

# 2023 FAV Summit: CAV in Florida



**Moderator: Rudy Powell, P.E.**

Director

State Traffic Engineering & Operations Office  
Florida Department of Transportation

Thursday, September 7

1:30 pm-3:00 pm

# Florida's CAV and Emerging Technology Initiatives



**Raj Ponnaluri, PhD, P.E., PTOE, PMP**  
Manager, Emerging Technologies  
Florida Department of Transportation



# Florida's CAV and Emerging Technology Initiatives

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ELECTRIC VEHICLE  
TECHNOLOGY  
RAIL MOBILITY  
EMERGENCY UAS FREIGHT DRONE  
COLLABORATION TECHNOLOGY CHARGING  
COMMUNICATION INNOVATION MANAGEMENT  
SAFETY NETWORK POWER MICROMOBILITY  
ECONOMY WIRELESS CONNECTION SHUTTLE  
AAM MULTIMODAL DEVELOPMENT  
CONNECTED VEHICLE

# CAV Business Plan/Focus Areas

- 1/ Policies and Governance**
- 2/ Program Funding**
- 3/ Education and Outreach**
- 4/ Industry Outreach and Partnerships**
- 5/ Technical Standards and Specifications Development**
- 6/ Implementation Readiness**
- 7/ Deployment and Implementation**



## Currently Operational CAV Projects

Roadway Segments

114  
Centerline Miles

Traffic Signals

159

Roadside Units

264

## Upcoming CAV Projects

Roadway Segments

2,142  
Centerline Miles

Traffic Signals

1,419

Roadside Units

1,206

# Projects/Initiatives

- ◆ Statewide Project/Initiative
- ◆ FDOT Led Projects
- ◆ Partner Agency Led Projects

## Design/Implementation

- 1 I-4 FRAME (2019 ATCMTD)
- 2 US 90 SPaT Tallahassee (Phase 2)
- 3 US 98 Smart Bay
- 4 SR-710/Beeline Hwy - CAV
- 5 US 41 FRAME
- 6 Florida's Turnpike Mainline and Beachline CV Deployment
- 7 Lake Mary Boulevard CV Project
- 8 I-10 Smart Road Ranger
- 9 ◆ V2X Data Platform
- 10 US 1 Keys COAST
- 11 Railroad Advanced Notification System
- 12 I-4 Active Work Zone
- 13 LeeTran Traffic Signal Priority
- 14 Collier Countywide Connected Traveler Information System (CTIS)
- 15 Train Vehicle Crash Avoidance Pilot Project
- 16 Wildlife Protection
- 17 AWZM - District 2
- 18 AWZM - District 3
- 19 AWZM - District 6
- 20 CV Smart Signal - Lake County
- 21 SR 436 PedSafe Project - City of Altamonte Springs
- 22 SR-40 ITS Safety Deployment
- 23 Pasco County SMART US-19
- 24 Hillsborough County Connected Vehicle Priority and Preemption System
- 25 AWZM - District 7
- 26 Pedestrian Warning System - I2V Deployment along Alt 19 (City of Clearwater)
- 27 Smart Signal Corridor (West St. Petersburg)
- 28 ◆ RSU Health Monitoring
- 29 Cybersecurity
- 30 First Responder
- 31 U.S. 17-92 Connected Vehicle Deployment
- 32 Ped/Safe II U.S. 441/State Road 50

## Operational

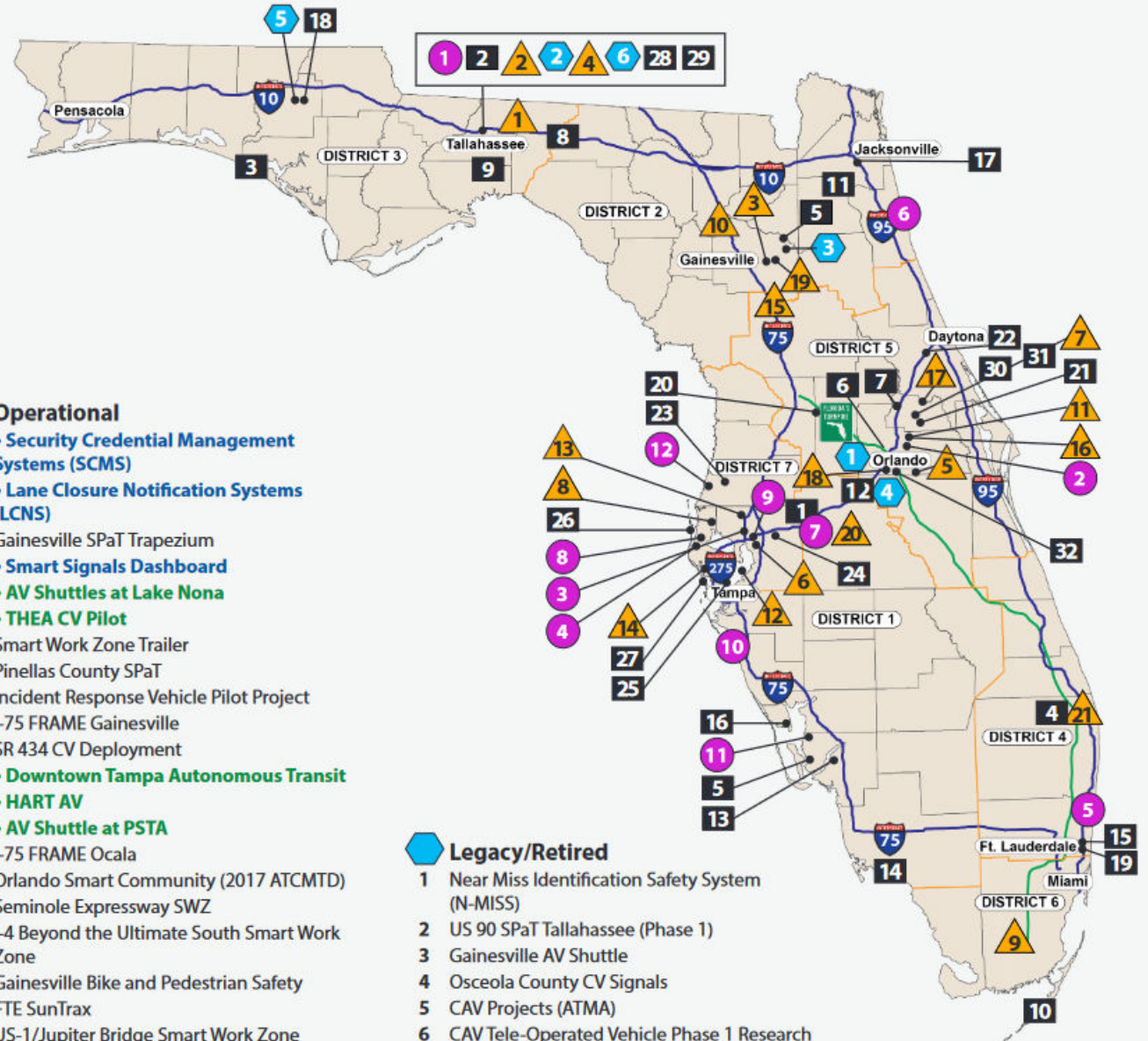
- 1 ◆ Security Credential Management Systems (SCMS)
- 2 ◆ Lane Closure Notification Systems (LCNS)
- 3 Gainesville SPaT Trapezium
- 4 ◆ Smart Signals Dashboard
- 5 ◆ AV Shuttles at Lake Nona
- 6 ◆ THEA CV Pilot
- 7 Smart Work Zone Trailer
- 8 Pinellas County SPaT
- 9 Incident Response Vehicle Pilot Project
- 10 I-75 FRAME Gainesville
- 11 SR 434 CV Deployment
- 12 ◆ Downtown Tampa Autonomous Transit
- 13 ◆ HART AV
- 14 ◆ AV Shuttle at PSTA
- 15 I-75 FRAME Ocala
- 16 Orlando Smart Community (2017 ATCMTD)
- 17 Seminole Expressway SWZ
- 18 I-4 Beyond the Ultimate South Smart Work Zone
- 19 Gainesville Bike and Pedestrian Safety
- 20 FTE SunTrax
- 21 US-1/Jupiter Bridge Smart Work Zone

## Legacy/Retired

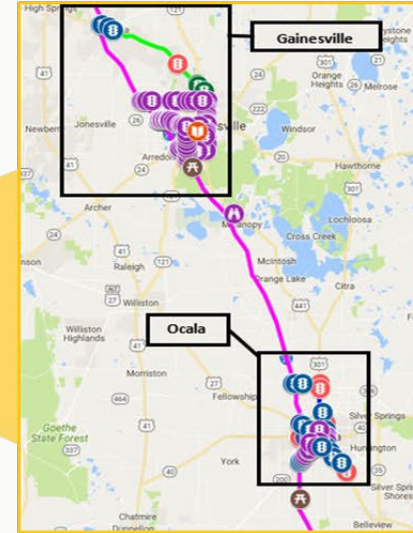
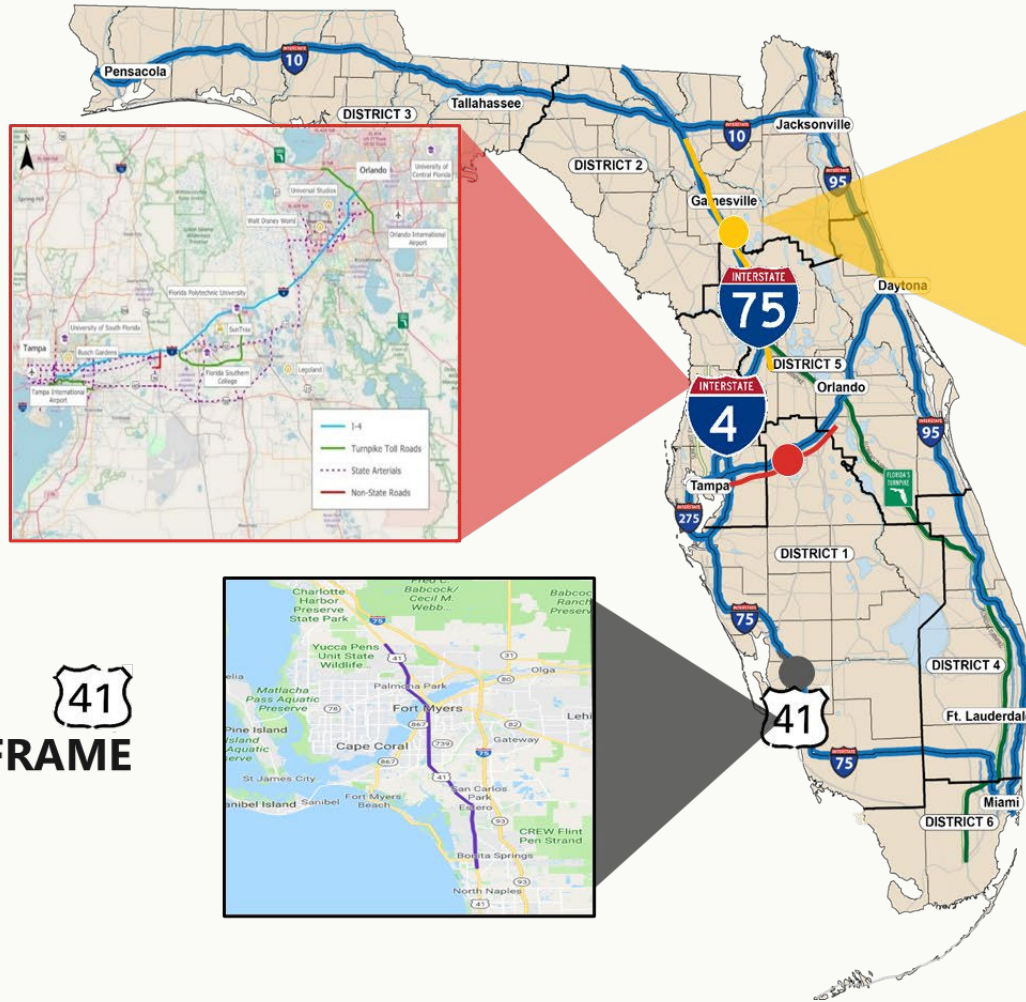
- 1 Near Miss Identification Safety System (N-MISS)
- 2 US 90 SPaT Tallahassee (Phase 1)
- 3 Gainesville AV Shuttle
- 4 Osceola County CV Signals
- 5 CAV Projects (ATMA)
- 6 CAV Tele-Operated Vehicle Phase 1 Research

## Planning

- 1 CV Bike Safety Pilot Deployments
- 2 State Road 423 Freight Signal Priority
- 3 Downtown Interchange Smart Work Zone
- 4 ◆ Pinellas County Smart Community (2020 ATCMTD)
- 5 SR-869/SW 10th Street Connector TSM&O SWZ
- 6 Smart St. Augustine
- 7 Intersection Collision Avoidance Safety Program
- 8 SR 60 West Coast Smart Signal Corridor Project
- 9 Connected Vehicle Priority and Preemption System (CVPP)
- 10 Bee Ridge Corridor Smart Signals
- 11 City of Sarasota CAV Project
- 12 SMART US 19



# Florida's Regional Advanced Mobility Elements

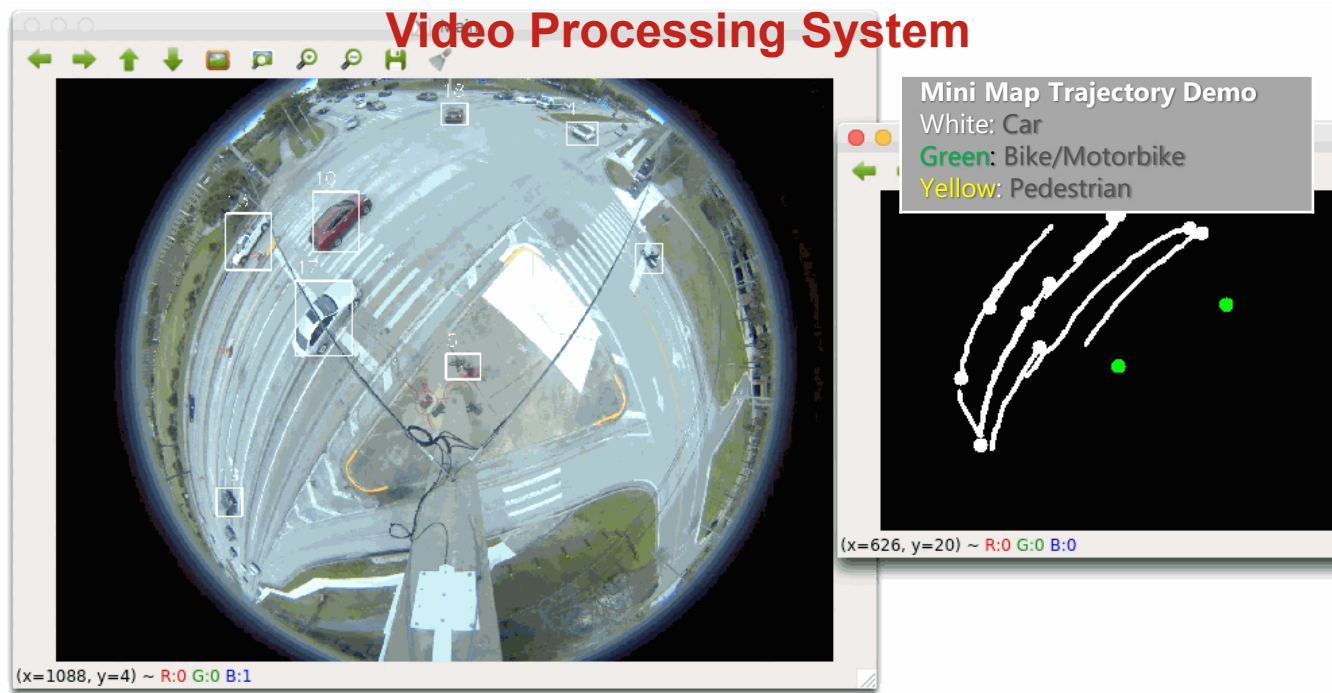
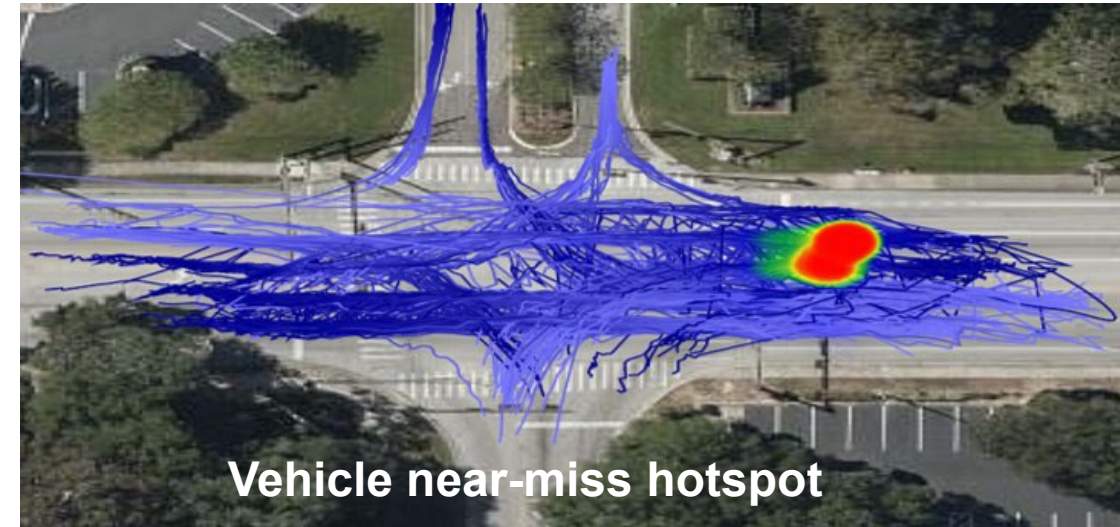


## CAV Applications in FRAME Projects

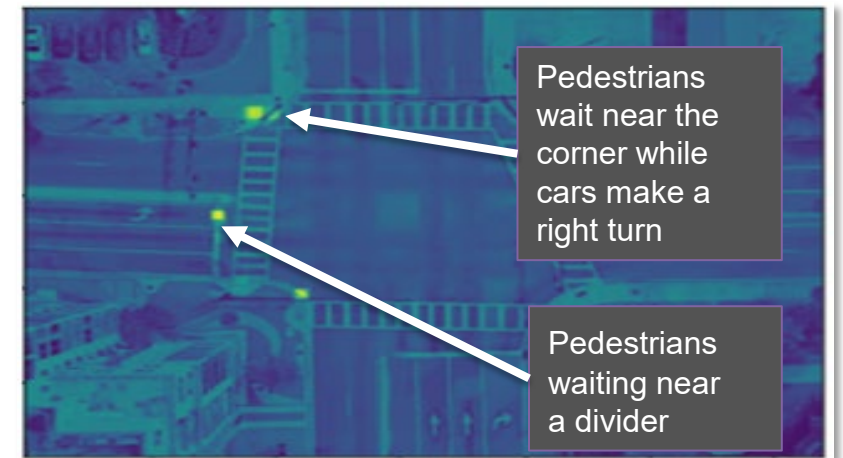
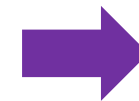
- Emergency Vehicle Preemption
- Transit Signal Priority
- Freight Signal Priority
- Signal Phase and Timing
- Traffic Incident Management
- Work Zone Traffic Management
- Freeway Back-of-Queue Warning
- Wrong-Way Driving

# Near Miss Detection

A distance and temporal motion-based method is applied to detect near-miss events



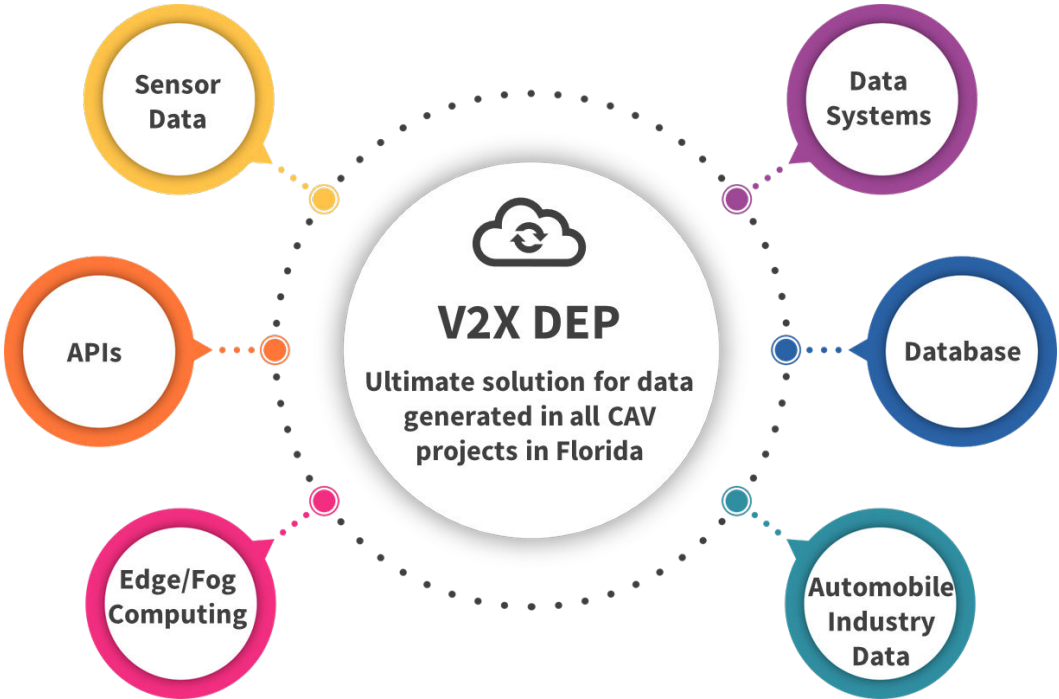
Result



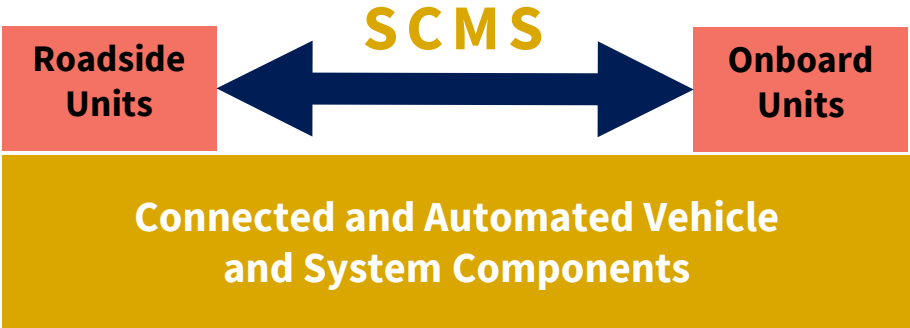


# Data Management

## Vehicle to Everything Data Exchange Platform



## Security Credential Management System



Images Source: Google

# Incorporating CAV into Complete Streets Strategy

First and last mile connectivity

Reduced congestion in urban areas

Zero direct carbon emission

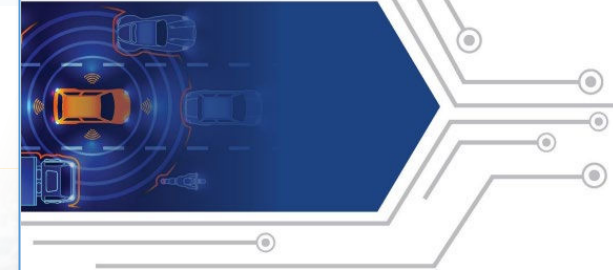
**Infrastructure  
- based**

**Vehicle  
- based**

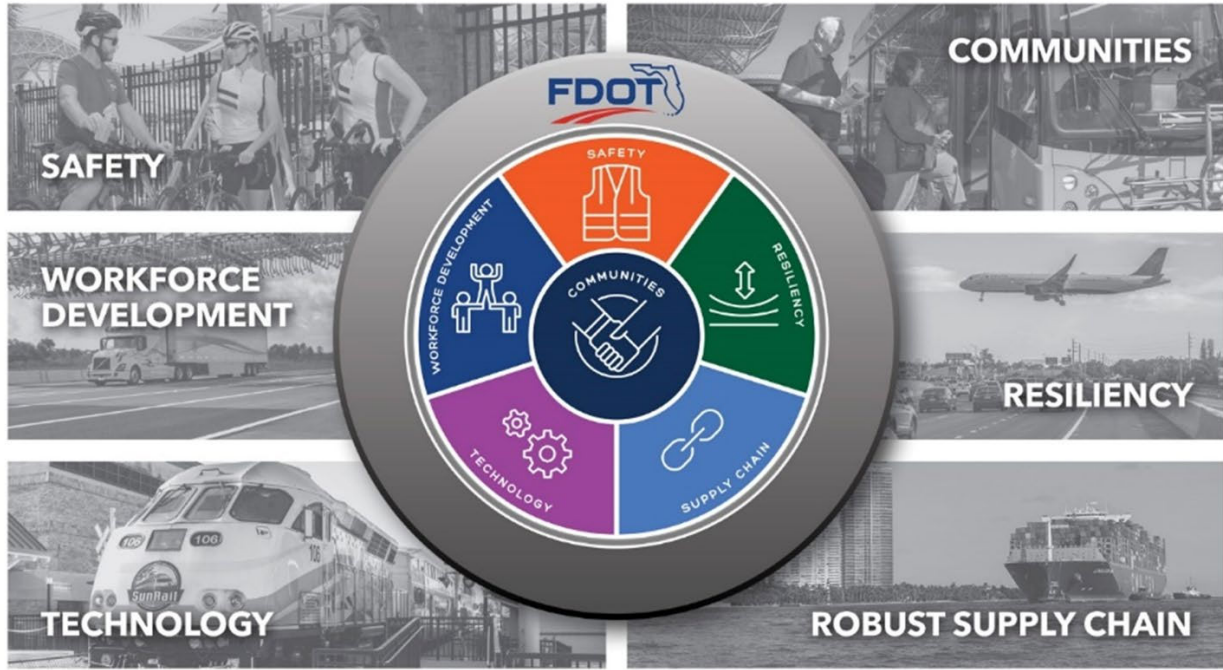
**Bike/ped/  
micromobility  
- based**

Considerations and  
Applications for Integrating  
CAV into Complete Streets

Technical Memo



September 09, 2021



# Multimodal Focus



Pedestrian



Drones



Air



Bicycle



AV/CV



Transit



Rideables



EV Charging



Shuttle



Motorbikes



Rail



Freight

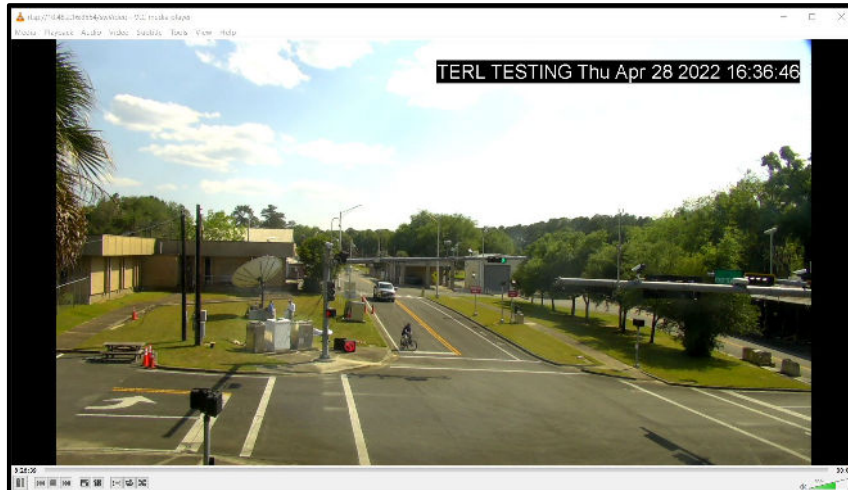
# Bicycle Detection Testing



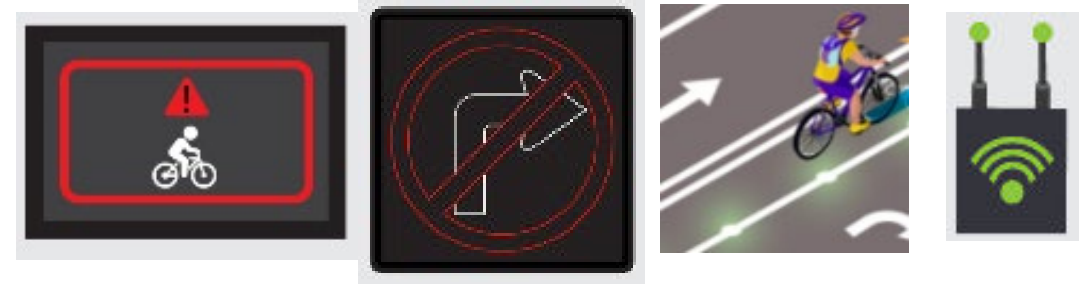
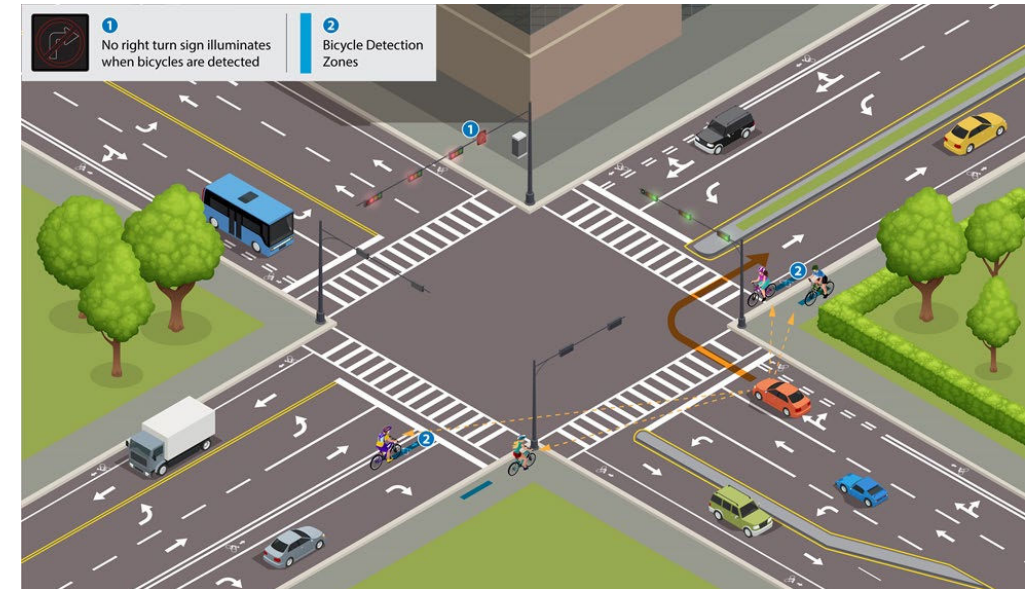
Testing setup



Thermal Detector

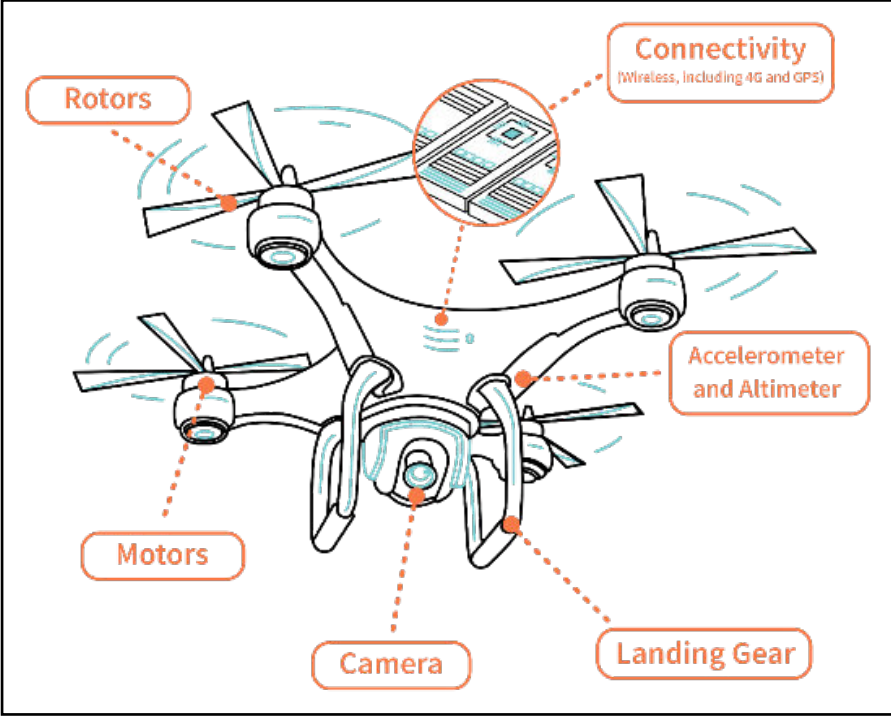


Demonstration from traffic monitoring camera

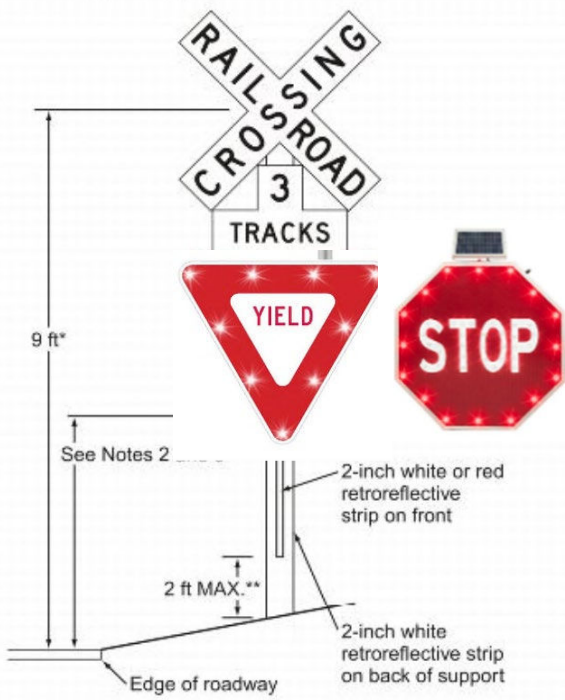
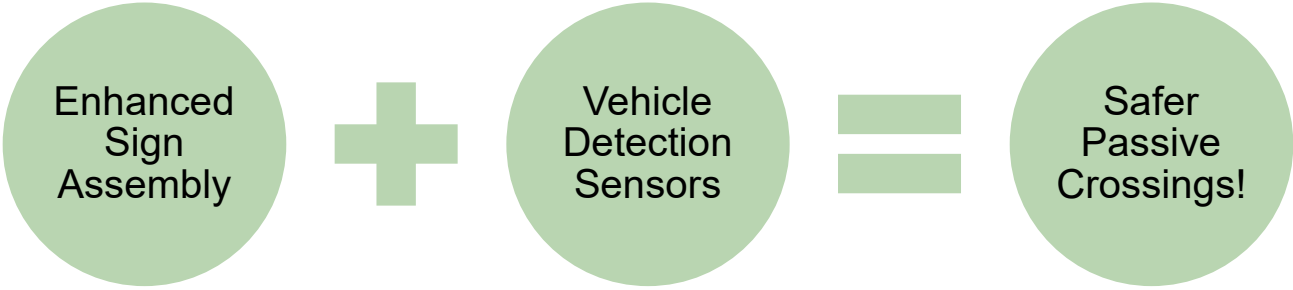


# Unmanned Aircraft Systems (UAS)

The screenshot shows a software interface for an event replay. On the left, a map displays the location of Ochlockonee Bay with a red line indicating the drone's flight path over a bridge. On the right, a video player shows a first-person view from the drone, looking down at the bridge structure over the water. The interface includes various controls and a timeline at the bottom.



# Rail Safety Technology

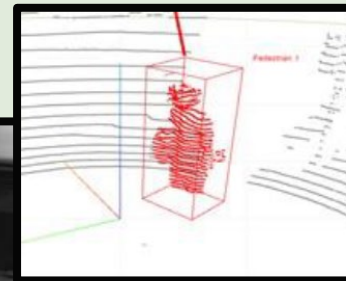
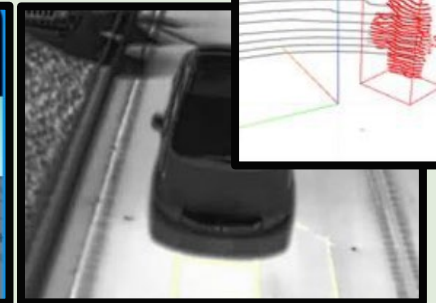
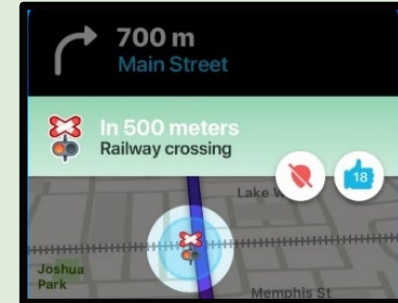


## Current FDOT Technologies

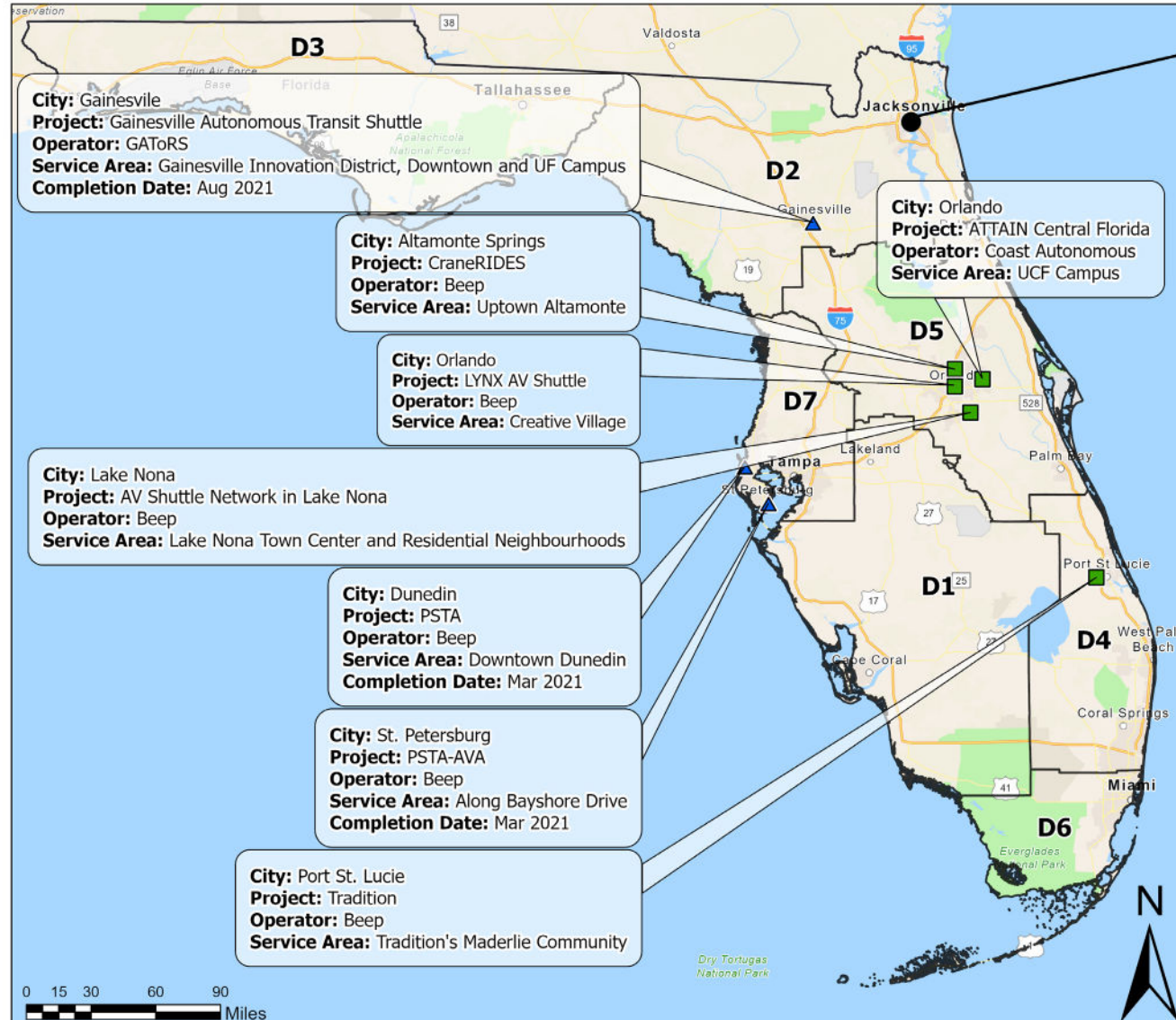
- Traffic Signal Preemption
- Dynamic Message Signs
- Incident Management Systems
- Surveillance Systems

## Additional Technology Considerations

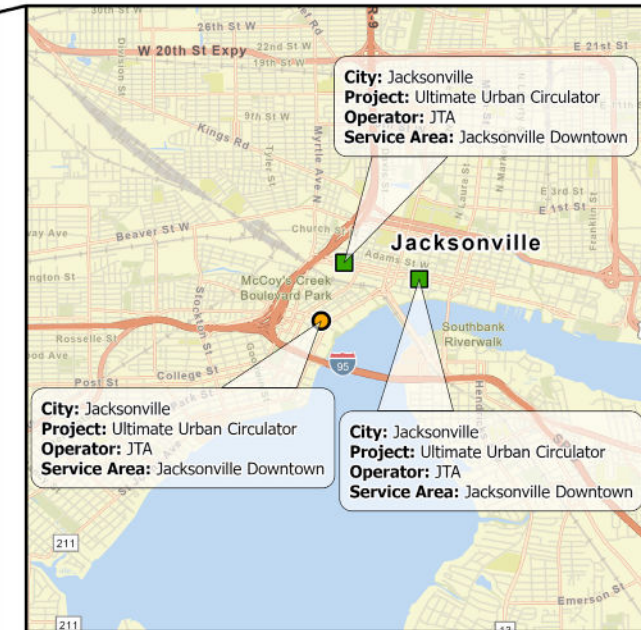
- Connected Vehicle Applications
- Predictive Blockage
- Detection Activated LED R8-8
- Thermal, Radar, or camera artificial intelligence



# AV Shuttle Projects – as of August 2023



## Jacksonville Area Projects





# I-STREET

## What?

Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies

## Aim

- Engage potential vendors
- Understands vendor's products availability

## Approaches

Showcase their expertise and functional areas related to safety and mobility applications



# Research Focus Areas



Bicycle / Pedestrian Safety

Machine Learning

Micromobility



Automated Vehicles

CV Infrastructure  
Deployment



# Lessons Learned



**Time, effort, and resources**



**Costs and benefits**



**Manage expectations**



**Drive innovation**



Thank you!

# Florida's CAV and Emerging Technology Initiatives



**Jeremy Dilmore, P.E.**  
TSM&O Engineer  
Florida Department of Transportation, District 5

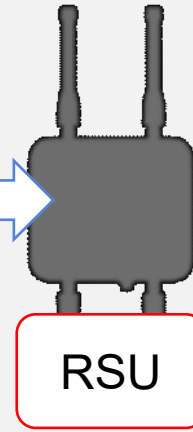
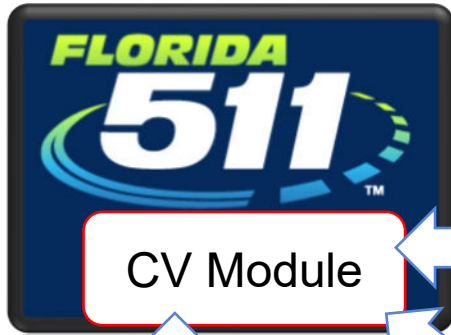


## V2X DEP / FL511 / CV SAAS

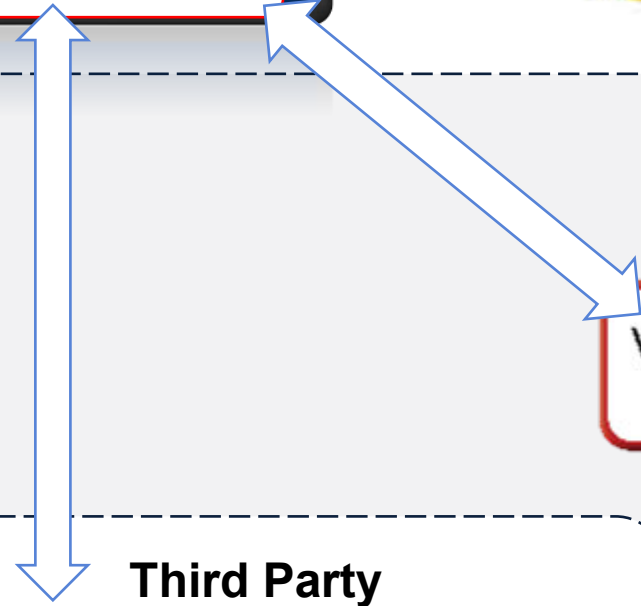
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- Connected Vehicle Messages through FL511
  - Low Hanging Fruit to start leveraging CV technology benefits while OEMs work to increase penetration of equipped vehicles.
  - Allows safety related TIM messages to be provided to the public now using the FL511 Mobile Application in unequipped vehicles.

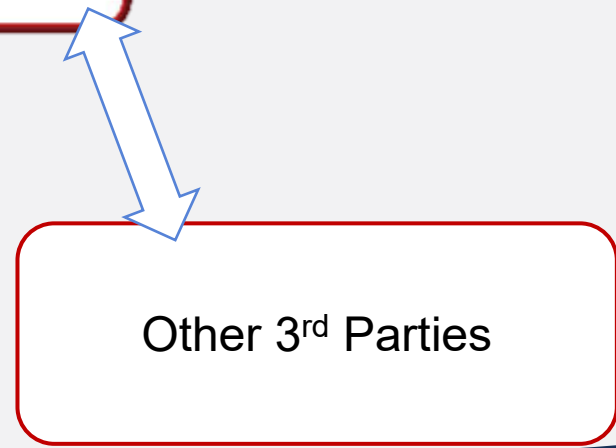
# EXISTING APPLICATIONS



Third Party



Other 3<sup>rd</sup> Parties



# FL511 CV APPLICATIONS

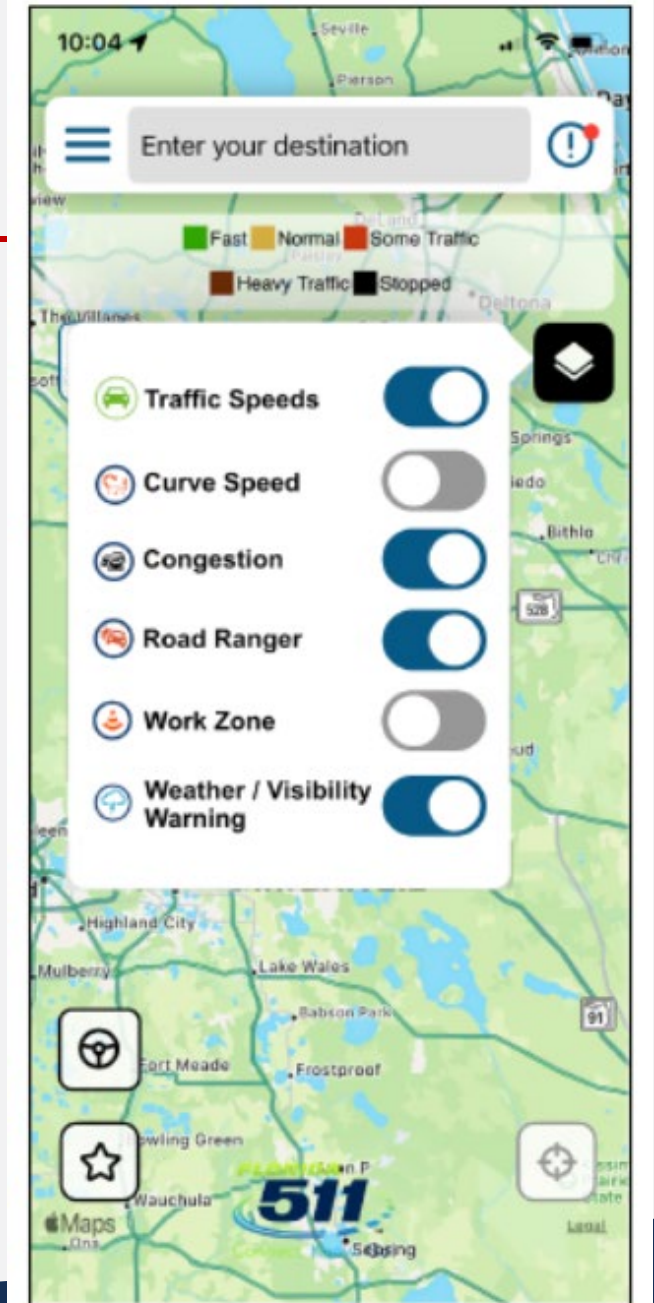
## Safety Related TIMs

- Curve Speed Warning
- Congestion
- Road Ranger
- Work Zone
- Weather / Visibility Warnings

For consistency, identify variables and thresholds for each application

Should ensure same logic is applied to create the alert

Opportunity for further research





# USER FILTERED AUDIO ALERTS

Need to ensure user acceptance/understanding

- Focus groups and further customer outreach needed

	"Curve speed warning. Please reduce speed."
	"There is congestion ahead. Please reduce speed."
	"There is a road ranger ahead. Please use caution."
	"There is a work zone ahead. Please use caution."
	"There are poor weather conditions. Please use caution."

10:28

### Auto Alert Filter

- Curve Speed Warning
- Congestion Ahead
- Road Ranger Ahead
- Work Zone
- Weather / Visibility Warning

Save



## Other key items to note

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- This will be a feature users can opt into. Including an alert filter to allow them to customize what they want to receive.
- Location data from users is anonymized.
- Notification messages will be provided by audio to reduce distracted driving.
- This will be available in Android and iOS

# Florida's CAV and Emerging Technology Initiatives



**Eric Gordin, P.E.**

Assistant Traffic Operations Engineer,  
Florida Department of Transportation, FTE

# FTE Connected Vehicle Projects

Eric A. Gordin, P.E.

FTE Assistant District Traffic Operations Engineer



# Agenda



**CV Mobility/Safety Testing**



**Central Florida CV Pilot**



**Expanding Users**



**Integration & Next Steps**



**Questions**

# Connected Vehicle Mobility/Safety Testing

- US DOT:
  - Cooperative Driving Automation/CARMA program test cases
- FDOT/Turnpike testing:
  - C-V2X & TMC use cases
  - Safety Applications
    - Wrong Way Detection
    - Curve Speed Alert
    - Stopped/Queue Warning
    - Others



# Connected Vehicle Safety Pilot

- 50 Roadside Units
  - First installations for FTE
- 20 Miles of FTE freeway and ramps
  - 4 system to system interchanges
  - Service plaza, Convention center
- TPK Mainline – Mile Posts 255-267
- Beachline West – Mile Posts 0-8
- CV Project Scope
  - Data Interface Management
  - SCMS & RSU Health Monitoring
  - V2X DEP Integration
  - MAP Development
  - TIM Message Alerting



# Connected Vehicle Safety Pilot

- Central Florida CV Deployment
- Cost: \$3.7 million
- Anticipated completion date: *October 2023*
- Infrastructure-to-vehicle (I2V), detection advisory and V2X
- Applications Include:
  - Wrong Way Vehicle Detection
  - Curve Speed Warning
  - Queue Warning



SR 528 & International Dr.



Eastbound SR 528 mp 1.7

## Time

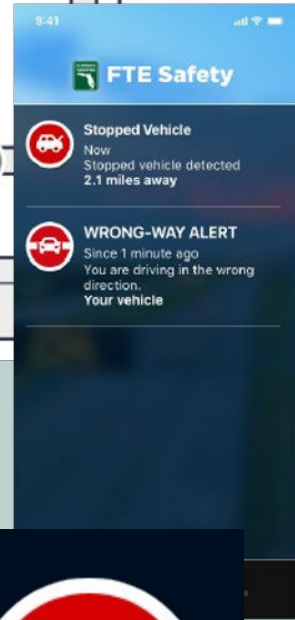
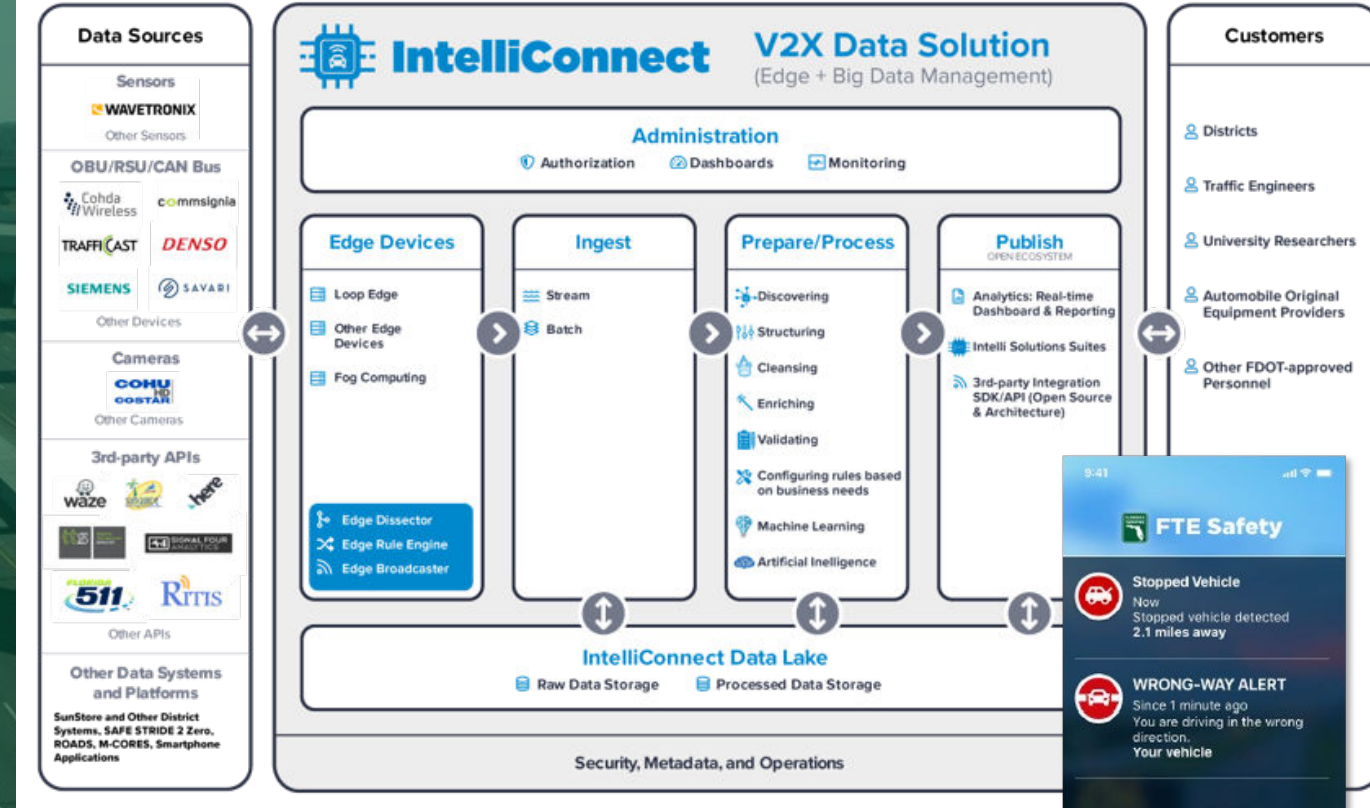
495 days, as of March estimate  
Allowable Time: 522 Days





# Connected Vehicle Expanding Users

- Smartphone as a Sensor
  - Cellular Delivery Model
- Surrogate for OBU Data
  - Speed Detection
  - Disabled Vehicle Detection
  - Wrong Way Vehicle Detection
  - Queue and Curve Speed Warnings
  - Loss of Control Detection
  - Lane Departure Detection



# Integrated Efforts

FTE is developing and delivering multiple innovative solutions in the CV marketplace.

Structured to provide value today and for many years to come, through:

- CV2X
- Data Integration
- Smartphone-based applications

## C-V2X

- Original Test Use Cases made at SunTrax
- Multiple RSU Vendors
- 3 Highly Accurate CV Applications

## Smartphones

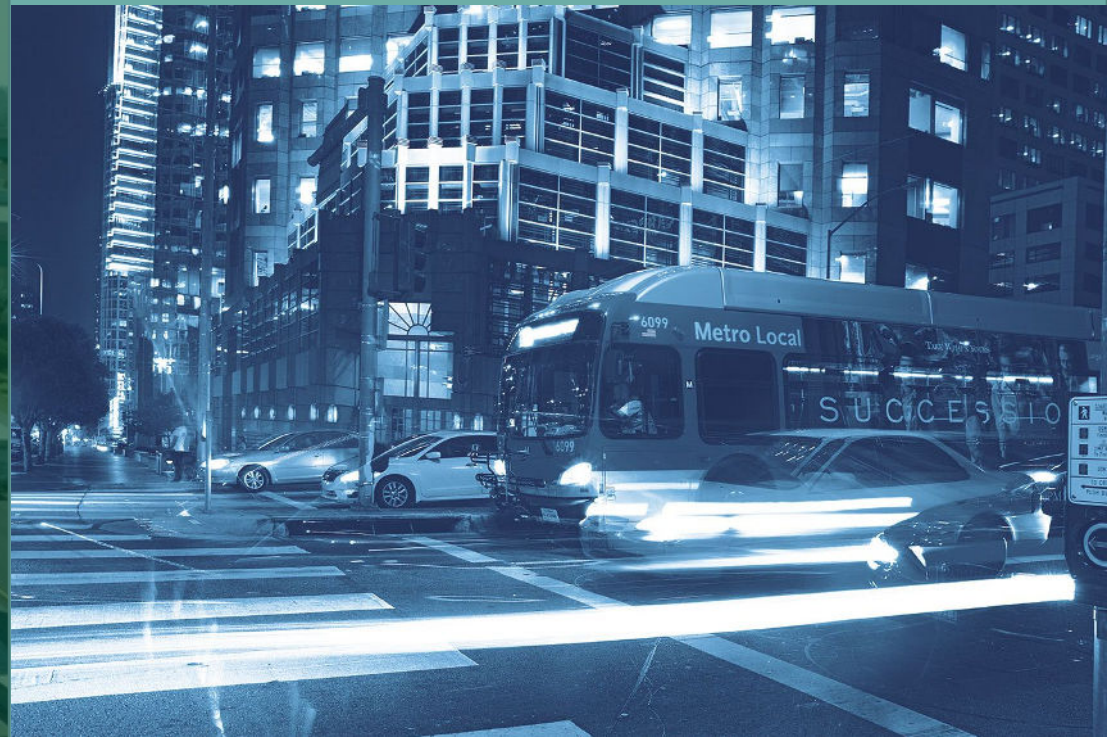
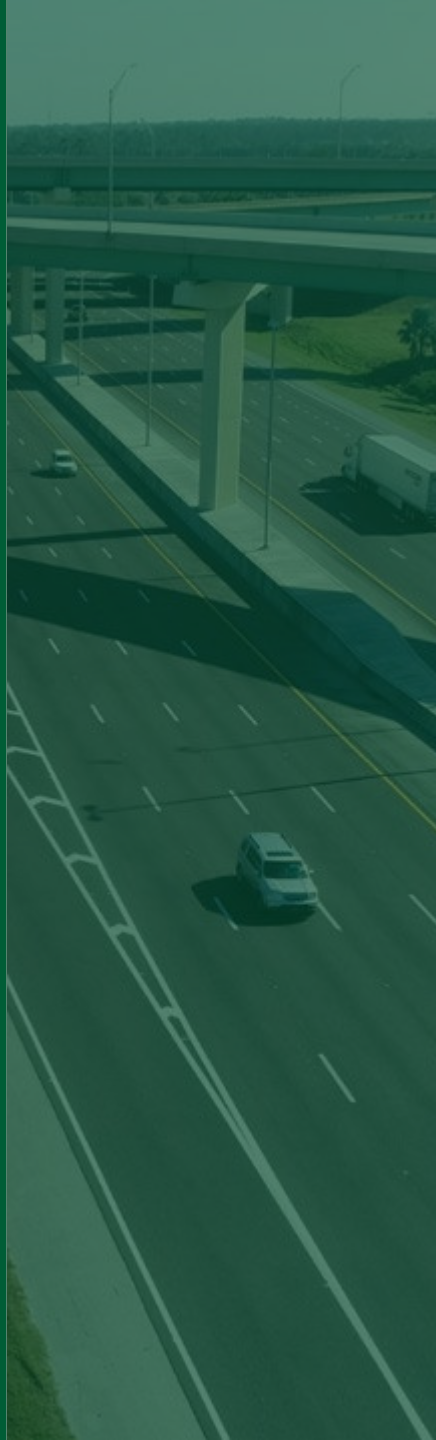
- Ubiquitous Availability
- Future-Proof Solution
- Scalable
- Reduced Infrastructure Needs

## V2X Data Exchange Platform (DEP)

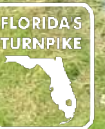
- Statewide CV Integration
- Regional Dashboarding
- Generate data insights & next generation applications

# Next Steps

- Complete Roadway Installation
  - 20 Miles of RSU Deployment in Central Florida (Orlando)
- Measure Changes in Motorist Behavior & Safety
- Additional Testing of Use Cases & Evaluation
  - Loss of Control, Lane Departure, Queue Detection
- Review and Collaboration on Expanding Users via Smartphone application(s)



Thank you!



# Florida's CAV and Emerging Technology Initiatives



**Sanjay Ranka, PhD**  
Distinguished Professor  
University of Florida

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# CAV INTERACTIONS WITH TRAFFIC INFRASTRUCTURE

Sanjay Ranka  
Distinguished Professor  
Department of Computer and Information Science and Engineering  
www.sanjayranka.com  
[sranka@ufl.edu](mailto:sranka@ufl.edu)  
352 514 4213

Work supported by FDOT (Raj Ponnaluri)

Collaborators: Lily Elefteriadou, Tania Mishra, Rahul Sengupta, Pruthvi Manjunatha, Emmanuel Posadas

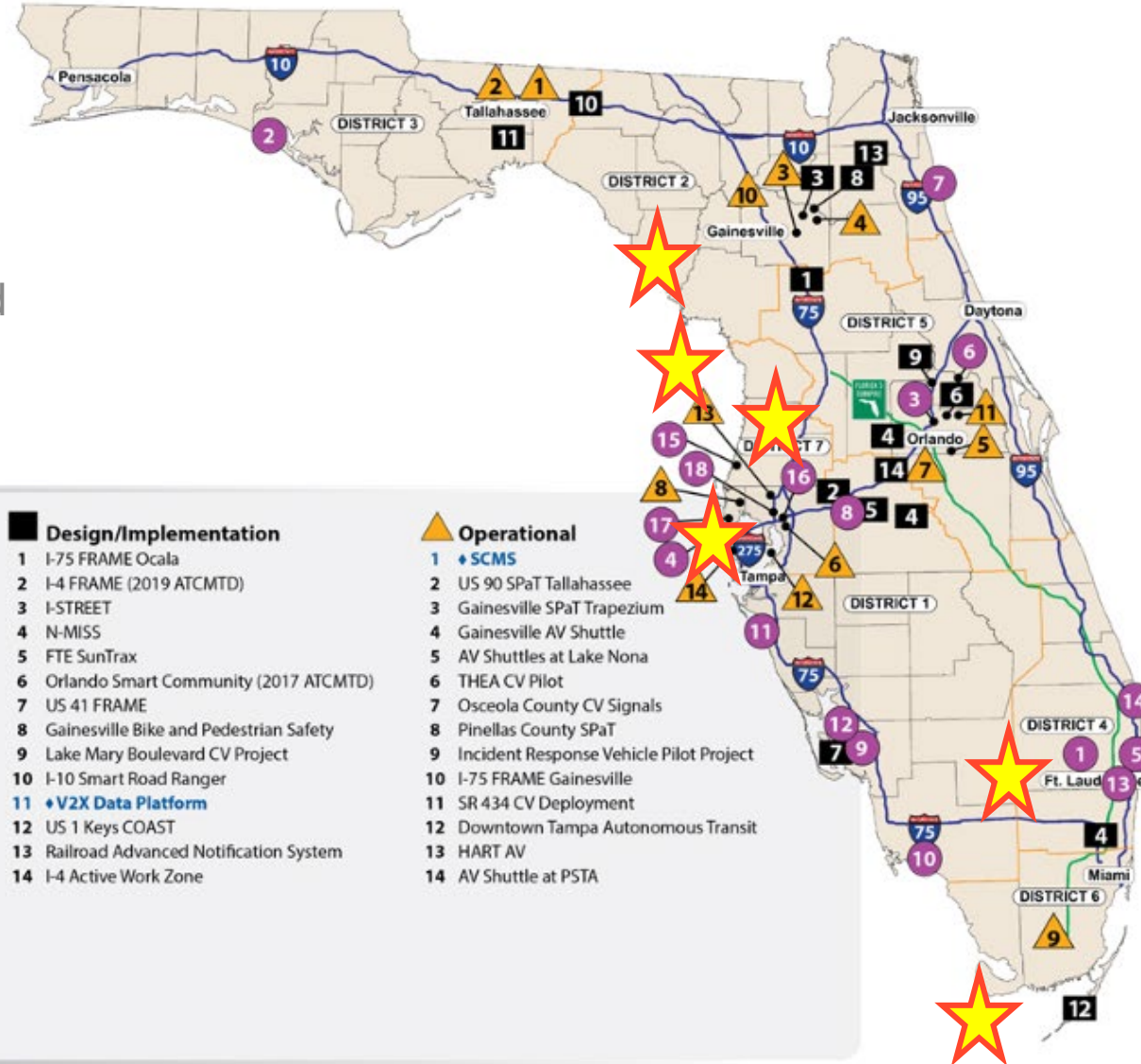


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# I-STREET and CAV

## Implementing Solutions from Transportation Research and Evaluating Emerging Technologies

- Collaboration of UF, FDOT, City of Gainesville
- Unique real-world living lab
- Significant improvements to transportation safety and mobility
- Uses advanced technologies installed and embedded in the transportation infrastructure in Gainesville and across Florida.



### Projects/Initiatives

◆ Statewide Project/Initiative

#### ● Planning

- 1 SR-710/Beeline Hwy - CAV Freight
- 2 US 98 Smart Bay
- 3 Central Florida AV Proving Ground
- 4 Pinellas County Smart Community (2020 ATCMTD)
- 5 SR-869/SW 10th Street Connector TSM&O SWZ
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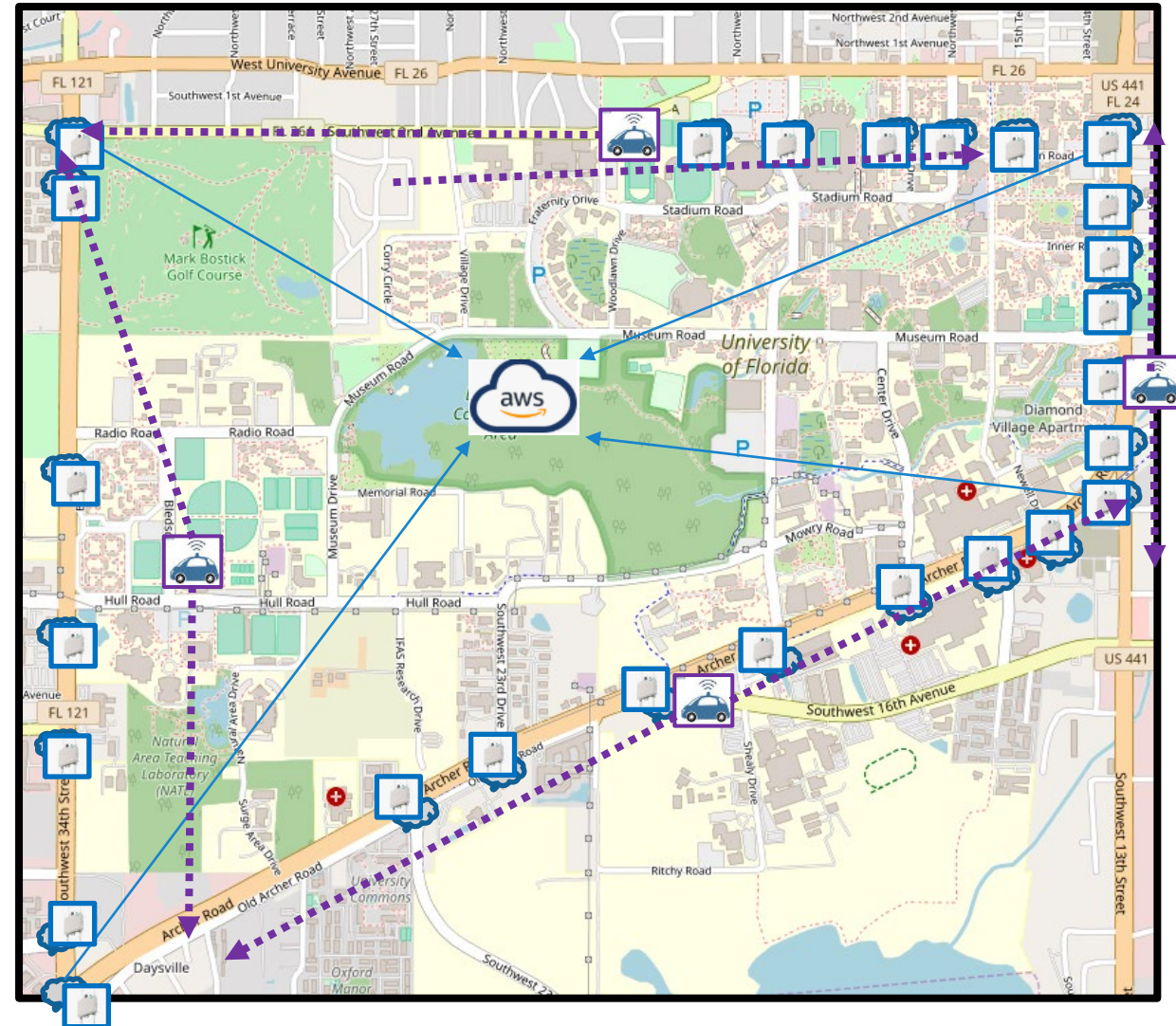
# I-Street in Gainesville (Trapezium)

## New Assets

- Upgraded Linux based 'ATC' Controllers for ATSPM Data
- Siemens DSRC Radios with MAP and SPaT Broadcast
- Emergency Vehicle Pre-emption and vehicle OBUs (WIP)
- 27 RSU, 60 OBUs

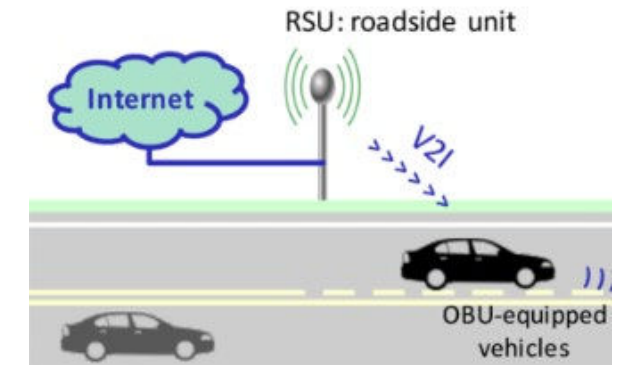
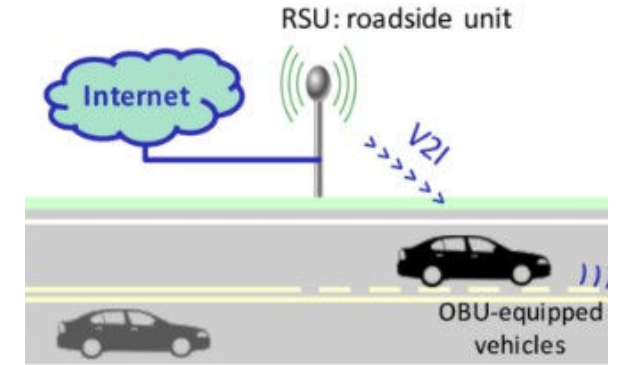
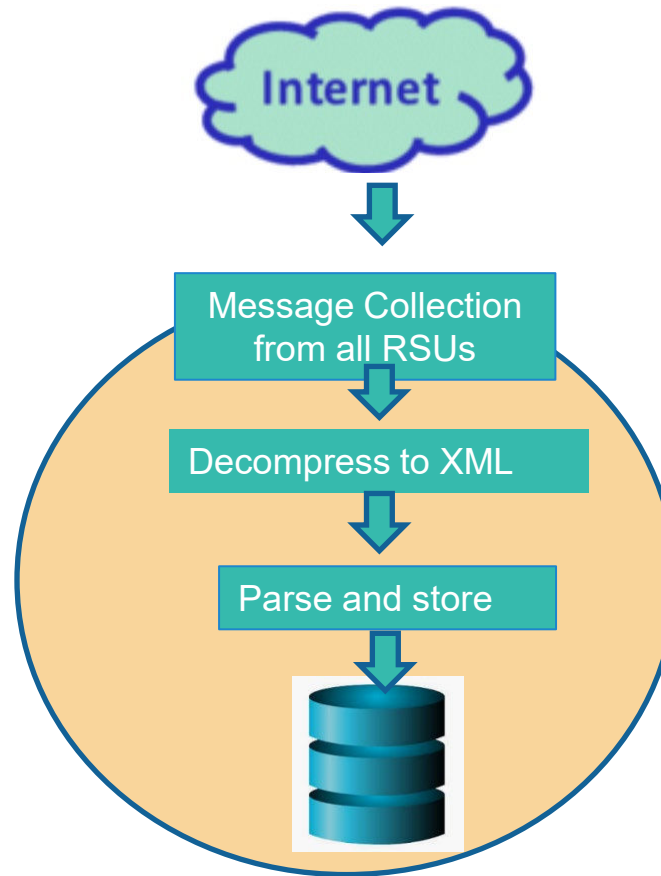
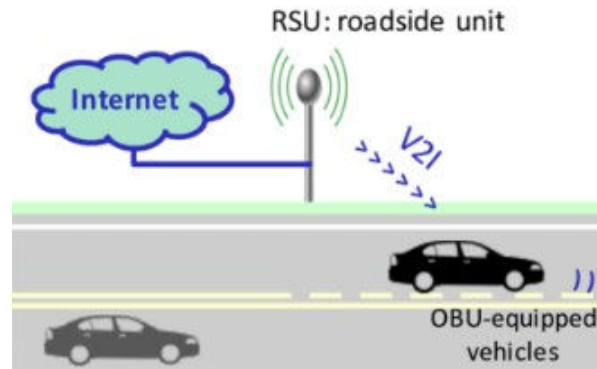
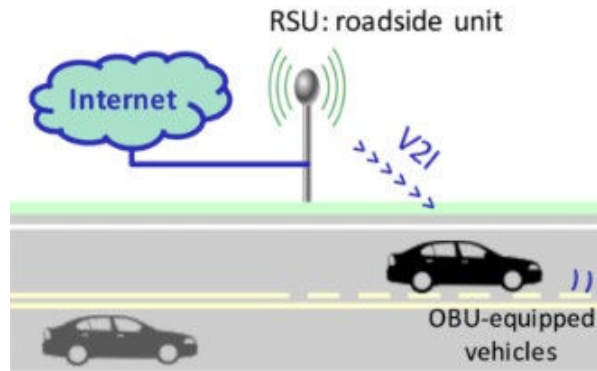
## Previous Assets

- Connectivity: Fiber Optic Gigabit at each signalized intersection w/ 12 port Ethernet
- Basic Video Monitoring: Bosch PTZ CCTV at each Signal
- Controllers: Linux Based ATCs
- Travel Time: Segment Bluetooth sensors

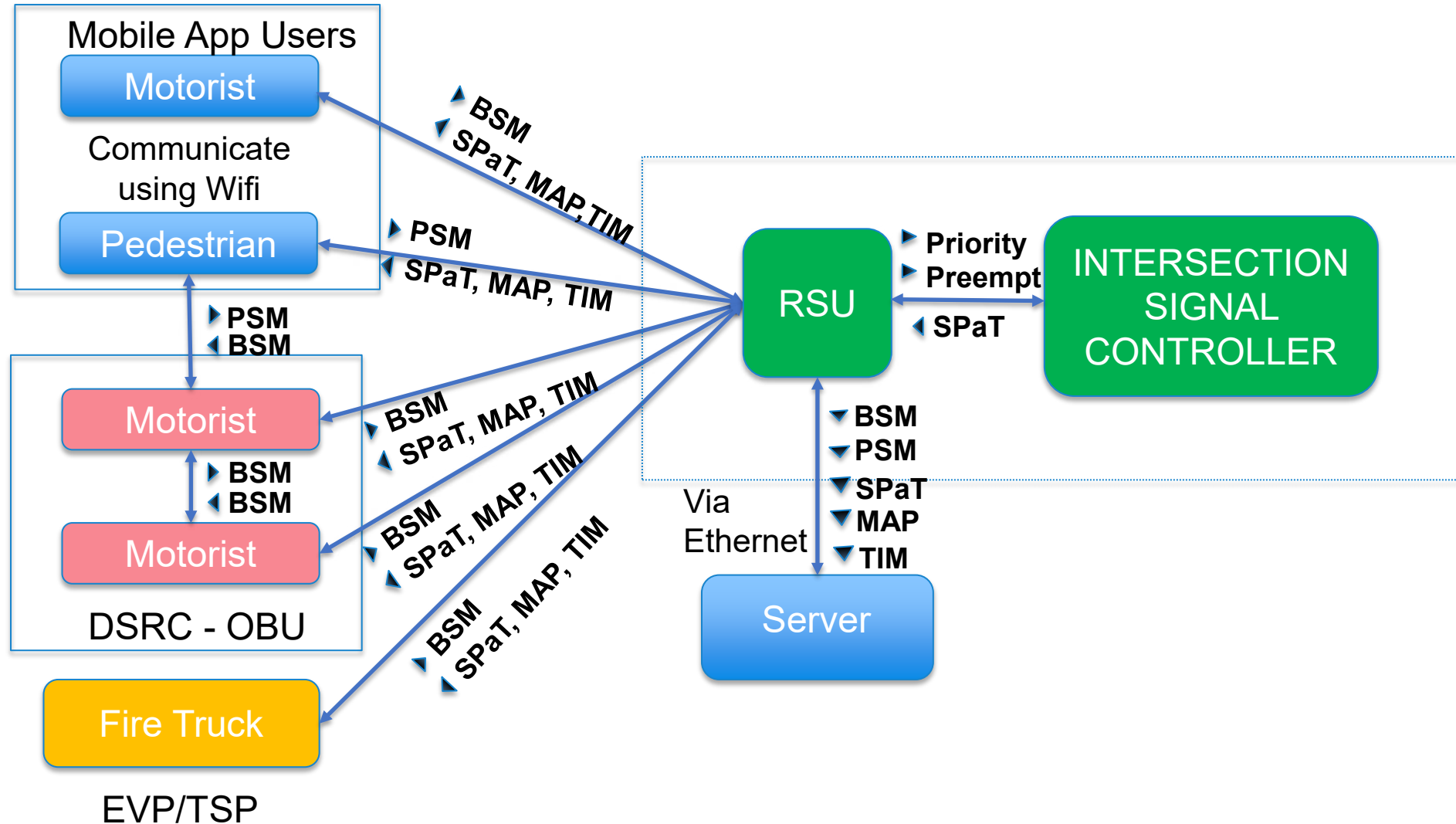




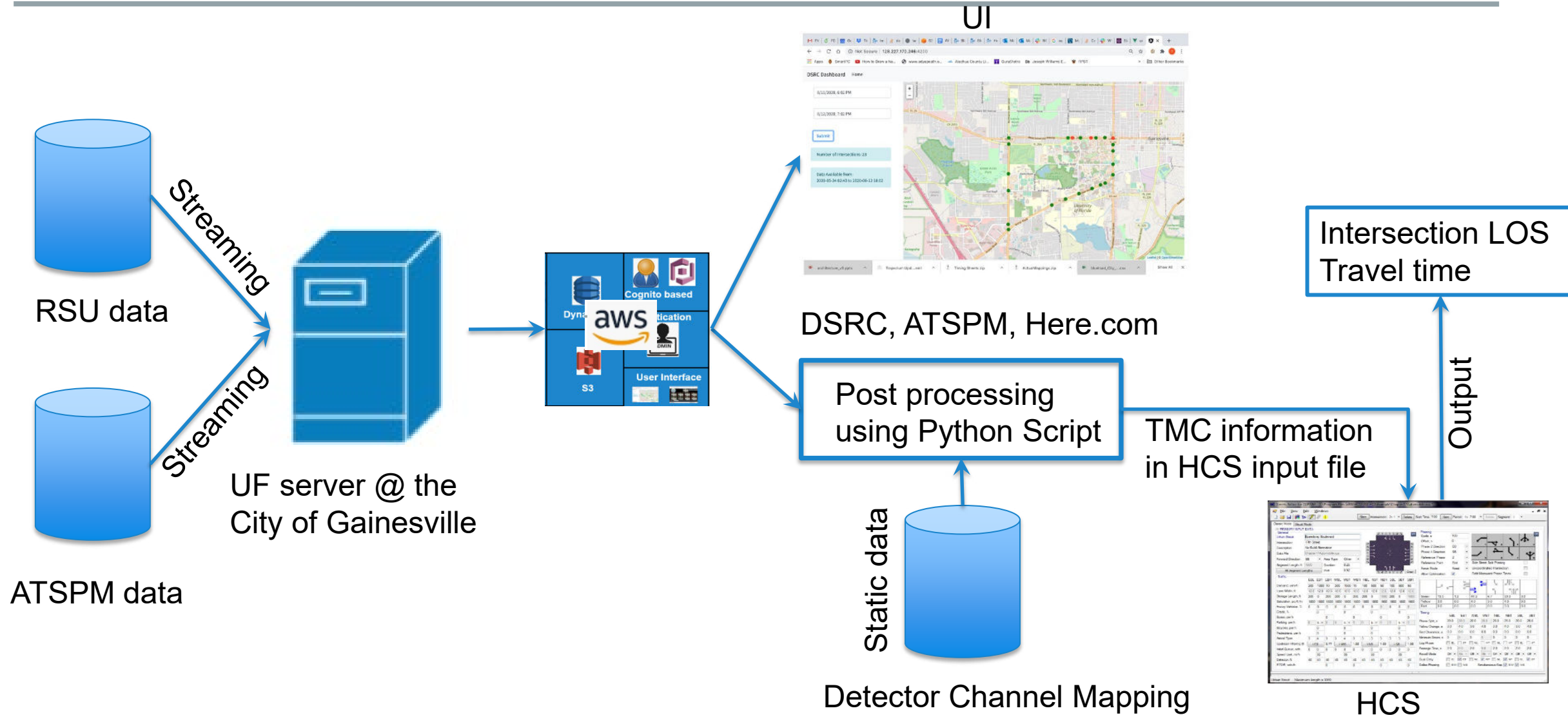
# Data Collection and Analysis System



# Data Flow Diagram for CV2X (DSRC) Messages



# Data Pipelines



# User Interface

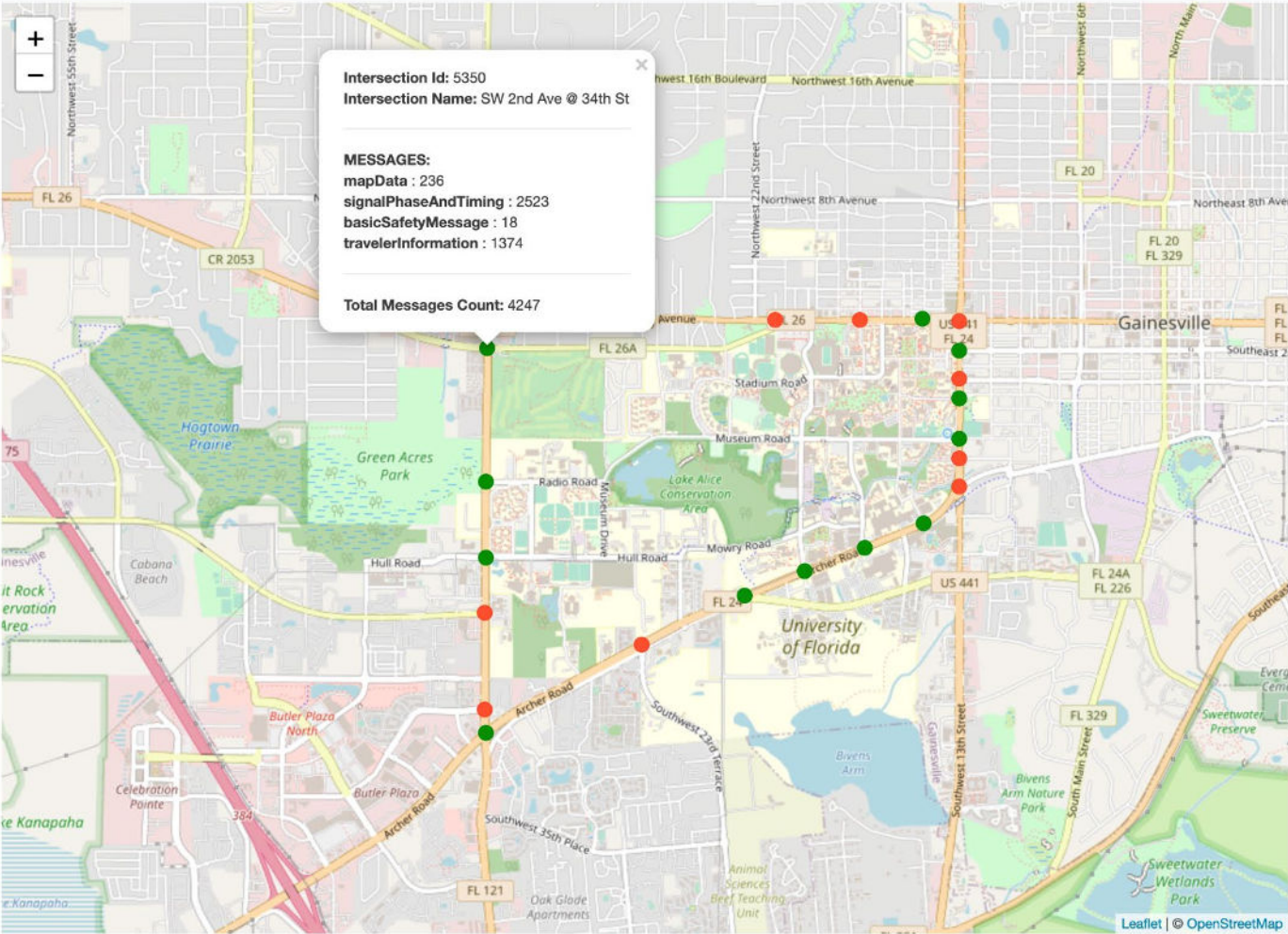
5/27/2020, 1:25 AM

5/27/2020, 9:25 PM

Submit

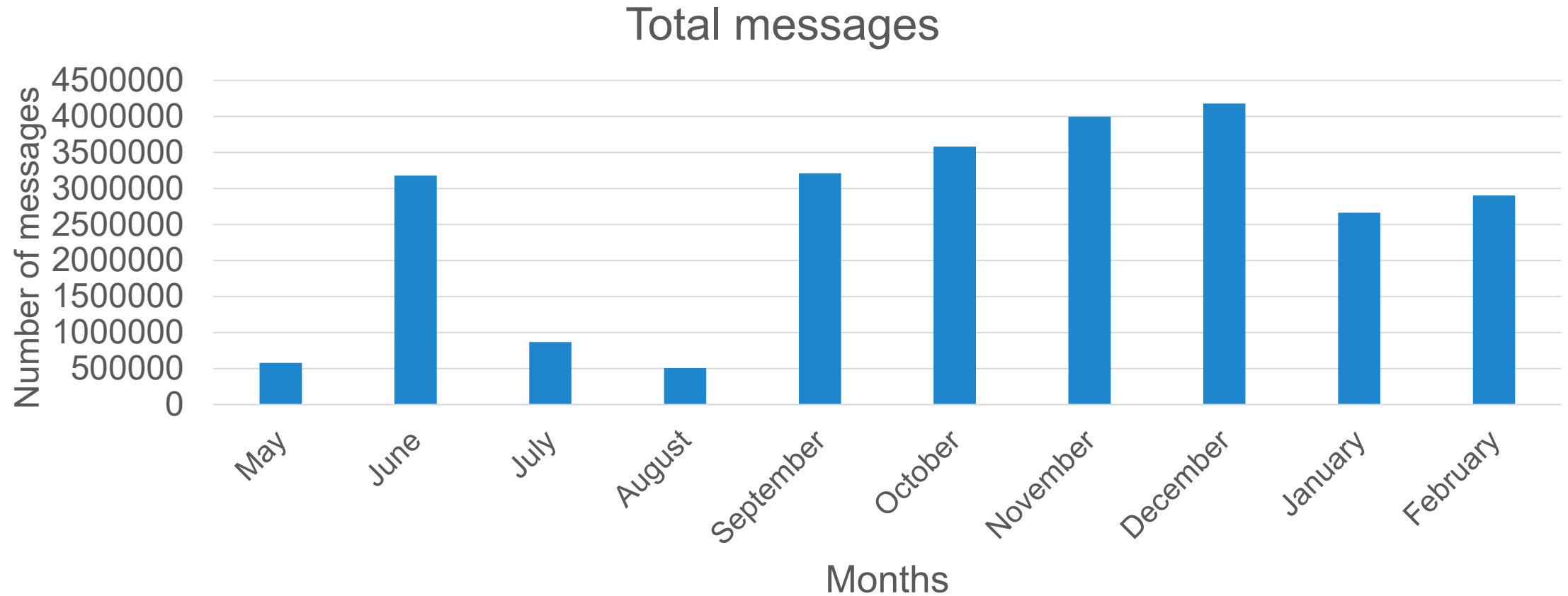
Number of Intersections: 21

Data Available from:  
2020-05-24 02:43 to 2020-05-27 21:25

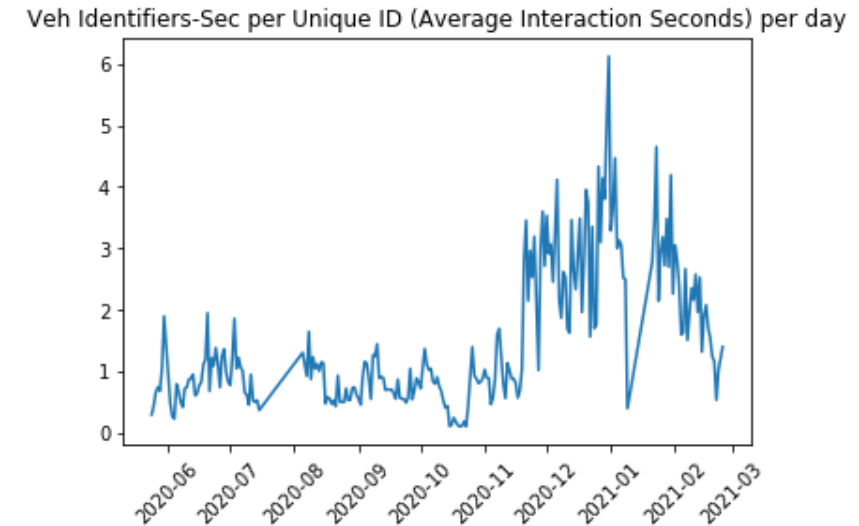
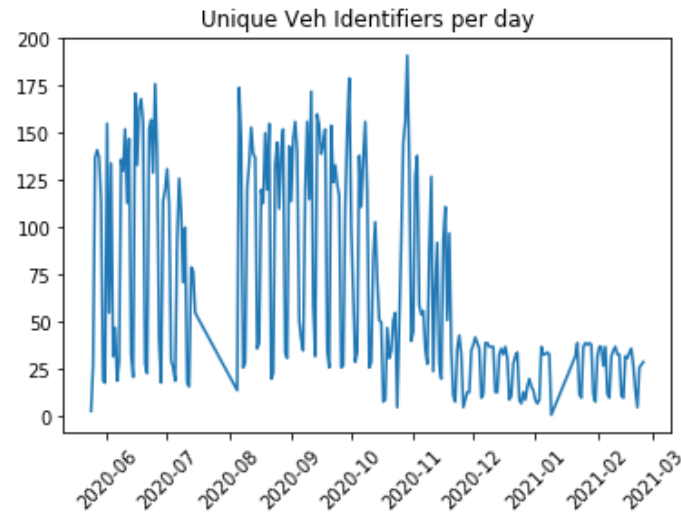
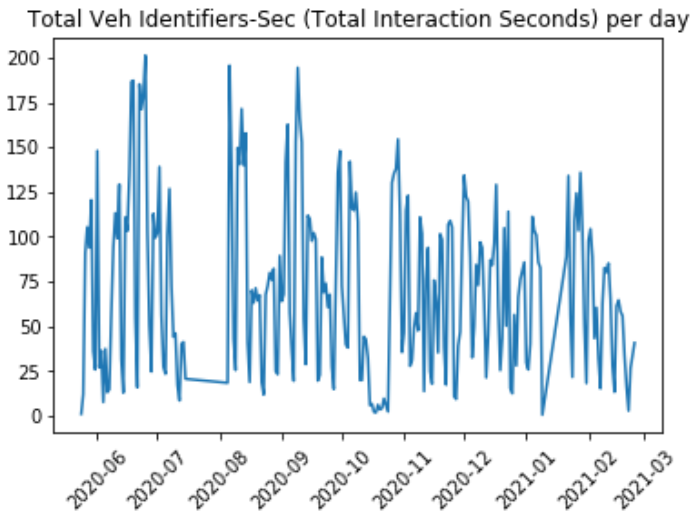
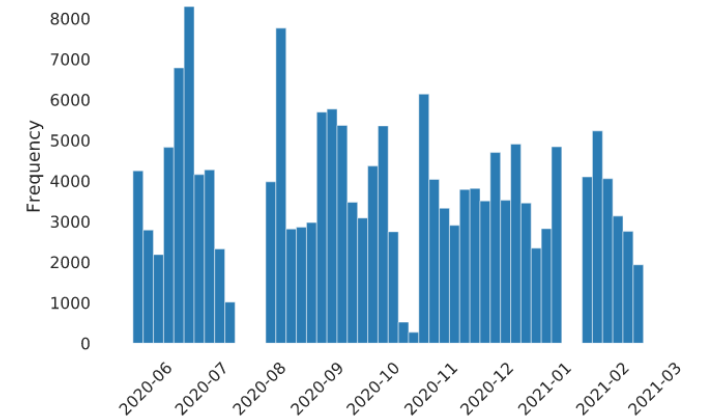
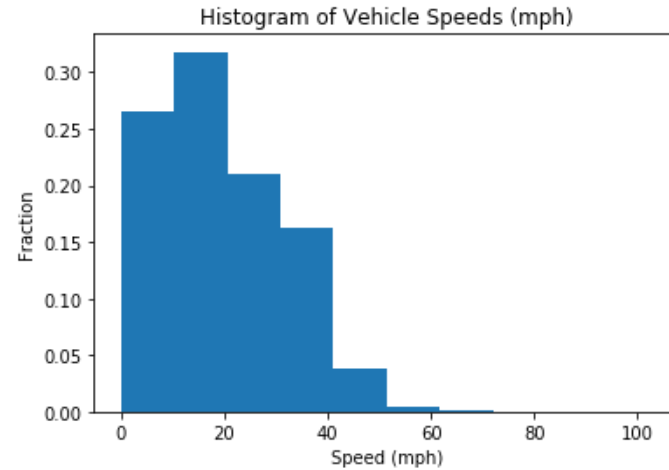
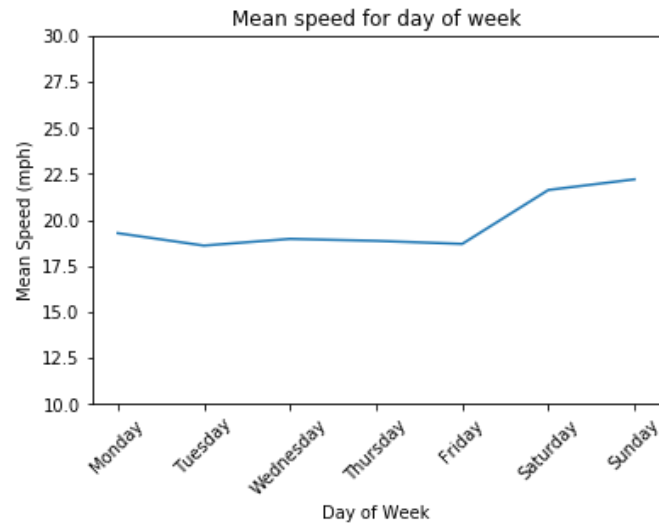


# Data Reception Statistics

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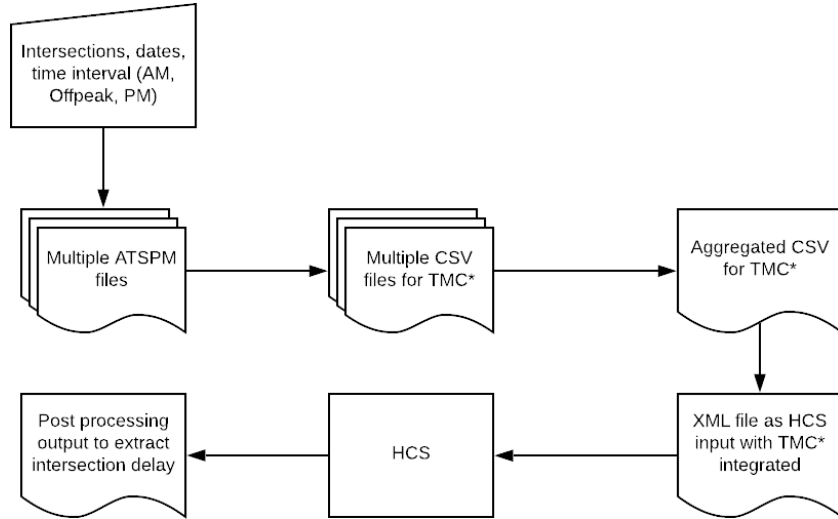


# Data Analysis (Basic Safety Message)

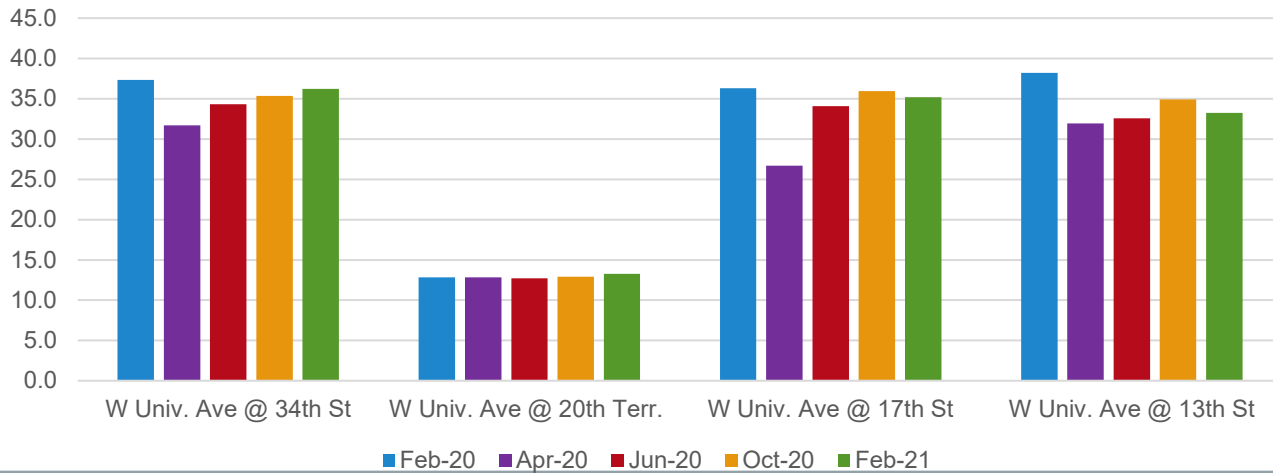


Timestamp	ISC ID	Veh ID	Veh Speed (mph)
24 May 20 - 12 Apr 21, with gaps	26 unique	27523 unique	[0, 103), mean 18.9 mph, STD 12.4 mph

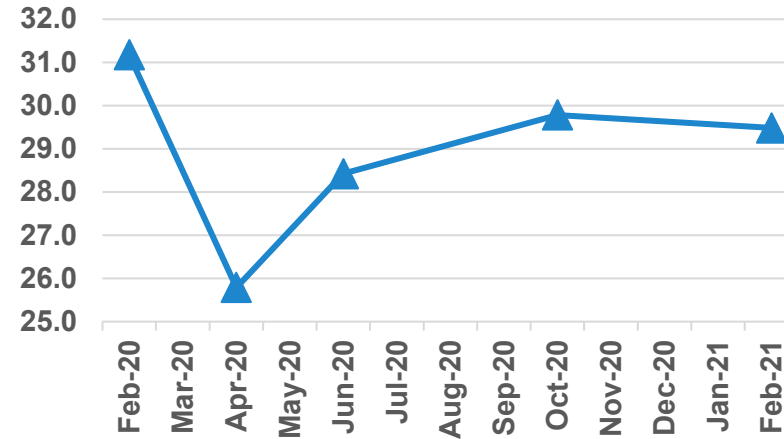
# HCS Pipeline



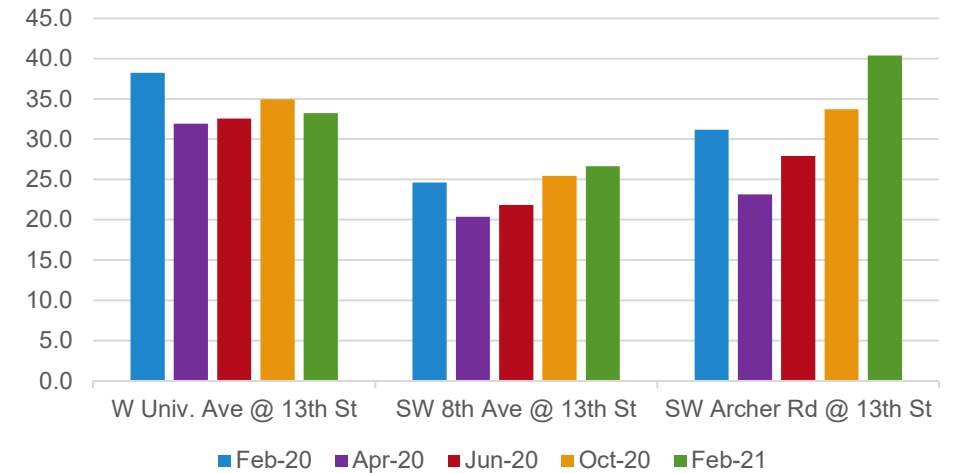
Intersection Delays- West University Ave.



Average Intersection Delay (West University Ave.)




Intersection Delays- 13th St.



# Summary of OBU Experience

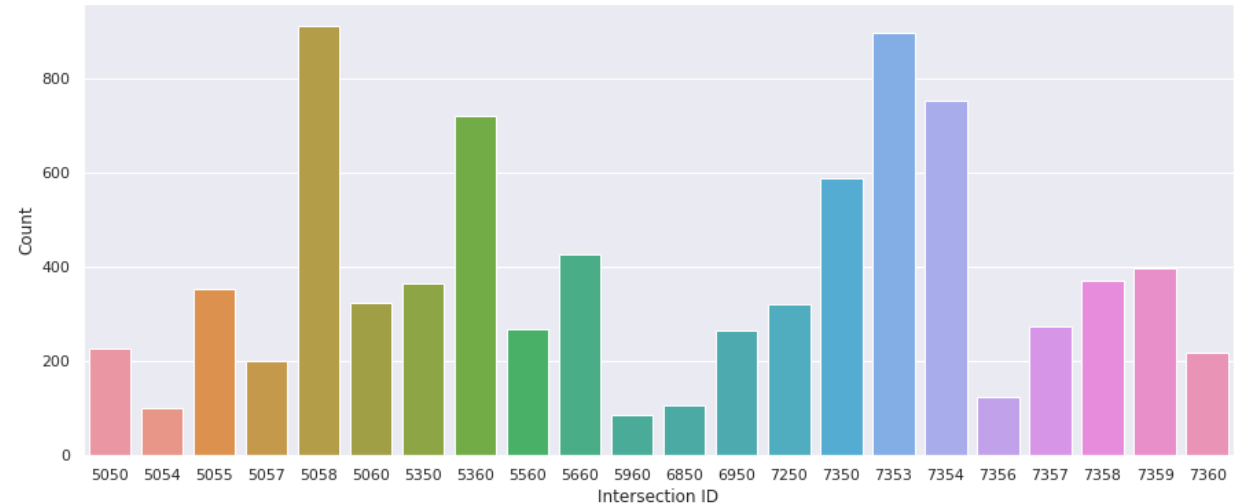
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- Drivers of vehicles equipped with on-board units (OBUs) were interviewed to understand their perception and use of the OBU technology.
  - Overall, the users found the signal timing messages to be useful and said other warnings need to be fine-tuned.
  - The users suggested improvements to the OBU, such as providing auditory warnings and integration with a navigation system.
- 
- 



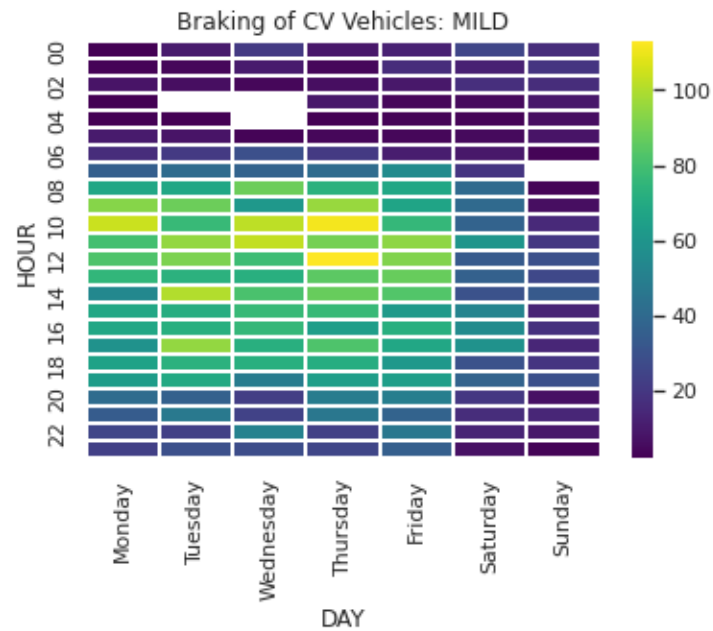
# Breaking Behavior using DSRC

- Using trajectory information collected by RSUs at 10 Hz
- Breaking Behavior
  - Analyze trajectories to determine deceleration
  - Smoothen the trajectories using a window
- Deceleration thresholds:
  - $-0.35g$  to  $-0.47g$  as MILD Braking
  - $-0.47g$  to  $-0.62g$  as HARD Braking
  - Beyond  $-0.62g$  is EXTREME Braking

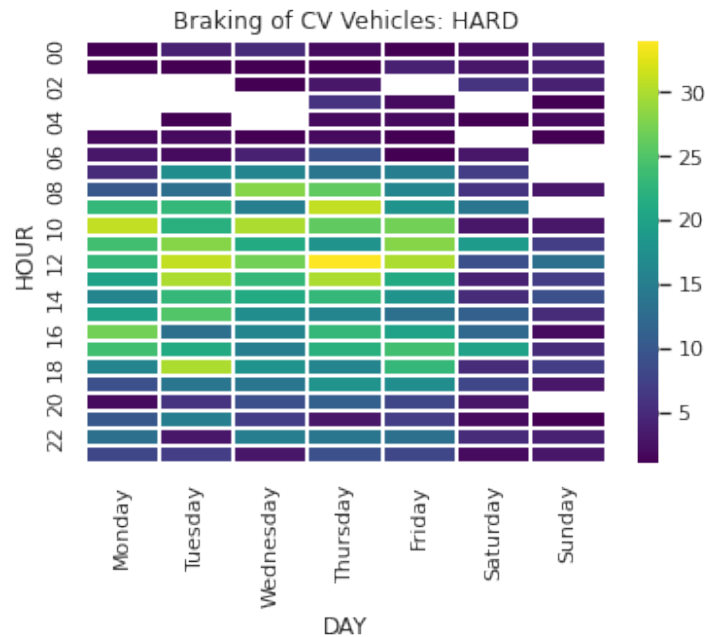


Cumulative intersection-wise counts of MILD/HARD/EXTREME events.

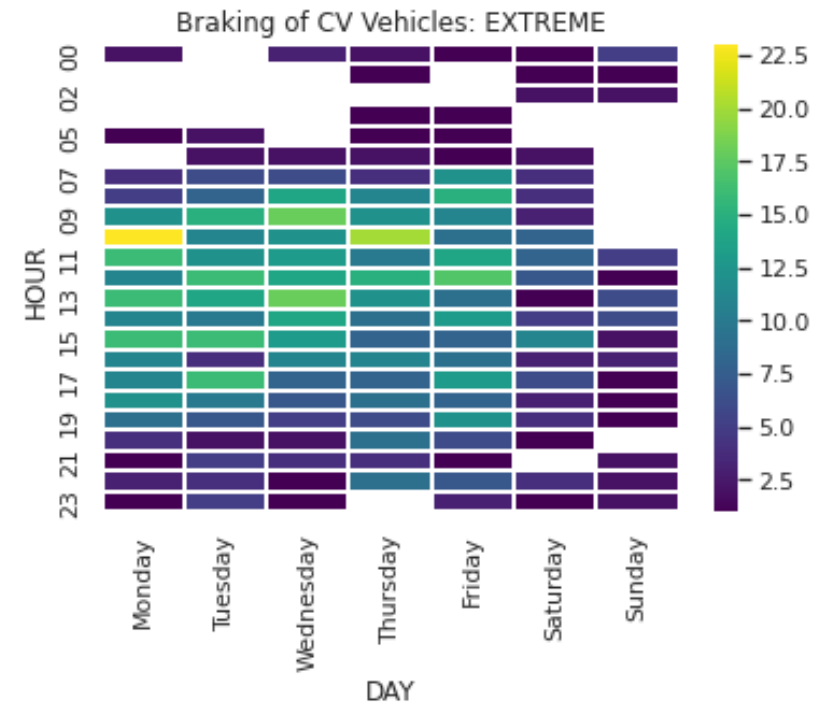
# Temporal Behavior of Braking



Heatmap showing  
MILD braking events



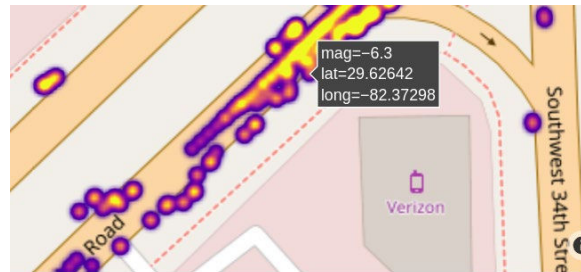
Heatmap showing  
HARD braking events



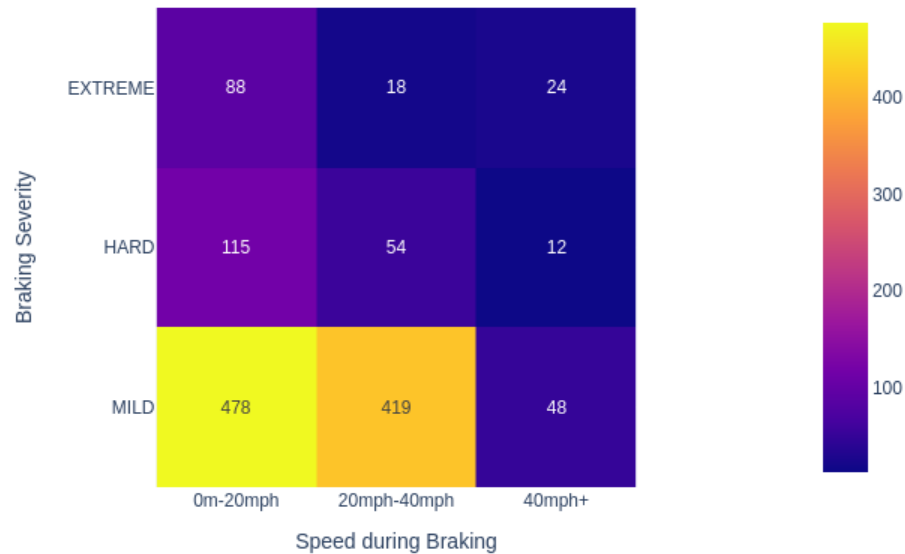
Heatmap showing  
EXTREME braking events

# Speed and Distance for the Braking Behavior

Plot showing the severity of braking against the speed at which the braking took place.



Intersection 5050



Plot showing braking severity vs. distance from the center of the nearest intersection.

Intersection 5050

