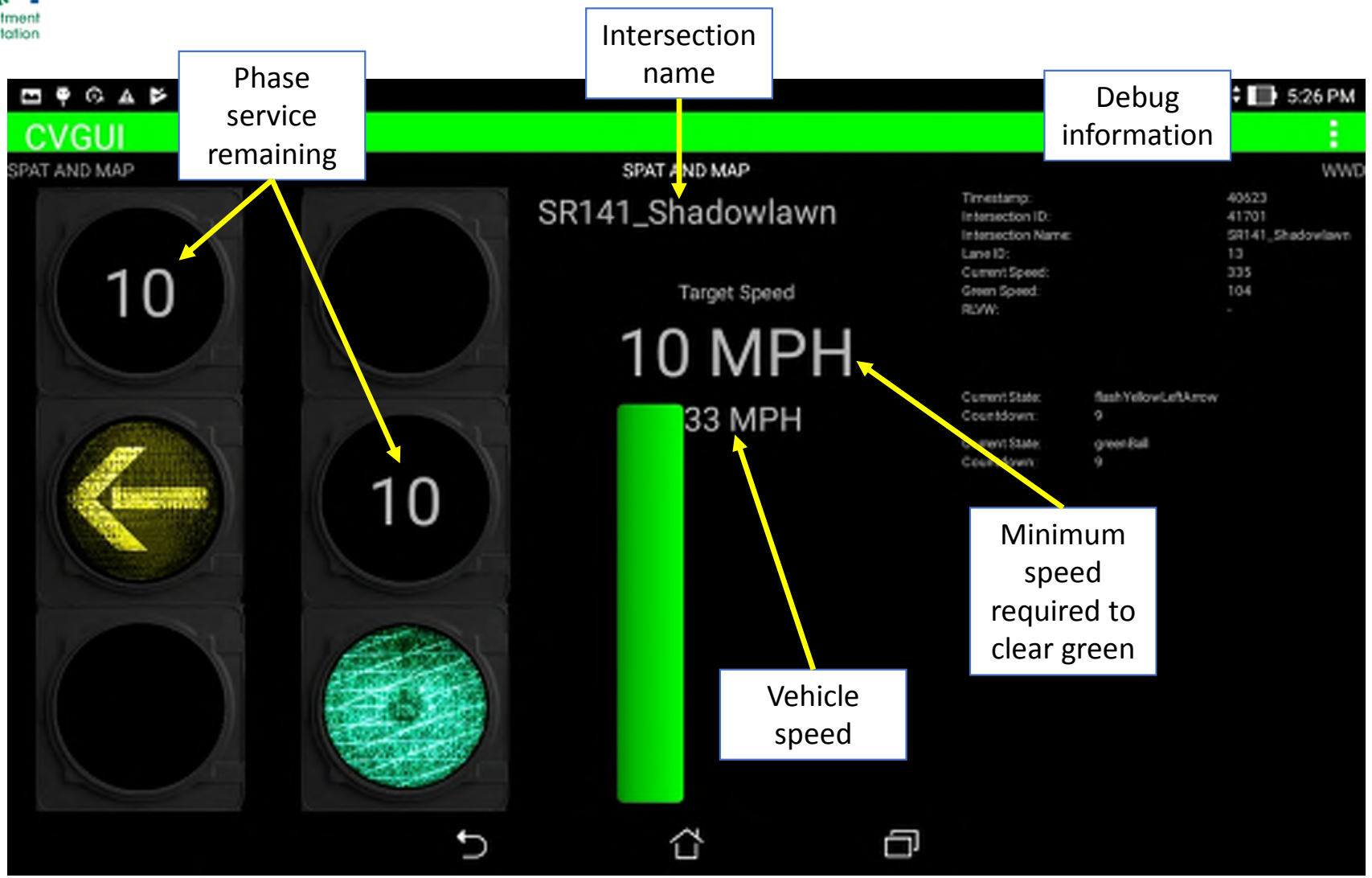
Search
Home
Status
Connected Devices
SPaT Message
MAP Message

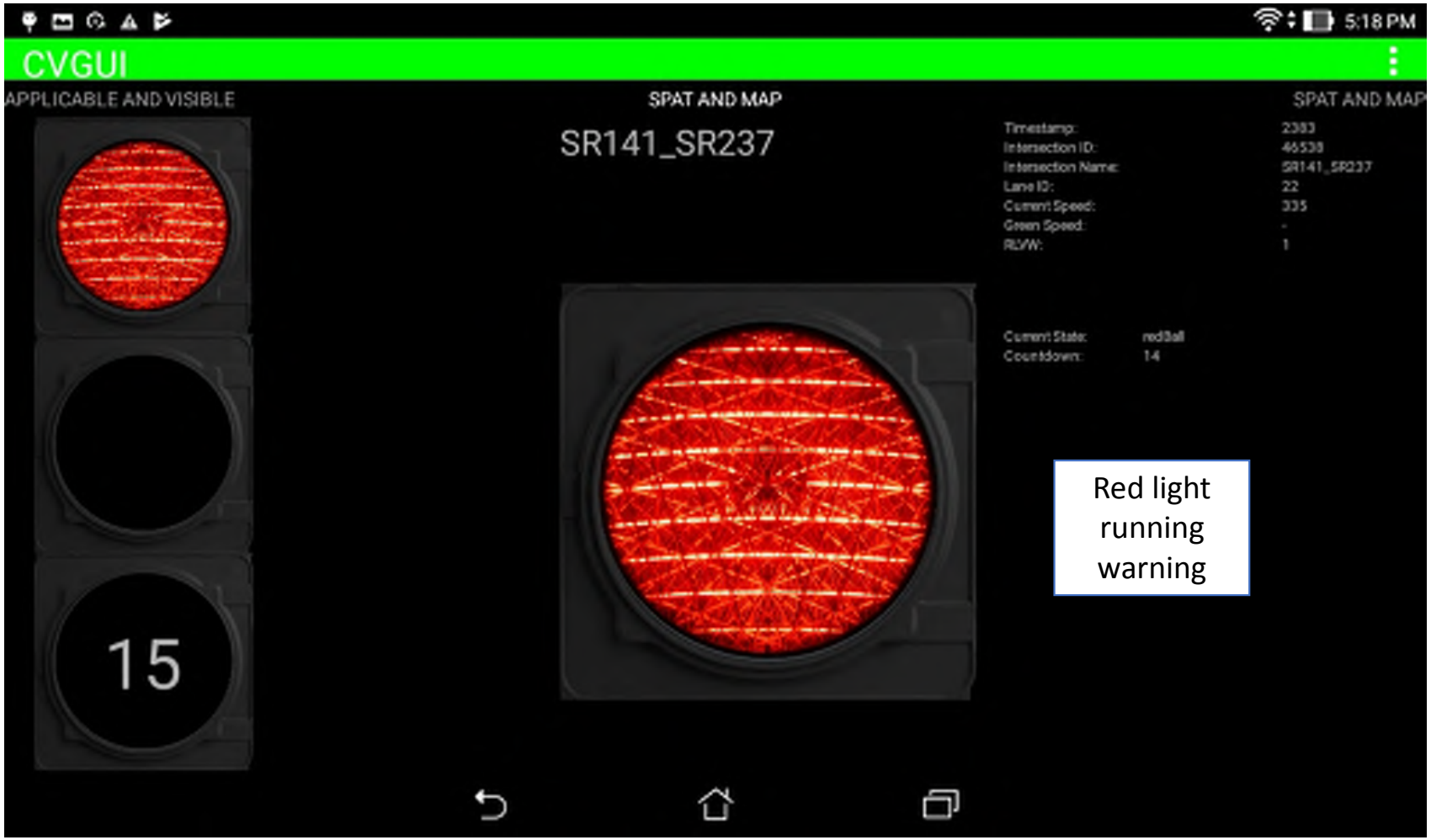
**Connected Devices Status**

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 |

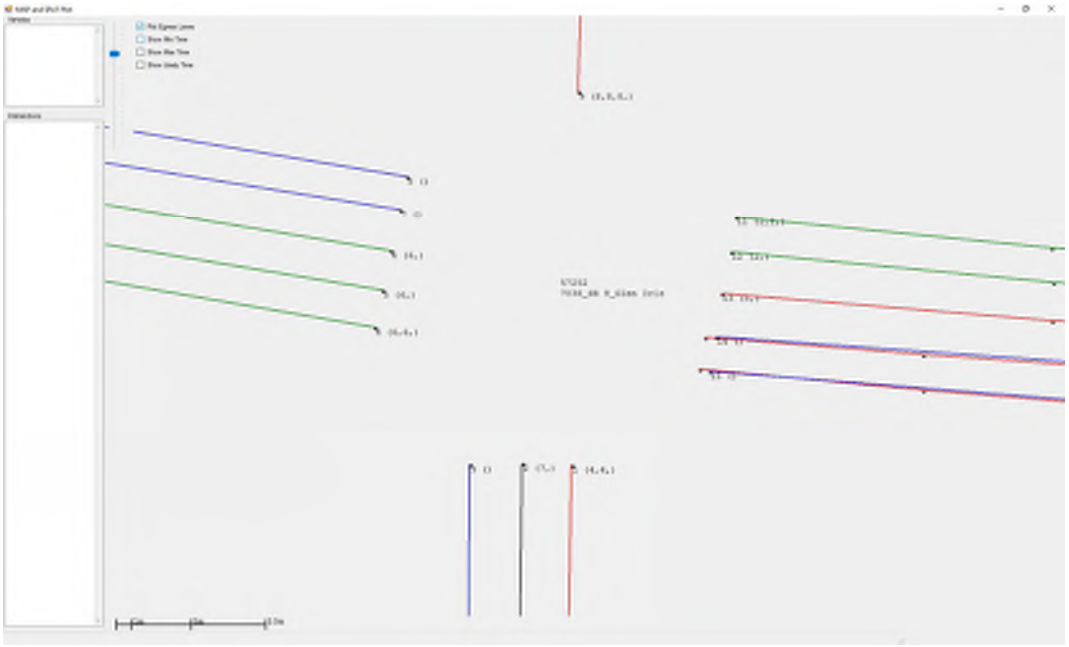

5:26 PM
CVGUI
SPAT AND MAP
SPAT AND MAP
WWD
SR141_Shadowlawn
Timestamp: 40623
Intersection ID: 41701
Intersection Name: SR141_Shadowlawn
Lane ID: 13
Current Speed: 335
Green Speed: 104
RLVW: -
Target Speed
10 MPH
33 MPH
10
10
Current State: flashYellowLeftArrow
Countdown: 9
Current State: greenBall
Countdown: 9


Intersection name
Phase service remaining
Debug information
5:26 PM
CVGUI
SPAT AND MAP
SPAT AND MAP
SR141_Shadowlawn
Target Speed
10 MPH
33 MPH
10
10
Minimum speed required to clear green
Vehicle speed


5:18 PM
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:
RLVW: 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



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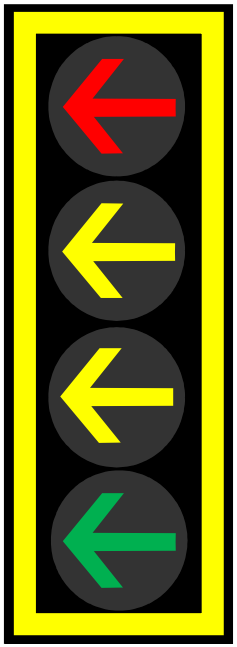
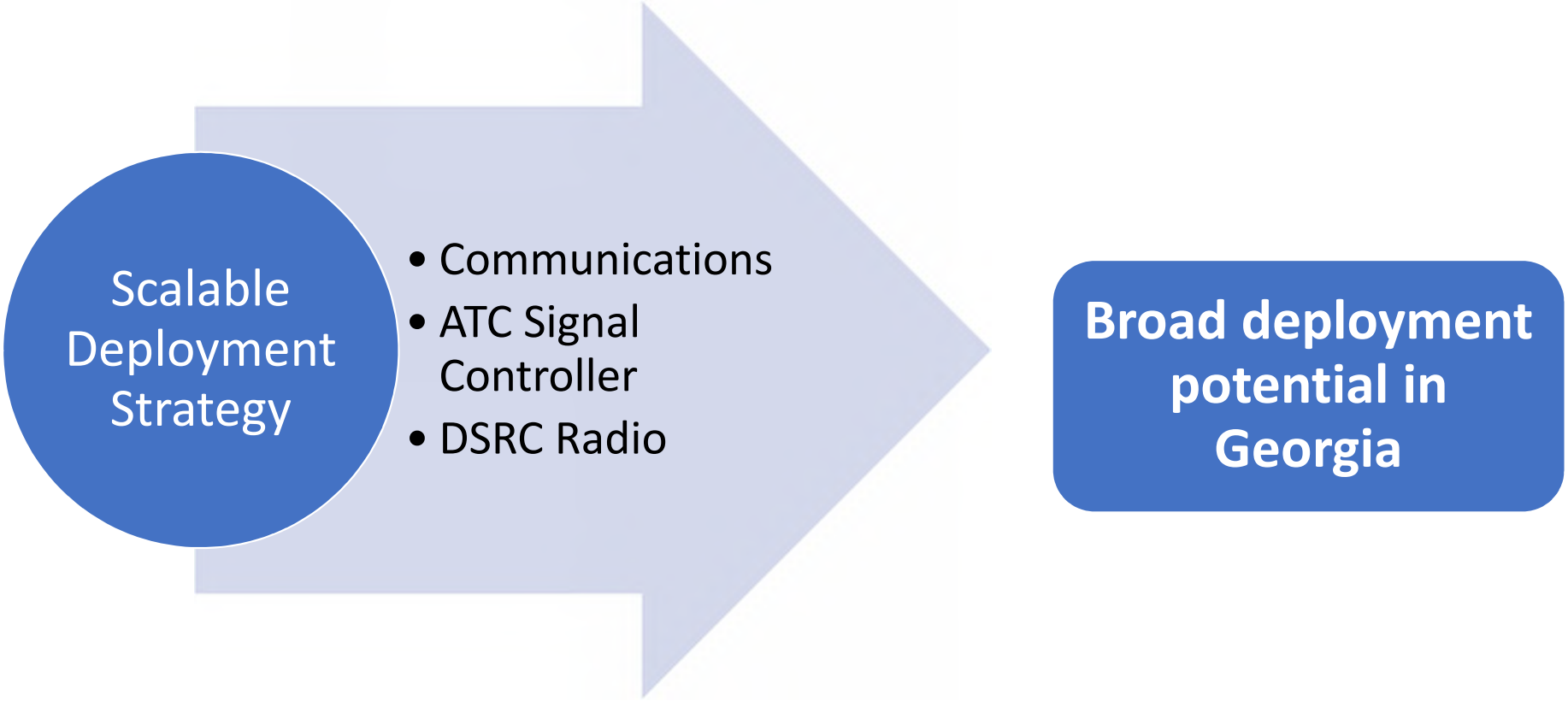
# Project Challenges

- Device interoperability
  - Controller to RSU
  - RSU to OBU
  - OBU to OBU
- MAP message creation and validation
- Protected/permissive left turns
- What's a ramp meter?
- Application deployments
- Security credentialing
- Data
- Limited fleet
- Regional communications network



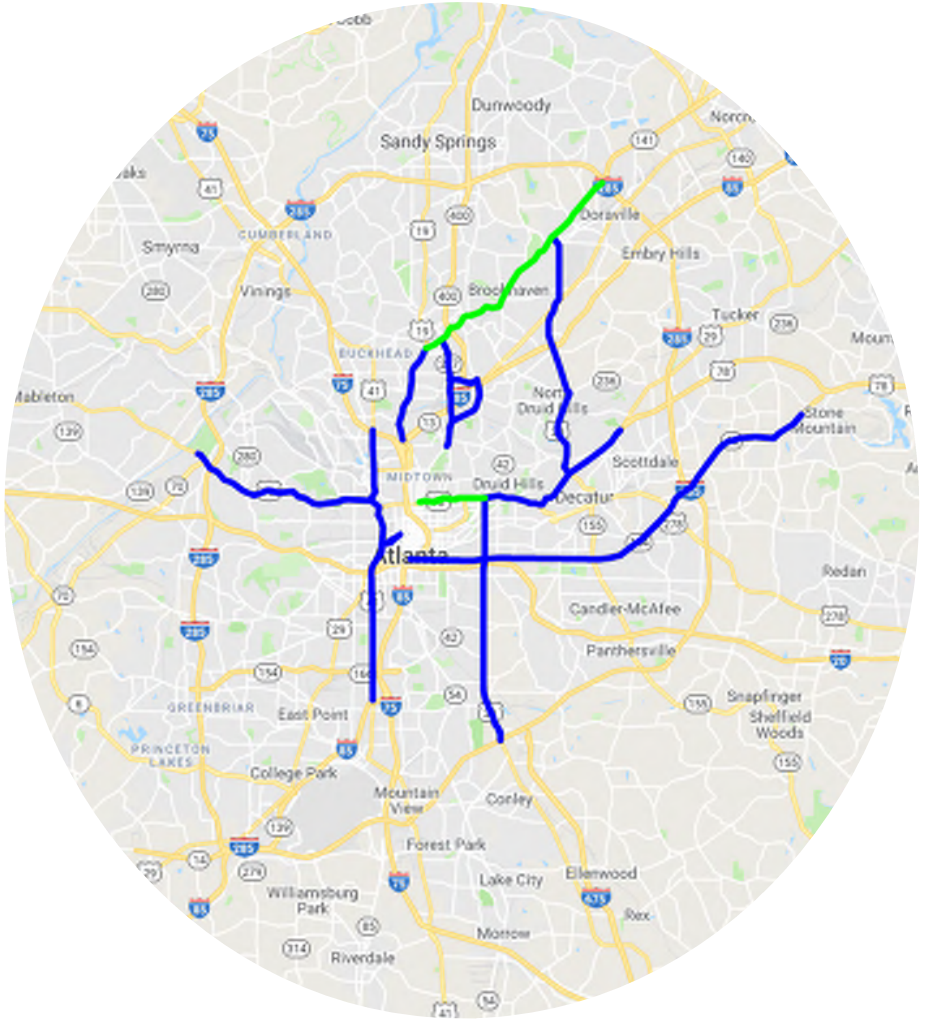
# Phase 2 Deployment



# Phase 2 Deployment

## Phase 2.1: RTOP – March 2019

- First 250 of FY 2019 to be installed by mid-March 2019
- Connectivity on every major arterial in metro Atlanta
- Open data stream to third parties also available
- Activation delayed by government shutdown (FCC approval)



# Phase 2 Deployment

## Phase 2.2: RTOP – June 2019

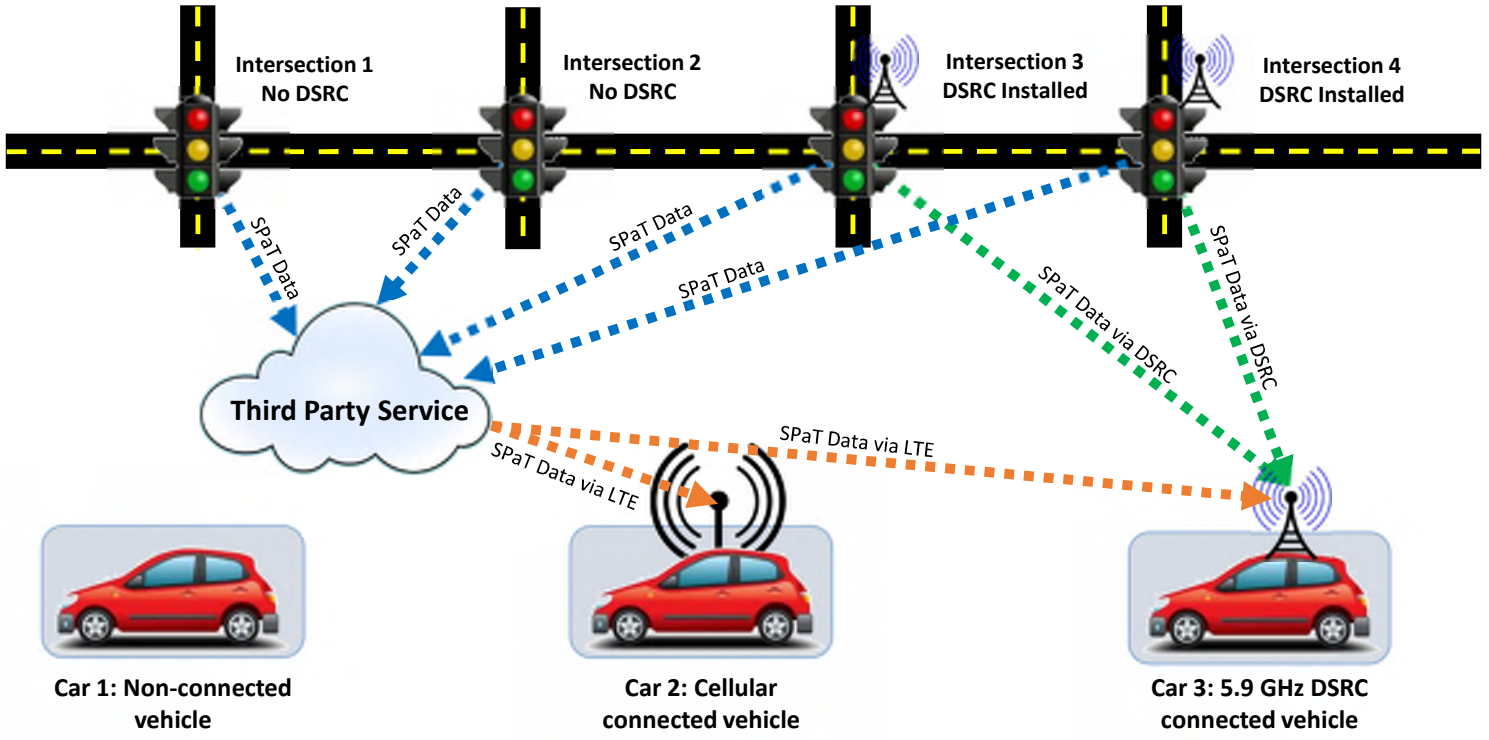
- Additional 350 of FY 2019 to be installed by June 2019
- Connectivity on every major arterial in metro Atlanta
- Open data stream to third parties also available

# Phase 2 Deployment

## Phase 2: RTOP – June 2020

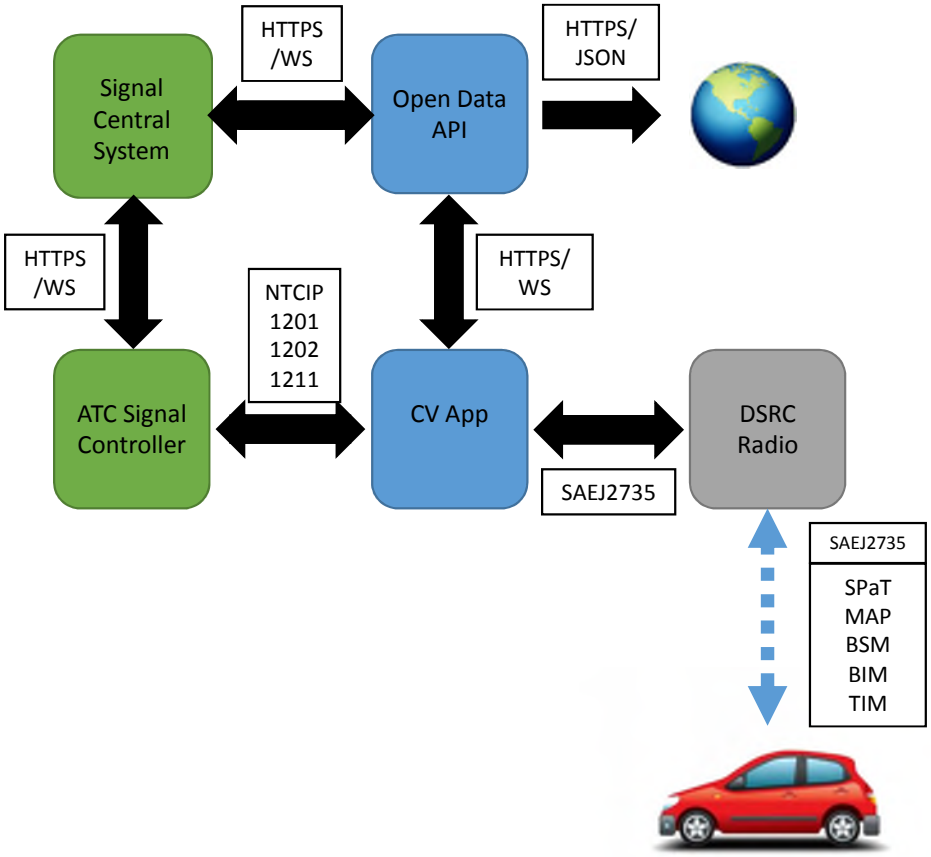
- 1,700 traffic signals in metro Atlanta
- 185 ramp meter locations
- Safety applications
- Signal applications
  - Red light warning
  - Pedestrian in signalized crosswalk
  - Phase termination/next signal phase
  - Green-band speed
- Road and traffic conditions information

# Multiple Broadcast Channels



# GDOT CV Architecture

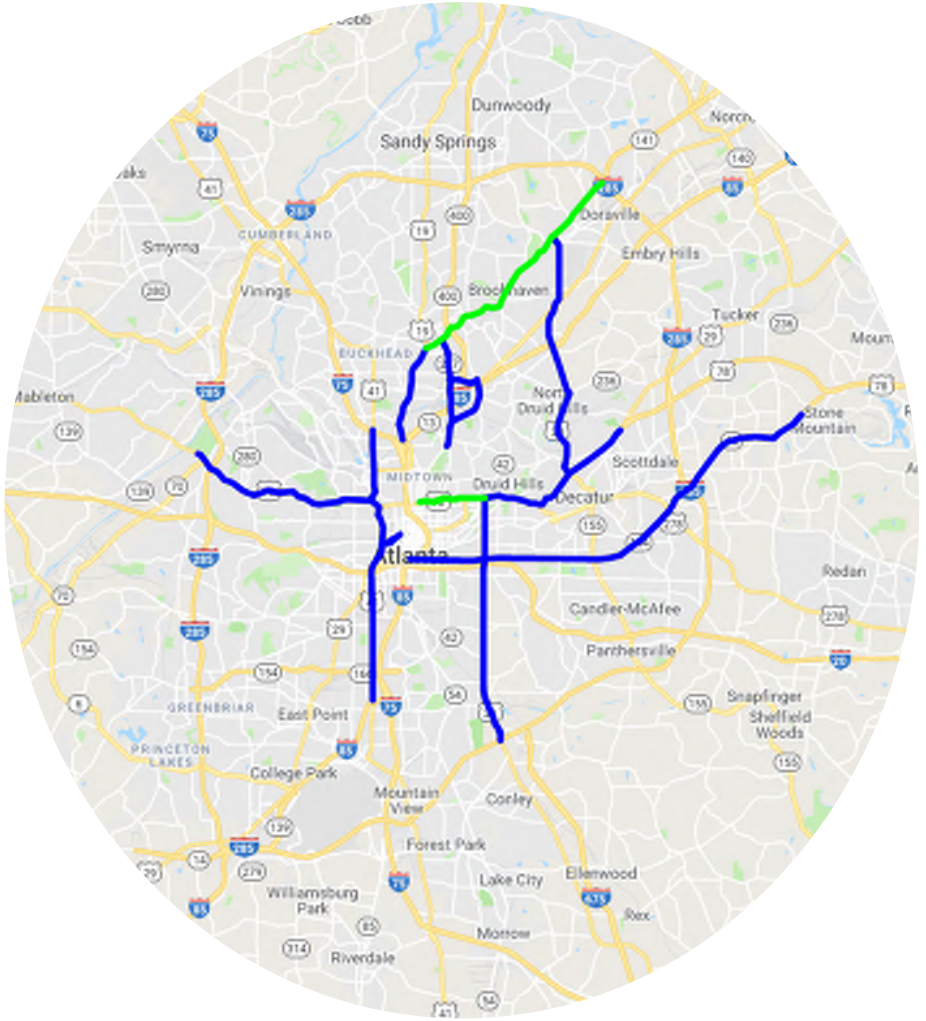
- CV Application resides on signal controller
- No additional hardware (outside of RSU) required
- Open access to third parties
- Controller can handle application
    - Signal priority



# Phase 2 Deployment

## Phase 2: RTOP – June 2020

- First 250 of FY 2019 to be installed by end of 2018
- Connectivity on every major arterial in metro Atlanta
- Open data stream to third parties also available



# Phase 2 Deployment

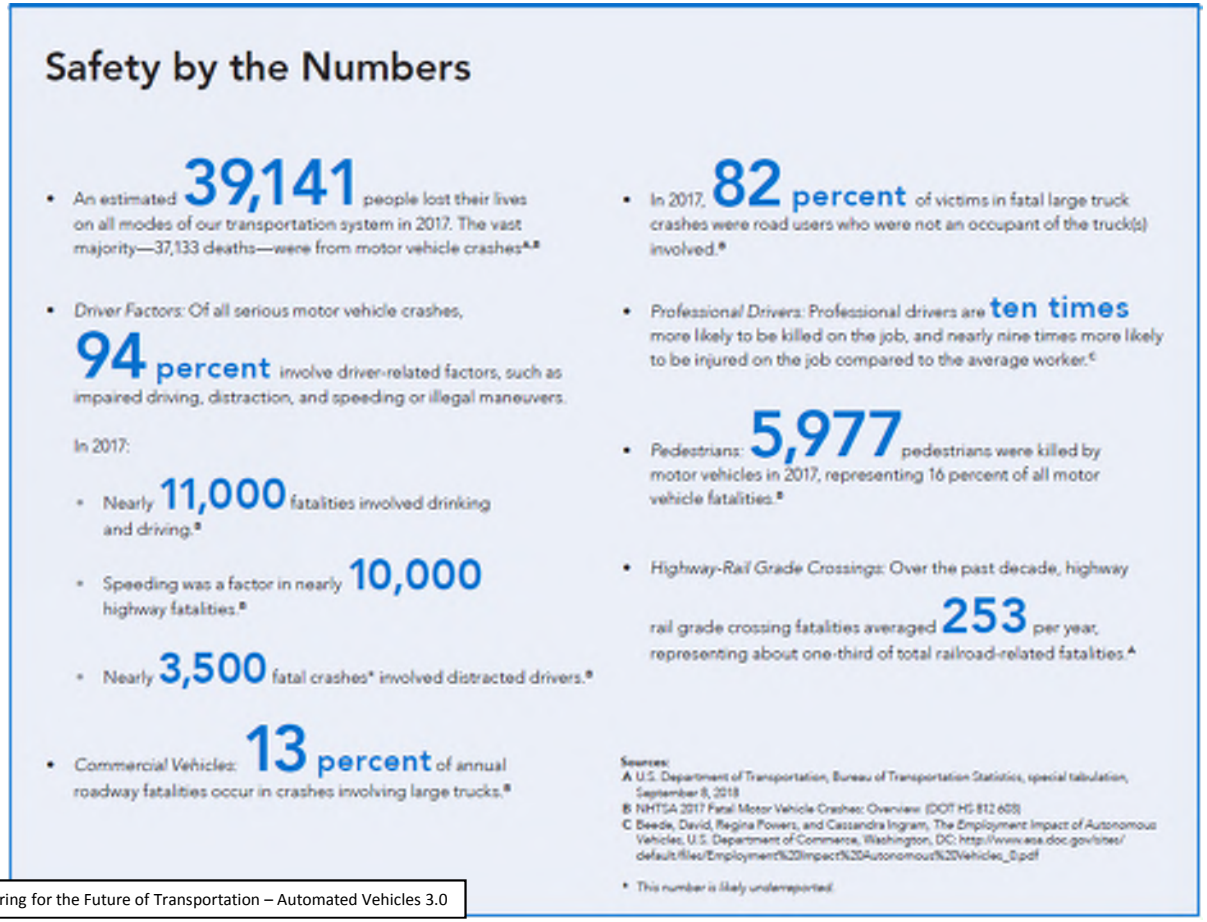
| Phase 2 Deployment Est. | FY 2019 (600) | FY 2020 (1100) |
|---|---|---|
| RSU Equipment | $780,000 | $1,430,000 |
| RSU Deployment | $510,000 | $935,000 |
| RSU Configuration & Support | $1,200,000 | $2,200,000 |
| TOTAL | $2,490,000 | $4,565,000 |

- 1,700 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: $7,055,000

**650 RSUs to be installed by Summer 2019**

# Why is this important to GDOT?



## Safety by the Numbers

- An estimated **39,141** people lost their lives on all modes of our transportation system in 2017. The vast majority—37,133 deaths—were from motor vehicle crashes[A,B]
- *Driver Factors:* Of all serious motor vehicle crashes, **94 percent** involve driver-related factors, such as impaired driving, distraction, and speeding or illegal maneuvers.

  In 2017:
  - Nearly **11,000** fatalities involved drinking and driving.[B]
  - Speeding was a factor in nearly **10,000** highway fatalities.[B]
  - Nearly **3,500** fatal crashes* involved distracted drivers.[B]
- *Commercial Vehicles:* **13 percent** of annual roadway fatalities occur in crashes involving large trucks.[B]
- In 2017, **82 percent** of victims in fatal large truck crashes were road users who were not an occupant of the truck(s) involved.[B]
- *Professional Drivers:* Professional drivers are **ten times** more likely to be killed on the job, and nearly nine times more likely to be injured on the job compared to the average worker.[C]
- *Pedestrians:* **5,977** pedestrians were killed by motor vehicles in 2017, representing 16 percent of all motor vehicle fatalities.[B]
- *Highway-Rail Grade Crossings:* Over the past decade, highway rail grade crossing fatalities averaged **253** per year, representing about one-third of total railroad-related fatalities.[A]

Sources:
A U.S. Department of Transportation, Bureau of Transportation Statistics, special tabulation, September 8, 2018
B NHTSA 2017 Fatal Motor Vehicle Crashes: Overview (DOT HS 812 603)
C Beede, David, Regina Powers, and Cassandra Ingram, *The Employment Impact of Autonomous Vehicles*, U.S. Department of Commerce, Washington, DC: http://www.esa.doc.gov/sites/default/files/Employment%20Impact%20Autonomous%20Vehicles_0.pdf

* This number is likely underreported.

Source: USDOT Preparing for the Future of Transportation – Automated Vehicles 3.0

**Alan Davis, PE, PTOE**
**Assistant State Traffic Engineer**
**404-635-2832**
**aladavis@dot.ga.gov**