



Gwinnett
Transportation

2018 Georgia Smart Communities Challenge

Connected Vehicle Technology Master Plan

Final Report

September 20, 2019

Why Should We Pursue Connected Vehicle Technology?

- Safety benefits for first responders
- Automakers are planning to produce vehicles with this technology
- Safety benefits for all road users
- Potential to improve traffic flow
- GDOT is deploying this technology on state routes in metro Atlanta





“Connected Vehicles Can Sense and Communicate Things Drivers Cannot” - USDOT

Definitions

Automated Vehicles are vehicles that are capable of sensing their environment and navigating without human input.

Connected Vehicles are vehicles that use wireless communication technologies to communicate with roadside infrastructure, the driver, other cars on the road, and other devices, such as mobile phones.



Source: USDOT. Connected Vehicles Pilot Deployment Program

Vehicles to Infrastructure (V2I)

- Red Light Warning
 - Driver Alert
- Pedestrian in Crosswalk Alert
 - Driver Alert
- Restricted Lane Warning
 - Driver Alert
 - Agency Response and Safety
- Emergency Vehicle Signal Preemption
 - Agency Response, Safety, and Coordination
 - Driver Alert



Connected Vehicle Technology Master Plan

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Why create this plan?

- Supplement the County's existing transportation plans by focusing on connected vehicle infrastructure
- Identify the potential safety and mobility benefits available with deployment of connected vehicle infrastructure
- Understand the current state of the technology and the plans of automakers
- Prepare for the Smart Corridor pilot located along PIB
- Provide guidance for future projects

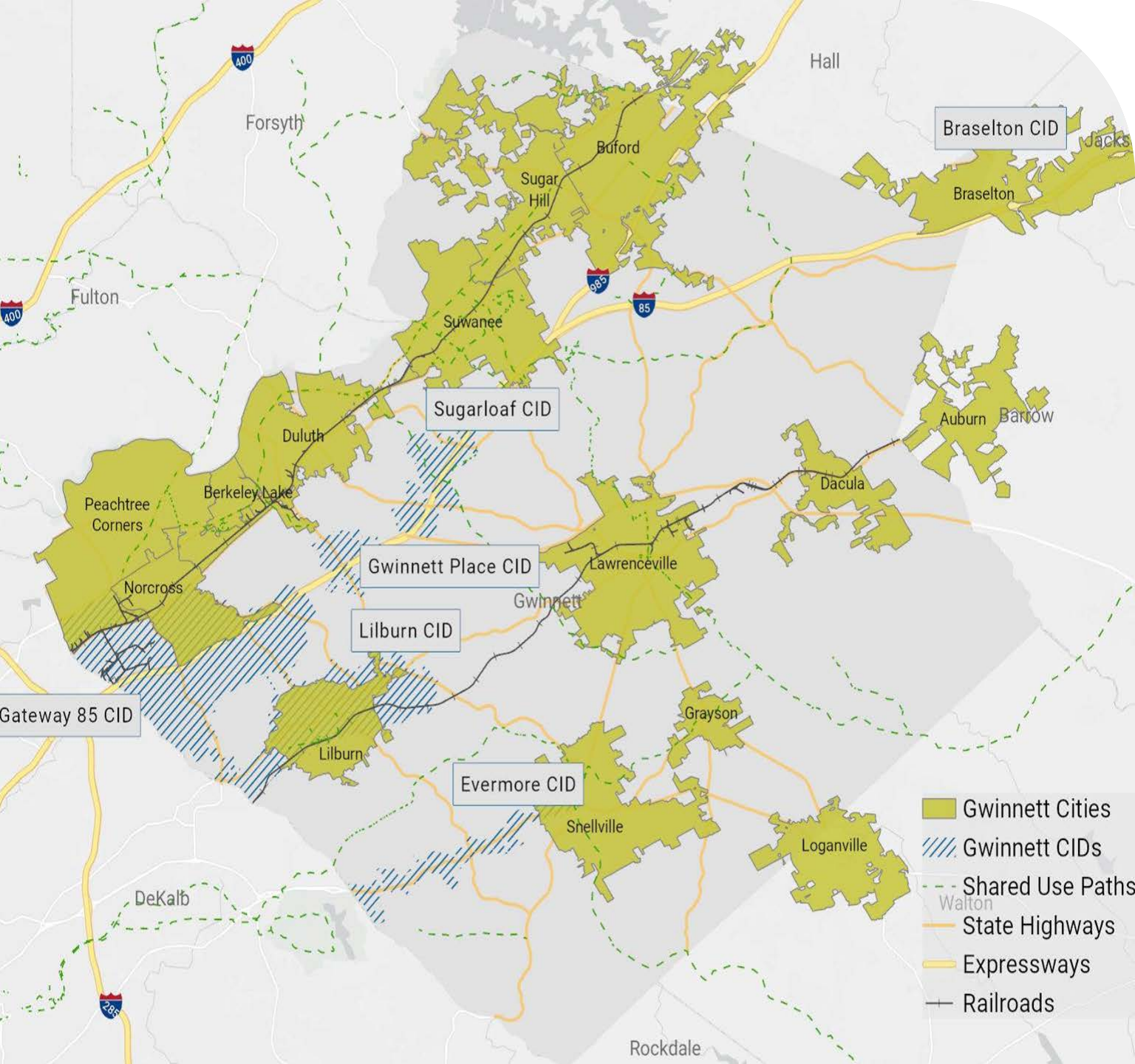
How to develop the plan?

- Awarded one of the inaugural Georgia Smart Communities Challenge grants
- Matched with County SPLOST funds
- Included research and data analysis conducted by Georgia Tech faculty



Goals for the plan

- Have broad applicability across the County, Atlanta region, and the State of Georgia
- Understand the needs and challenges to ensure regional and statewide compatibility for road users
- Establish guidelines for deploying a new and evolving technology
- Set the standard for the implementation of connected vehicle technology for a local government



Project Team

- Gwinnett County:
- AECOM:
- Georgia Tech:
- Stakeholders:
 - Public Safety
 - GDOT
 - Cities
 - Community Improvement Districts

Project Team

Gwinnett County: Tom Sever, Alex Hofelich, Ken Keena

AECOM: Marc Start, Suzanne Murtha, Leslie Langley, Sinan Sinharoy

Georgia Tech: Angshuman Guin

Stakeholders:

- Gwinnett County: Transportation, Transit, Fire, Police, and IT
- GDOT Office of Traffic Operations
- 15 city governments
- 6 community improvement districts (CIDs)
- 3 peer agencies in Atlanta region
- City of Chamblee

Project Timeline

- September 2018: Project initiation (Georgia Tech Workshop)
- October 2018: **Local stakeholder kick-off meeting**
- November 2018: Technology review meeting
- January 2019: CV applications identification meeting
- March 2019: CV applications completion meeting
- April 2019: **Regional CV stakeholder workshop as part of Ga Smart site visit**
- June 2019: Data collection and evaluation
- August 2019: Connected Vehicle Technology Master Plan completion
- September 2019: **Final presentation at Georgia Tech**

Stakeholder Meetings

- Location and nature of the transportation issues
- Priority



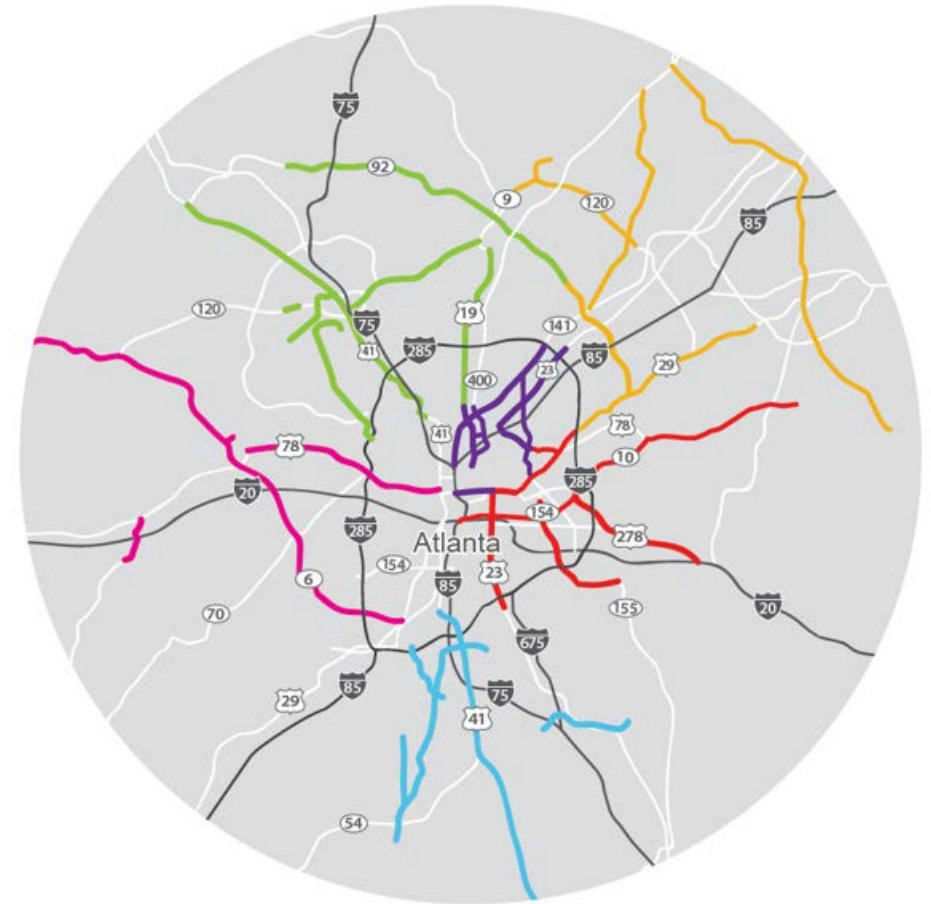
Project Actions

- Interviewed peer agencies that had already installed or are planning to install connected vehicle infrastructure
 - RenewATL
 - City of Marietta
 - Cobb County DOT



Project Actions

- Meetings with GDOT to coordinate on technical issues and standards
- GDOT-funded opportunities
 - Connected vehicle software
 - Roadside Unit (RSU) device testing
 - Expansion of GDOT's deployment of roadside units in Gwinnett County by 56 intersections



Source: GDOT

Benefits of the process

- Learned about transportation challenges from stakeholders
- Explained the technologies and systems at a conceptual level
- Provided overview of industry trends and opportunities
- Developed a 5 year deployment plan for connected vehicle applications and technologies
- Refined the scope of the Smart Corridor pilot project
 - Expansion from PIB signals to more roads west of I-85
 - Status of the desired connected vehicle applications

5-Year Deployment Plan

Application	Near-Term (2020)	Short-Term (2020-2022)	Long-Term (2020-2024)
	Smart Corridor project	In Coordination with ARC, GDOT	In Coordination with GDOT
Signal Phase and Timing (SPaT) Information	<ul style="list-style-type: none"> • Enable red light warning, phase termination/next signal phase, and green band speed applications 	<ul style="list-style-type: none"> • Monitor benefits of safety applications related to fleet penetration of RSUs and cellular OBUs 	<ul style="list-style-type: none"> • Monitor benefits of safety applications related to fleet penetration of DSRC/cellular OBUs
Emergency Vehicle Preemption (EVP)	<ul style="list-style-type: none"> • Enable EVP • Install OBUs on fire trucks 	<ul style="list-style-type: none"> • State-wide; manage EVP conditional priority requirements 	<ul style="list-style-type: none"> • Alerts for excessive transition time
Transit Signal Priority (TSP)	<ul style="list-style-type: none"> • Enable TSP • Install OBUs on transit vehicles 	<ul style="list-style-type: none"> • Manage TSP conditional priority • Test schedule adherence conditional priority • Test bus occupancy conditional priority 	<ul style="list-style-type: none"> • County-wide system development • Alerts for excessive transition time

- Identification of those connected vehicle applications that could be deployed in pilot project
- Understanding of which applications would need support from other parties and more development
- Table has just a few examples to show the current state and steps to desired state of applications

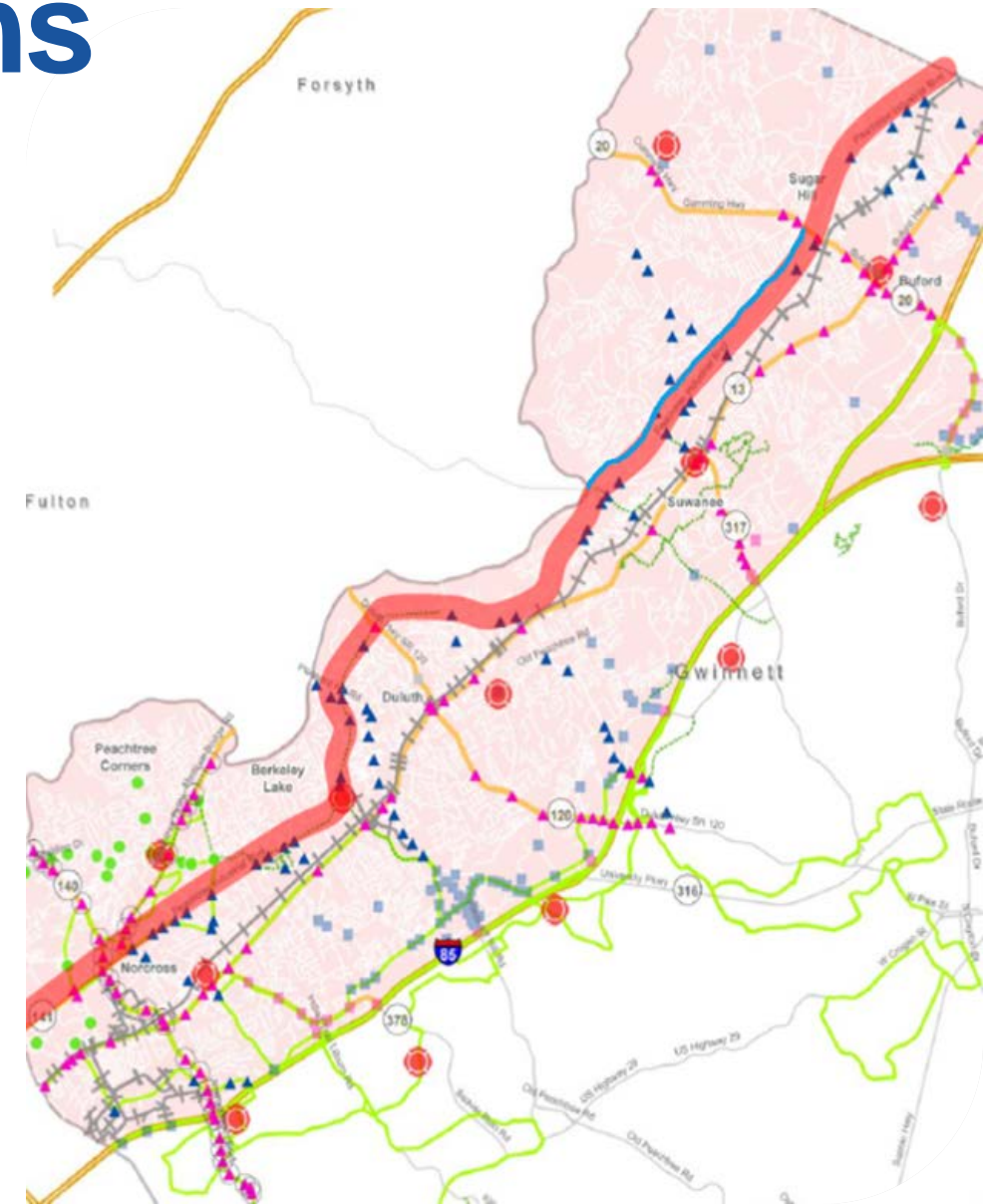
Connected Vehicle Applications for Smart Corridor Pilot Project



- Emergency vehicle preemption
- Transit signal priority
- Pedestrian presence notification
- Railroad crossing status
- Construction and maintenance activity notification
- Signal timing and phasing information

Project Recommendations

- Solve real problems
- Coordinate with GDOT, since connected vehicle functions should be boundary-less
- Recognize that plan flexibility is necessary due to the speed of technology evolution
- Budget time and finances for system field testing, O&M, and security certification



Georgia Tech Research Actions & Results

Research Focus

- Evaluate the potential for improvements in safety and response time for emergency vehicles
- Focus on fire apparatus at stations within the pilot project area
- Develop strategies for maximizing benefits and minimizing impacts

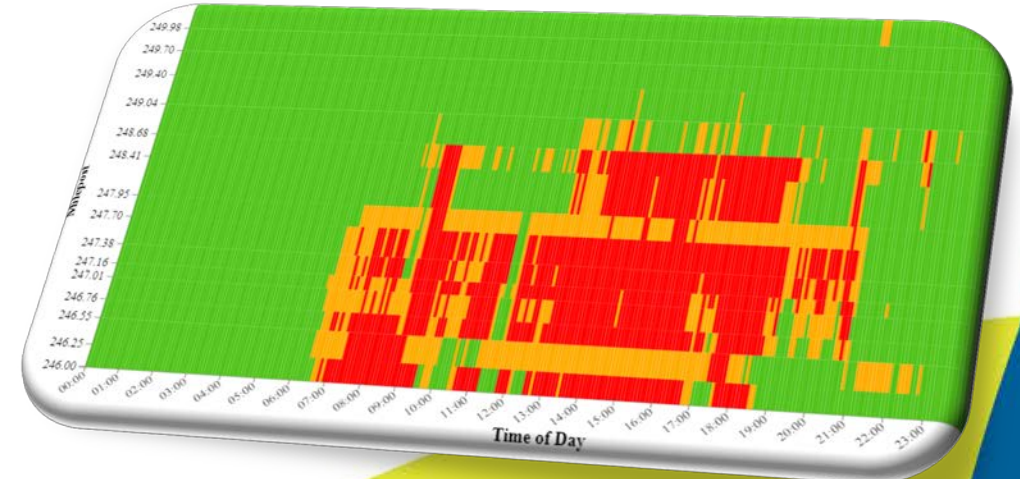


Photo Credits:

<https://www.cnn.com/2013/04/10/us/georgia-firefighters-hostage/index.html>

<https://www.semanticscholar.org/paper/GPS-and-ZigBee-based-traffic-signal-preemption-Kodire-Bhaskaran/b1d0e1034d5c147b44f6fcb51ab06d722b30acaa>

Emergency Vehicle Preemption (EVP)

EVP Basics

- Signal controller receives a message from an emergency vehicle as it approaches intersection
- Signal transitions to green light
- Current technology limited to line of sight

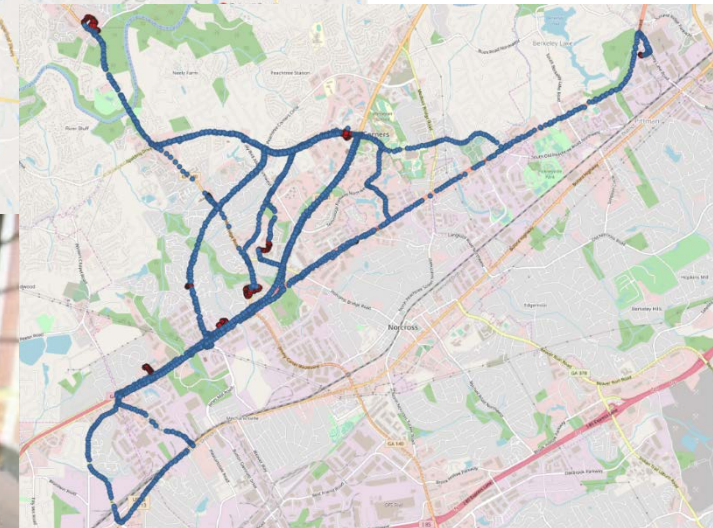
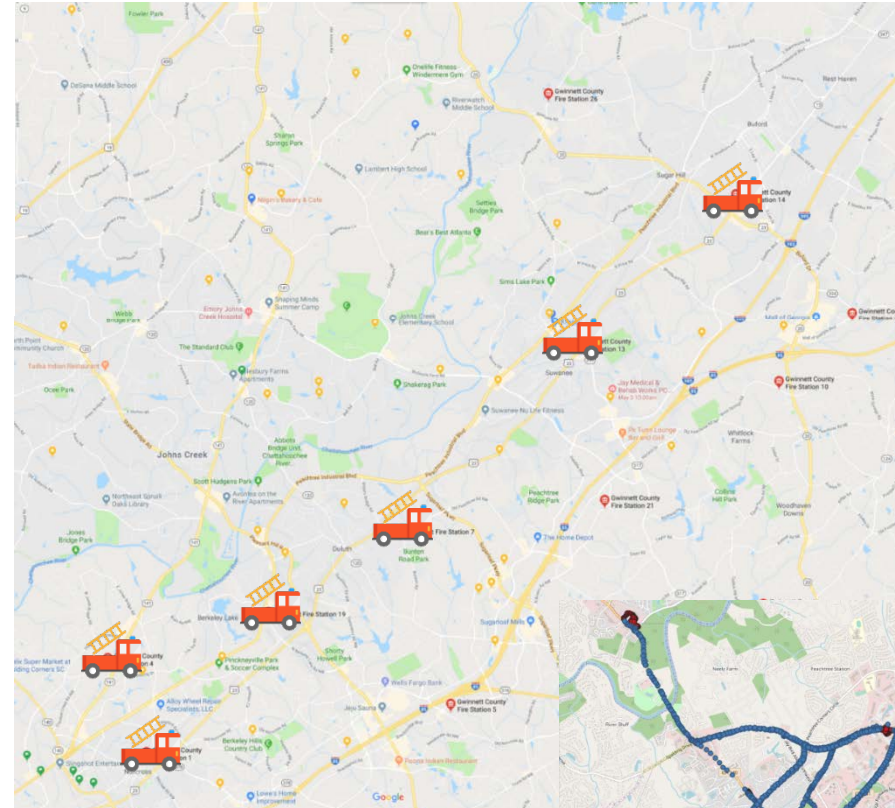
EVP using connected vehicle technology

- Potential for multi-signal preemption
- Clear vehicle queue in advance of emergency vehicle arrival
- Minimize impacts to normal traffic flow



Data

- GPS data collection on 17 trucks/engines/med-units from 6 Fire Stations
- GT equipment deployed on Gwinnett county fire vehicles
- 1 month of second by second location data



Georgia Tech Student Engagement



Smart Community Corps student

- On-site placement at the Gwinnett County DOT Traffic Control Center
- Streamlined the process for data transfer for high resolution (massive volume) traffic signal data from Gwinnett to GT on a regular basis

- Developed data fusion API for GPS and Signal status data

Civic Data Science team

- Performed Bottleneck Analysis using GPS and Signal data
 - Developed data quality checks
 - Developed data transformation protocols for GPS data
- Identified Intersections contribution to maximum delay for Emergency Vehicles



Data Processing

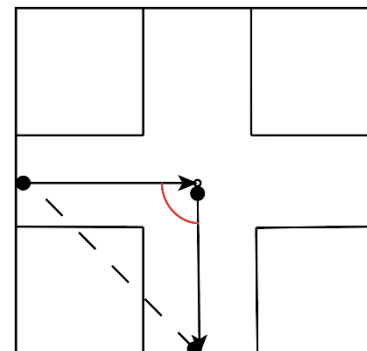
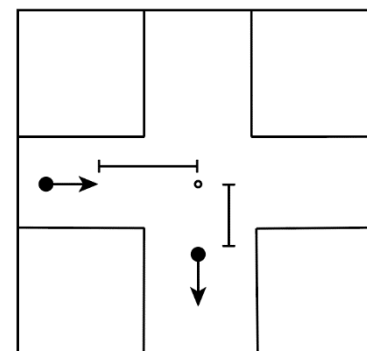
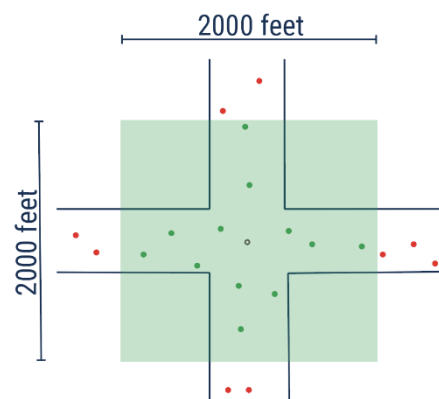
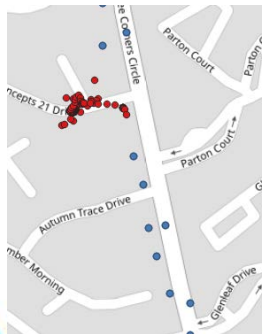
Off-route
filter

Intersection
filters

Intersection
association

Approaching
/ receding
determination

Signal light
association



Approach
Direction
+ Turn

Traffic
Signal
status

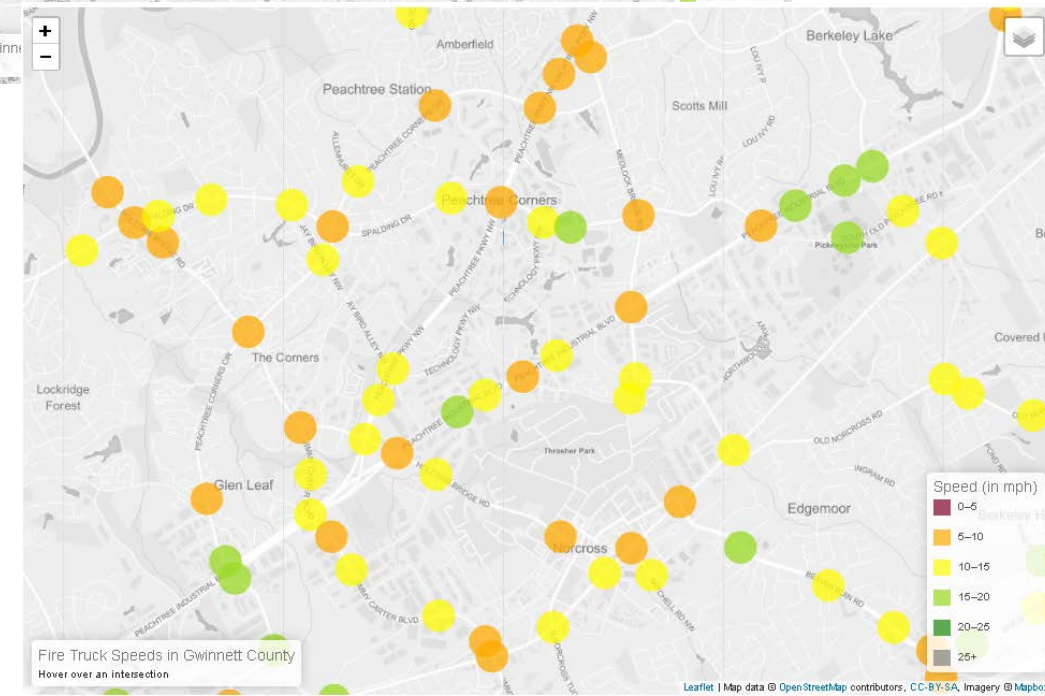
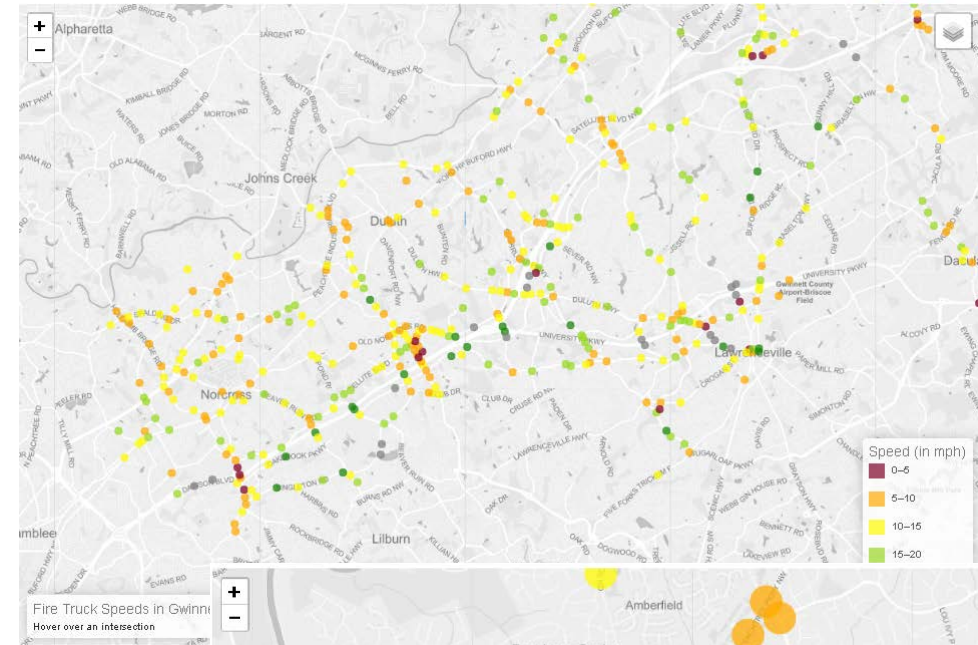


Results

Average Speed Near Intersections

Top 10 intersections

Intersection	Speed
PLEASANT HILL RD	7
HOWELL FERRY RD	8
MCGINNIS FERRY RD	8
NORTH BERKELEY LAKE RD	8
PEACHTREE HILL S/C / DUNKIN DONUTS	8
ALTON TUCKER BLVD / FIRST AVE	9
SUWANEE DAM RD	9
MEDLOCK BRIDGE RD	9
SR 20 / NELSON BROGDON BLVD	9
REPS MILLER RD	10

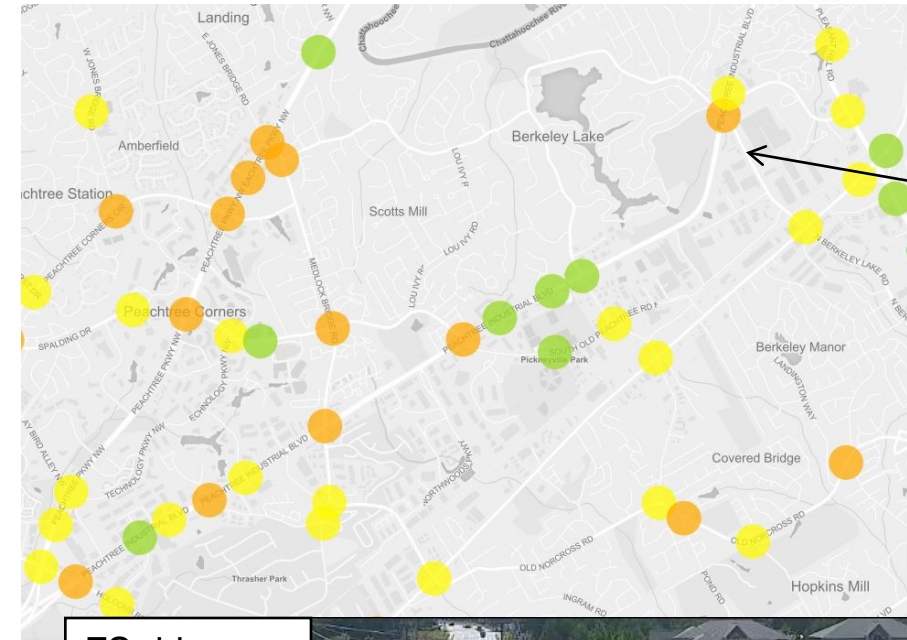


Results

Average Speeds on Approach

Top 10 intersections

Intersection	Speed	%Red
PLEASANT HILL RD	7	57%
MCGINNIS FERRY RD	7	63%
HOWELL FERRY RD	8	90%
NORTH BERKELEY LAKE RD	8	86%
PEACHTREE HILL S/C / DUNKIN DONUTS	8	81%
SUWANEE DAM RD	8	74%
ROGERS BRIDGE RD	9	33%
MEDLOCK BRIDGE RD	9	46%
REPS MILLER RD	9	40%
ALTON TUCKER BLVD / FIRST AVE	9	84%



FS 19
Driveway
~1,100 feet
From PIB

FS driveway



Results

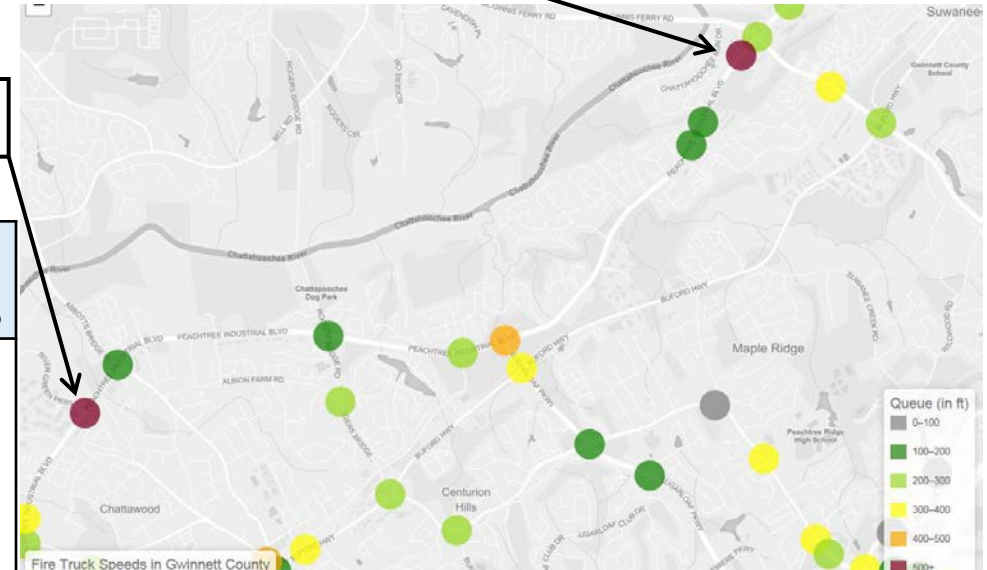
Average Queue Length

Top 10 intersections

Intersection	Queue Length	Occurrences
SUWANEE WALK AVE (~670 FEET SOUTH OF MCGINNIS FERRY RD)	734	13
RIVERGREEN PKWY (NORTH)	622	19
SUMMITT RIDGE PKWY / SWEETWATER CENTER	378	113
PEACHTREE HILL S/C / DUNKIN DONUTS	364	36
ALTON TUCKER BLVD / FIRST AVE	344	36
REPS MILLER RD	331	71
SUWANEE DAM RD	319	87
PLEASANT HILL RD	299	118
SR 20 / NELSON BROGDON BLVD	299	190
WEST PRICE RD	289	12

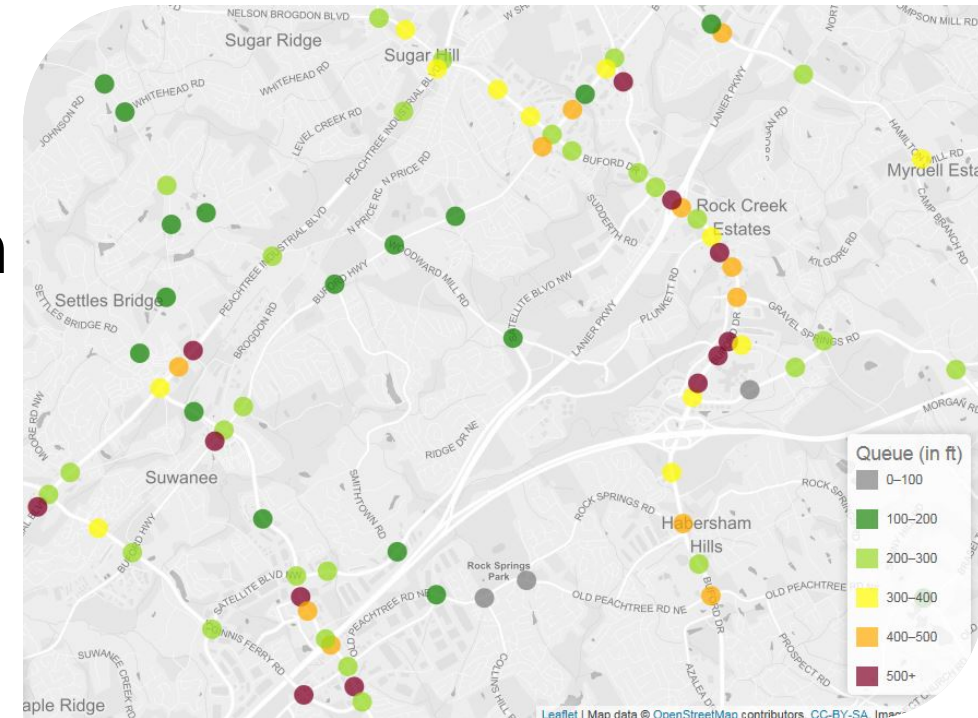
Suwanee Walk Ave

Rivergreen Pkwy



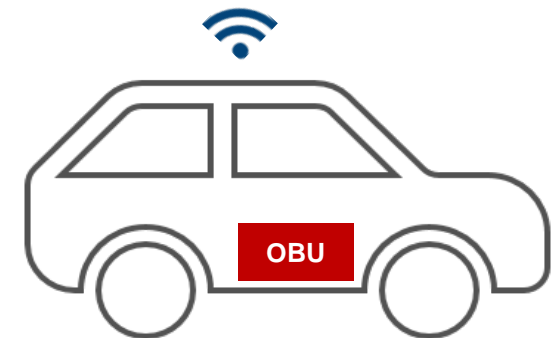
Next Steps in Analysis

- Deeper analysis of data
- Quantify total observed delay
- Identify critical signal phases for emergency vehicles at each intersection
- Evaluate forward looking preemption feasibility
- Collect more before-deployment data in Fall 2019
- Post-deployment analysis (2020-2021)



Process Improvement, Data, & Automation

- Greater understanding of how connected vehicle technology will support the goals of improved mobility and safety
- GDOT coordination improves the opportunities for connect vehicle technology to be applied state-wide



Process Improvement, Data, & Automation

- Connected vehicle application selection that will benefit the full spectrum of transportation users
- Data evaluation provides a detailed understanding of where emergency vehicles are experiencing delays



Research Recommendations

- The emergency response community is welcoming CV technology. Demonstration and quantification of benefits, through pilot field applications, will be critical to inducing acceptance from the public and convergence from the manufacturers that are both necessary for widespread success of CV in improving mobility, safety and sustainability.
- Lessons learned: Identifying key data needs early in the project is critical to success of short term data-heavy projects

Impact

Project coverage

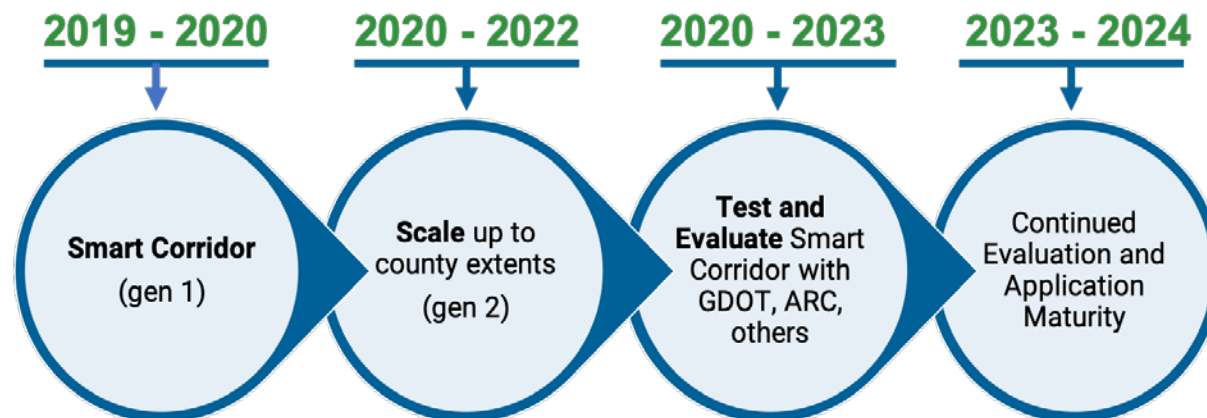
- WSBTV People 2 People September 2018
- Gwinnett County Connection Newsletter July 2019
- Suwanee Connects Newsletter September 2019

"I am particularly thrilled about the prospect of experienced Gwinnett DOT staff members working with their Georgia Tech research partners to help us challenge the status quo, make bold recommendations, experiment and adapt technology. Together, using a smart risk approach, we can implement a traffic system which is at the cutting edge of what is possible with recent scientific advances."

- Charlotte Nash, Gwinnett County Board of Commissioners Chairman

Future Plans

- Smart Corridor pilot project in western Gwinnett County – implementation in 2020
- Atlanta Regional Commission CV1K initiative participation – will help to equip all Gwinnett signals with CV technology
- Vehicle fleet starts to become equipped with CV technology – observe the impact to traffic and data flow and how infrastructure needs to respond



Future Funding

- Gwinnett County has \$2.6 million in funding for the Smart Corridor pilot project
- Identify sources for matching funds to participate in CV1K initiative
- Will need to plan for future operations and maintenance funds as CV technology expands and becomes more integral to everyday travel

Grant Monies Financial Reporting

September 2018 –
August 2019
AECOM invoices

Georgia Smart Budget Spend Details		
AECOM assistance	Invoice amount towards grant	Balance
Aug 2018 Needs and Technology Assessment	\$2,556.00	\$22,444.00
Sept 2018 Needs and Technology Assessment	\$4,956.00	\$17,488.00
Oct 2018 Needs and Technology Assessment	\$6,876.00	\$10,612.00
Nov 2018 Needs and Technology Assessment	\$8,788.00	\$1,824.00
Dec 2018 Needs and Technology Assessment	\$1,824.00	\$0.00
Dec 2018 Needs and Technology Assessment	\$4,894.00	\$20,106.00
Jan 2019 Needs and Technology Assessment	\$12,106.00	\$8,000.00
April 2019 Documentation & Deliverables	\$2,400.00	\$5,600.00
May 2019 Documentation & Deliverables	4000.00	\$1,600.00
June 2019 Documentation & Deliverables	636.00	\$964.00
July 2019 Documentation & Deliverables	844.00	\$120.00
August 2019 Documentation & Deliverables	120.00	\$0.00
50,000.00	50000.00	-

Community Match Financial Reporting

September 2018 – August 2019
AECOM invoices representing total of grant monies and Gwinnett County match

Invoice #	Invoice Date	Total This Invoice	Total to Date	Contract Balance	Work Period
2000113651	9/20/2018	\$6,695.00	\$6,695.00	\$143,300.00	01-AUG-18 to 31-AUG-18
200124517	10/18/2018	\$6,695.00	\$13,390.00	\$136,605.00	01-SEP-18 to 05-OCT-18
2000137043	11/15/2018	\$10,595.00	\$23,985.00	\$126,010.00	06-OCT-18 to 02-NOV-18
2000154842	12/27/2018	\$10,985.00	\$34,970.00	\$115,025.00	03-NOV-18 to 30-NOV-18
2000159151	1/10/2019	\$9,397.50	\$44,367.50	\$105,627.50	01-DEC-18 to 04-JAN-19
2000175373	2/14/2019	\$32,467.50	\$76,835.00	\$73,160.00	05-JAN-19 to 01-FEB-19
2000186717	3/13/2019	\$27,422.50	\$104,257.50	\$45,737.50	02-FEB-19 to 01-MAR-19
2000201209	4/17/2019	\$14,767.50	\$119,025.00	\$30,970.00	02-MAR-19 to 05-APR-19
2000214028	5/17/2019	\$12,452.50	\$131,477.50	\$18,517.50	06-APR-19 to 03-MAY-19
20000225062	6/13/2019	\$15,447.50	\$146,925.00	\$3,070.00	04-MAY-19 to 31-MAY-19
2000235748	7/11/2019	\$795.00	\$147,720.00	\$2,275.00	01-JUN-19 to 05-JUL-19
2000251224	8/15/2019	\$1,625.00	\$149,345.00	\$650.00	06-JUL-19 to 02-AUG-19
2000264580	9/17/2019	\$650.00	\$149,995.00	\$0.00	03-AUG-19 to 30-AUG-19

Supplemental Information

- Connected Vehicle Technology Master Plan will be submitted separately
- The research has helped develop the much needed conduits for data communication between Gwinnett County and Georgia Tech.
- County provided traffic signal controller log data – 10Hz (1/10 of a second resolution) for over 500 traffic signals in Gwinnett County
- Looking for opportunities to continue research using these rich datasets with hopes that the results will be presented in conferences and potentially published
- The Civil Data Science students have expressed interest in continuing to work towards a publication.

Impact of Connected Vehicles

- Safety benefits to first responders and all road users
- Compatibility with GDOT connected vehicle technology can create a regionwide system



Project Team Contact Information

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