U.S. Department of Transportation

NOFO 693JJ319NF00001

Automated Driving System Demonstration Grants

Project Title:

Autonomous Shuttle Demonstration for Safe Integration into our Nation's Transportation Network

City of Chamblee, GA

CITY OF CHAMBLEE
5468 PEACHTREE ROAD CHAMBLEE, GA 30341

March 21, 2019

To Whom it May Concern:

The City of Chamblee, Georgia, is excited to submit its proposal to USDOT for the Peachtree Road Shared Autonomous Vehicle demonstration project. As a city of just over 30,000 diverse residents with a rapidly growing, transit-oriented downtown, Chamblee is now in its third year of planning for how to maximize and leverage the last-mile connectivity, economic development, environmental protection, and technological advancement this project will bring.

Chamblee's 2018 *Self-Driving Shuttle Feasibility Study and Concept Plan*, itself a product of the vision of the City as a forward-thinking center of innovation with strong multi-modal transportation connections as established in the *Town Center Livable Centers Initiative (LCI) Plan* and *Comprehensive Plan*, demonstrated that the Peachtree Road corridor is a strong candidate for a successful self-driving shuttle system (p. 68). 2019's in-progress *Shared Autonomous Vehicle (SAV) Operation Plan* builds on this momentum by providing a detailed analysis of the route and system operations. Implementation has already begun with the start of construction of 2017's *Peachtree Road Streetscape & Rail Trail Concept Plan*, which will fundamentally transform the route into a significantly more pedestrian- and transit-friendly corridor.

Chamblee has partnered with the Georgia Tech Research Institute (GTRI) to help ensure that this project goes beyond the shuttle service itself. Both partners are committed to being on the cutting edge of this technology, and Peachtree Road's lively mix of users, including trains, cars, trucks, buses, bikes, scooters, and pedestrians, along with stop signs, traffic signals, construction sites, and a variety of land uses, is an ideal corridor for studying how these vehicles react and

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adapt in often unpredictable urban settings. Chamblee and GTRI are enthusiastic about the opportunity to work with USDOT to provide unfettered access to any and all data that will help this technology thrive in the safest manner possible.

We look forward to the day that autonomous vehicles provide a valuable transit connection within Chamblee's thriving downtown and are confident that this funding opportunity is ideal for making this vision a reality.

Sincerely,

R. Eric Clarkson
Mayor
City of Chamblee, Georgia

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Summary Table	
Project Name/Title	Autonomous Shuttle Demonstration for Safe Integration into our Nation's Transportation Network
Eligible Entity Applying to Receive Federal Funding	City of Chamblee, Georgia
Point of Contact	Rebecca Keefer, AICP Chamblee Special Projects Manager rkeefer@chambleega.gov 770-639-7096
Proposed Location	Chamblee (Metropolitan Atlanta), Georgia, USA
Proposed Technologies for the Demonstration	L4 SAV Demonstration, Connected Vehicle Communication (V2V, V2I), Signage
Federal Funding Amount Requested	$9.7 million
Non-Federal Cost Share Amount Proposed	$4,000,000
Total Project Cost	$13.7 million

Table of Contents

Listing of Tables/Figures

1. Project Narrative and Technical Approach

1.1 Executive Summary

The City of Chamblee, a metropolitan Atlanta community in Georgia, is pleased to submit this proposal on behalf of a collaboration with the Georgia Institute of Technology (Georgia Tech) and EasyMile, an existing L4 autonomous vehicle (AV) manufacturer. Chamblee proposes to demonstrate and test the integration of an autonomous shuttle into existing public spaces through regular operation of a sensor enabled Autonomous Driving System (ADS) over a two-year period of performance. Through this demonstration the City of Chamblee plans to operate an EZ10 model shared autonomous vehicle (SAV) [*Figure 1*] operating at L4 autonomy (Driving Automation levels defined by SAE J3016) in mixed traffic on a fixed route providing first/last mile connectivity in the community. Georgia Tech and EasyMile will outfit the EZ10 shuttle with a broad array of relevant AV sensors to capture, analyze, and provide data to the USDOT and the broader research community. Testing and data collection will be completed using a phased approach designed to emphasize safety while also advancing the integration of the vehicle into the municipal infrastructure. This phased approach begins with testing on a closed course test track in typical and atypical situations and progresses to regular shuttle use on a specified route in the city. Data captured will be made available to USDOT with no access restrictions for use in its Secure Data Commons. This ADS demonstration program will focus on 1) the identification of infrastructure and 2) communications modifications necessary to support the safe introduction of AV's into our nation's transportation network.

Figure 1.1. EasyMile EZ10 SAV

The EZ10 SAV has a demonstrated L4 capability on fixed routes and in mixed traffic. EasyMile has successfully deployed 250 vehicles in over 23 countries with vehicles traveling more than 200,000 miles with no accidents involving vehicles in operation. The EZ10 has specifically been deployed in Singapore, Sweden, China, Australia, Germany, France, and the United States in Arlington, Texas and Otsego, Minnesota.

Using the EZ10 as an ADS demonstration vehicle, the team will outfit the vehicle with a comprehensive sensor suite of redundant sensors beyond those used by EasyMile to navigate. These additional sensors will be used as the testbed and data collection platform so as not to interfere with existing automation sensors and software on the vehicle. The proposers will 1) identify challenges to the safe integration of AVs into the road system, 2) identify potential strategies and changes to municipality infrastructure and communications that can mitigate these challenges, and 3) collect the and analyze the data to test these risk mitigation approaches on-road to successfully and safely operate AVs in the transportation system. The team proposes to look at the integration holistically, including both strategies and technology needed for the vehicles to successfully integrate as well as the strategies and infrastructure changes required by this municipality and other governments to enable the safe integration of AVs.

A key component of this demonstration is to identify the key changes to municipality infrastructure required to successfully operate municipality owned ADS safely in mixed traffic. The City of Chamblee will provide program management and coordination with all involved stakeholders throughout the demonstration program. Additional key partners will include the Atlanta Regional Commission (ARC) and the Georgia Department of Transportation (GDOT). Georgia Tech will be the project's lead researchers and provide data management. EasyMile will provide the EZ10 driverless shuttle for the project demonstration through a contract with Chamblee. EasyMile will collect high-level data to share with the USDOT in addition to the data collected by Georgia Tech. The City will provide the operations and maintenance staff to serve as onboard safety operators and customer service ambassadors for the duration of the program. Public engagement is also an integral component of the project, providing qualitative data to better understand customer mobility needs and improve the user experience.

The full set of data collected and analyzed throughout the effort includes the data from the sensor-outfitted vehicle, data from any installed infrastructure in the City, the data from the municipality safety, operations, and maintenance staff, and public opinion data. Combined, this data will provide key feedback to adjust risk mitigation strategies and develop safe practices.

The City of Chamblee has already laid the groundwork for just such an AV demonstration through its *Self-Driving Shuttle Feasibility Study & Concept Plan*, completed and adopted over the last two years, and its in-progress *Shared Autonomous Vehicle (SAV) Operation* Plan, which are in direct support of the City's Livable Centers Initiative (LCI) Plan. The goals of the LCI plan – to maintain and enhance the City's multi-modal transportation network, to support efficient land use, minimize traffic congestion, and to facilitate community-wide and regional mobility – have been the driving factors for Chamblee to pursue the integration of an SAV route in our community. The SAV program will address the City's mobility, economic, and environmental goals. Public transportation through the historic downtown will support local businesses, alleviate parking challenges, and reduce environmental pollutants while developing and maintaining strong multi-modal connections. These existing studies have used significant public input to compile information on the necessary infrastructure improvements required to implement the SAV while helping determine the route, schedule, and other key factors needed to drive successful outreach and usage.

Chamblee is fully committed to operating an SAV to provide our community with mobility access for all while providing connectivity between the road network, public transit, and pedestrian paths. The team proposes a multi-year ADS program that will provide the USDOT data needed to drive safety decisions and regulations to allow the widespread integration of L3+ AVs into communities.

The proposed final phase of the SAV demonstration route will be along a core route of 2.2 miles on Peachtree Road in Chamblee's downtown district corridor. Construction on a comprehensive overhaul of the route, based on the City's *Peachtree Road Streetscape & Rail Trail Concept Plan,* will begin in the spring of 2019. This traffic-calming project will result in the route becoming significantly more bicycle- and pedestrian-friendly, greatly improving access to the SAVs. The route will include five stops to serve as a vital first/last mile connection for pedestrians who live, work, shop, or dine in the development along Peachtree Road. The stops include the Peachtree Station commercial development, Mercy Park senior housing and medical center, Chamblee MARTA station, Chamblee Dunwoody Way, and the municipal center (including City Hall) at Broad Street (*Figure 2*). The operation of the EZ10 over the period of performance will provide significant public benefit as well as a platform for open data collection in complex on-road conditions.

Figure 1.2. Proposed SAV route in downtown

The proposing team is eager to demonstrate an SAV in Chamblee while collecting much-needed data for the USDOT from sensors on board an AV operating in one of the first mixed-traffic routes in the nation. The team believes this proposal's phased approach will provide the USDOT with a safely executed demonstration that develops a comprehensive data set aligned with its intention to use the data to inform decisions related to expanded AV use in the United States. We believe the project will produce significant public benefits in the form of recommendations for data collection, storage, and communications that should be considered in order to safely operate AVs on our nation's public transportation networks.

As one of the first mixed-traffic SAVs in North America, Peachtree Road will be unlike any other, and as such, needs to orient users to the new operating conditions. The City of Chamblee's self-driving shuttle is both scalable and relatable to other government organizations/transit agencies. The lack of efficient, safe and affordable first and last-mile connectivity is a problem throughout the country. A self-driving shuttle appears to be one of the more sustainable methods of providing this missing link. Therefore, similar treatments would be very attractive to places throughout the country. By partnering with the Atlanta Regional Commission and the Georgia Institute of Technology, the City will have a local, regional and national forum to share information and lessons learned to transfer knowledge throughout the country. To ensure broad exposure, the City will host a webpage regarding the project and host an annual site visit and education program to highlight the demonstration project in tandem with these partners. The proposal anticipates implementation of Phase 1 in mid to late 2019 with Phase 2 implementation in mid-2020.

1.2 Goals

Creating transportation options that allow for collective use by pedestrians and commuters is an integral component of safe and efficient multi-modal transportation. The proposing team's primary goal is to pursue the safe integration of an SAV into a multi-modal transportation system using a phased approach that begins with closed-course testing for risk mitigation, progressing to full testing on a 2.2 mile mixed-traffic shuttle route. The goal of this effort will be to demonstrate a framework that uses proper infrastructure, planning, and technology to mitigate the uncertainties of traffic and ensure the safe integration of ADS, as well as provide the USDOT with the necessary data to determine appropriate policy for the safe integration of ADS throughout the nation.

1.2.1 Demonstrate Safely

The proposers are seeking a wider understanding how AVs impact the safety of a community utilizing multi-modal transportation. This assessment includes necessary changes to road and pedestrian infrastructure, emergency response, construction/maintenance equipment, and processes. Chamblee considers safety of the utmost importance when implementing autonomous vehicles for public use. Creating transportation options that allow for collective use by pedestrians and commuters is an integral component of safe and efficient multi-modal transportation.

1.2.2 Research Goals & Collaboration

The proposing team offers several goals of this ADS demonstration. Specific research goals are as follows:

1) Demonstrate the safe integration of ADS into on-road transportation and collect vehicle-level data for an AV shuttle operating at L4 in mixed traffic for safety analysis and rulemaking. The team will investigate situations such as adverse weather conditions, temporary construction zones in the vehicle travel lane, vehicles or transit stopped in the travel lane, vehicle collisions blocking the travel path, pedestrians, cyclists, and other scenarios which will strain the current state of the art autonomous systems.
    a. A phased approach will be used to approach the demonstration of safe operations on municipal roadways starting with testing on a closed course under nominal and anomalous circumstances and ending with a demonstration of multiple L4 AV shuttles operating on a fixed route in mixed traffic.
    b. For data collection, the team plans to use the EZ10 manufacturer standard sensors combined with a custom sensor suite that will include additional sensors such as radar, LIDAR, cameras, IR sensors, Dedicated Short Range Communications (DSRC) on board units (OBU), etc. These sensors will collect data aboard the AV operating in mixed-traffic in a peri-urban environment. Data will be collected during all operations, and the data will be provided to USDOT and the public, and can be

used to advance the understanding on key autonomy challenges, such as determining how filtering and fusing algorithms can be improved to increase safety critical actions.

c. While collecting this data, the team will ensure safety by monitoring the AV shuttle as it moves in mixed traffic along a fixed route. EasyMile offers a "Safety First" approach through an added independent "Safety Chain" used to mitigate the risk of processing unit failure, with the ability to trigger emergency stops if necessary. In addition to the vehicle's established safety features, an onboard safety operator will be employed for the duration of the demonstration as a back-up.

2) Looking toward eventual L5 systems, identify infrastructure modifications necessary for safely integrating the AVs into mixed-traffic on-road transportation systems.
   a. The ADS demonstration program will include the identification of infrastructure modifications necessary for safety. A Site Assessment Report will be produced by EasyMile, summarizing recommendations and requirements for the route that Chamblee will need to implement before the ADS is put in place. For example, existing roadway and sidewalk conditions may require modest improvements. Recommended stop amenities which will drive usage based on current surroundings will also be included. In particular, signage locations must be determined and implemented for pedestrian and vehicle safety along the route. To address this prior to deployment, the engineering staff of EasyMile will identify all potential risks and mitigation strategies along the proposed route for operating in nominal conditions. The City has already begun this work through the operations plan development process currently underway.
   b. The team will use a phased approach to integration, with a closed course being used to test the system in off-nominal and high-risk conditions to determine the needed infrastructure and policies to ensure safe operations of SAVs deployed on the roadways. Identified infrastructure improvements will be made as necessary to improve operations in traffic.
   c. Prior to EZ10 deployment, an EasyMile engineer will manually drive along the route to pre-learn the operating environment and create a reference map. Every intersection and station will be defined; speed limitations and the use of bell/indicators will be programmed. As a result, the EZ10 will know exactly what to do and where to go. EasyMile has demonstrated a proven history of safety, with a zero-accident record after deployment of autonomous vehicles.
   d. Future ADS will not always have the opportunity to operate in ideal conditions. While the proposed EZ10 will carry an onboard operator for these off-nominal conditions, the vehicle will be outfitted with a host of sensors, and the data collected will be provided to the USDOT so that researchers can analyze and identify hazardous conditions resulting from off-nominal driving conditions.

3) Leveraging the strengths of the City of Chamblee, Georgia Tech, and EZmile, to collaboratively engage stakeholders in the community (including law enforcement, EMS, etc.) and affected residents to solicit public feedback is a critical element for successfully implementing the AV shuttle in a way that provides benefits to the community at large.

Figure 1.3. SAV Implementation Steps

   a. Collaboration has been essential throughout the process of preparing for this project. The City was awarded the Georgia Smart Communities Challenge, a Georgia Tech-led initiative bringing together industry and public agencies to help local governments implement smart development. The *Self-Driving Shuttle Feasibility Study & Concept Plan*, created in partnership with Stantec, provided City leaders and community members an opportunity to express their vision for the future of public transportation. Chamblee hopes to promote a healthy and safe living environment by harnessing technological resources and funding to make the vision of developing and maintaining strong multi-modal transportation connections a reality, including the use of SAVs.
   b. As part of this effort, the City of Chamblee plans to engage with the public to obtain qualitative data to better understand customer mobility needs and improve the user experience, as well as understand and mitigate public concerns.

4) Collect data for use in analyzing the path determination and travel of an L4 AV in mixed traffic on a fixed route. Classification of the data according to incidents for use in understanding and recommending potential requirements for data and communications requirements to promote safer AV use on-road.
   a. Incidents will be divided into a number of sub-categories:
      i. Accident: The proposers are planning for this to remain an empty dataset.
      ii. Near-Miss
      iii. Notable Incident
      iv. Correct Vehicle Intervention
      v. Operator Noted Incident
      vi. Random Sample of Nominal Operation

   All data will be tagged and timestamped for search and recovery.

1.3 Focus Areas

1.3.1 Significant Public Benefit(s), Economic Vitality and Prototypes

Chamblee is focused on the safe introduction of Shared Autonomous Vehicles (SAVs) because we believe they will provide significant public benefits. For example, focusing on first/last mile to connect to the Chamblee MARTA station's rail transit would give citizens that struggle making it from the transit station to their destination an alternative option. With Mercy Care – a medical clinic for underserved populations – located along the core SAV route identified in the *Self-Driving Shuttle Feasibility Study and Concept Plan*, the SAV will provide a way to get to and from public rail transit to a group that may not otherwise have access. While the MARTA Gold Line through Chamblee connects to popular local destinations such as the Civic Center and the Arts Center, it also leads directly to Atlanta's Hartsfield Jackson International Airport, providing an even greater national and even international impact of the SAV route.

The EZ10 Driverless Shuttle from EasyMile provides a built-in access ramp for elderly and disabled riders. Aside from increased accessibility, we believe the SAV will cause a decrease in traffic congestion as well as an increase in MARTA ridership. The SAV would help fill some of the gaps that are present along the core route that cause people to drive instead of walk or bike to transit. The introduction of electric SAVs will also contribute to a reduction in carbon emissions and will encourage additional public health benefits throughout the community.

In 2017, the City of Chamblee adopted a *Strategic Economic Development Plan* that identifies a clear pathway to expand the economic base to improve the quality of life of the residents and increase economic vitality of the region. This plan encourages the construction of additional mixed-use developments and infill developments adjacent to Peachtree Road, where the core route of the SAV would be located.

The EasyMile shuttle is one of the most straightforward vehicles to implement on existing streets. The EZ10 Driverless Shuttle is advertised to, "operate on existing roadways with no additional infrastructure required". The City is working with EasyMile to evaluate options for "quick charge" infrastructure. This infrastructure, would allowing the shuttle to charge at a stop while picking up passengers, effectively keeping the vehicle in operation for longer periods at a time.

1.3.2 Technological Complexity, Market Failures and Transportation-challenged Populations

Autonomous vehicle developers are currently advancing fully self-contained and self-sufficient autonomous vehicles that do not rely on active external information being passed to the vehicle. No information coming from the vehicle's surrounding infrastructure or from other vehicles on the road is being integrated or incorporated into the vehicle's decision-making processes. The critical reason is that external information is not mandated or regulated and currently does not yet exist in significant quantities for integration. Therefore, autonomous vehicle developers advancing into this space must develop vehicles which are self-reliant, using on-board sensors only to define the world around them. As of now, using this unregulated framework, no Level 5 autonomous vehicles exist.

This project will focus on exploring the options for improving AV safety and driving autonomy towards L5. The team will investigate what and how external communications from an AV's surroundings, both from infrastructure and from fellow vehicles on our roads, should be provided to AVs in order to overcome limitations in on board sensor technology, machine intelligence, and other technologies used in safe path determination. This project will explore the use of DSRC communications from infrastructure and vehicles in nominal and atypical driving situations and in various weather conditions. The team will focus on determining the necessary external communications that should be recommended for increasing AV safety. The team plans to determine the types of communication that if provided by government and automobile manufactures will lead to safer and more robust ADSs.

The current market of Shared Autonomous Vehicles lacks private entities that provide shuttle services to all citizens. Furthermore, data and lessons learned about the implementation requirements on municipal governments remains unstudied. The City of Chamblee desires to be on the forefront of this technology and provide public access to SAVs as an amenity to all its citizens. The diverse demographics that are present within Chamblee would allow the SAV to reach many different groups of individuals; 50% of our population speaks Spanish, 25% of the residents in Chamblee are millennials/young adults (25-34) compared to 13% of the Atlanta metro-area population, and the City of Chamblee is more densely populated than the Metro Atlanta area (3,720 residents per square mile vs. 630 residents per square mile in the metro-area). To assist in incentivizing ridership on the SAV, the City of Chamblee will subsidize fares during this demonstration program. This program would be a pioneer for this type of technology not only in the region, but also nationally.

1.3.3 AVs are an Impetus for a Diversity of Projects

The City of Chamblee has developed concept plans to create a Mobility Hub in an underutilized area in front of the MARTA train station along Peachtree Road. This would provide riders a pleasant place to relax while their connecting bus arrives, a place for the SAV to stop and pick up passengers, and even serve as a destination for some individuals. The Mobility Hub, in conjunction with the SAV, would provide a number of transportation options for current and potential bus and train riders in need of first/last mile connectivity.

The implementation of a Shared Autonomous Vehicle in the Town Center area would serve as a catalyst for a range of capital improvement

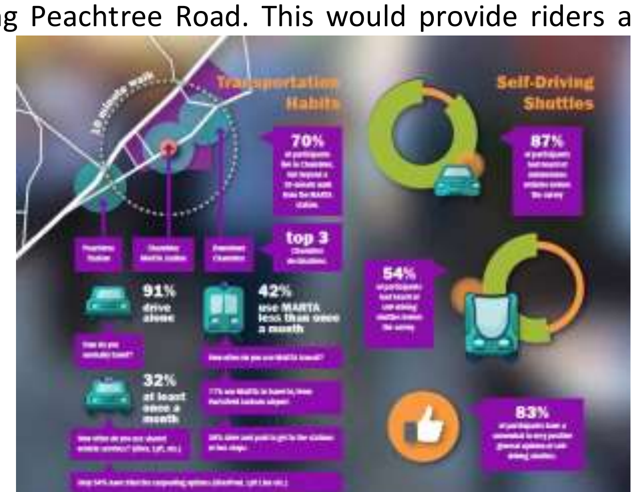

Figure 1.4. Proposed SAV route in downtown

projects, benefitting both private and public entities. We believe a SAV route will increase the desire to redevelop MARTA properties as part of their Transit Oriented Development program, which would economically benefit both the area along the SAV route and the City as a whole. With the advanced technology that is required for the SAV, it would show the growing technology sector that a market for these industries exists outside of downtown Atlanta and encourage new high-tech jobs in the region.

1.4 Requirements

The USDOT has outlined a number of requirements specifying the types of demonstration and information to be produced by the performers under this grant. The following section describes how the proposers plan to satisfy the requirements by building from extensive ongoing work in enabling Chamblee to be a leader in AV implementation.

1.4.1 Advancement of Automation Technologies

The collaborative team including local government, an AV manufacturer, and academia is proposing to advance the state of the art in AV technology through series of multi-year testing activities leveraging the strengths of each of the team members.

Georgia Tech will be outfitting the vehicle with additional sensing capability and data storage with the goal of providing an open data set for use by current and future researchers in improving system safety. However, beyond this long-term data collection activity, the proposers are additionally offering to advance the AV industry through purposeful introduction of off-nominal operating conditions, and storage and sharing of those that may occur throughout regular use within the period of performance. The off-nominal cases are intended to assist the USDOT and vehicle manufactures with information allowing regulatory changes, such as potential mandatory data sharing around accidents, and infrastructure changes, such as required connected vehicle technology inclusion in emergency response and construction. These proposed interactions between the infrastructure and the vehicle are designed with the eventual future of L5 autonomous systems in mind.

1.4.2 Physical Demonstration

The City of Chamblee, in partnership with the Georgia Institute of Technology, Atlanta Regional Commission, Georgia Power and Stantec Consulting, has been developing the framework for a self-driving shuttle in Chamblee over the past 18 months. Most of the analysis and planning work is complete, and this timely grant proposal offers the opportunity to accelerate the implementation of this plan with an on-road AV. The planned implementation includes an initial physical demonstration on a closed course to test the vehicle's behavior in off nominal circumstances, followed by a series of on-road demonstrations.

The City of Chamblee Self-Driving Shuttle Feasibility and Operations plans resulted in the selection of the Peachtree Road corridor as the preferred route and proposed recommendations for changes to the built environment including revisions to the roadway, curbs, transit stops, signage, ADA accessibility, etc. These changes will ensure that the right environment is created for the testing of ADS technology. This preparatory effort eliminates a major hurdle to the demonstration project and will result in a shuttle-ready corridor, from a safety perspective. This will allow the project to focus on the implementation and testing of ADS and associated technologies as well as maximizing operational time for data collection.

The proposed demonstration shuttle will connect residents to metro Atlanta's heavy rail line (MARTA) at the Chamblee MARTA Station and will travel through the City's Town Center and Mid-City districts which are currently experiencing a renaissance with multiple multifamily residential, restaurant, office, and retail developments recently built or underway. The goal will be to provide connectivity to key city locations, with an emphasis on improving access to affordable transportation in the community.

The physical demonstration consists of 3 separate demonstrations, described below:

1) Testing on a closed course with intentionally introduced anomalous events to understand the vehicle's response across a full range of possible operating scenarios and make adjustments as necessary. This phase will last at least 6 moths, with the goal of obtaining enough test data to ensure confidence in the safety of the vehicle in the extents of possible scenarios that may be encountered on-road. The length of this initial phase may be adjusted based on the results of the testing. This will be supplemented by modeling and simulation activities that will use the data gathered from the closed course testing to simulate real-world driving conditions when a high percentage of cars are connected vehicles (can be AVs). This will be used to investigate the situations and messages required (leading to regulation recommendations) to increase safety and autonomy of AVs based on knowledge gained from initial research. The addition of modeling and simulation at this step will allow the team to test integration behaviors prior to operating the vehicle in traffic as well as conduct additional experiments that will explore technologies required for eventual L5 operation.
2) The AV shuttle will traverse a fixed route through the City's main street, Peachtree Road, and work seamlessly with already available local and regional transportation options. The **proposed initial SAV route** is 1.1 miles long with five stops, including a connection to the MARTA Gold Line and Bus Routes 103, 132, 825, and 408 at MARTA's Chamblee Station. Five proposed stops: Peachtree Station, Mercy Park, MARTA, Chamblee Dunwoody Way, and Broad Street comprise the core route. The core route is also very conducive to safe SAV operations, with an array of traffic-calming measures and multi-modal accommodations. Operational

Figure 1.5. Proposed SAV Stop along Peachtree Rd

details for core route are shown below.
- Core Route Distance, one-way: 1.1 miles
- Headway (two vehicles in service): 8 minutes at an operating speed of 12 mph
- System Capacity: 90 persons/hour

3) In the final stage of the demonstration, an **extended route** will be used that increases the route length to 2.1 miles and adds stops at Third Rail Studios and Assembly Yards, connecting these employment and future residential areas with businesses and services along Peachtree Road. To safely serve these employment centers, additional efforts to calm traffic and reduce driveway access are necessary, and this route will begin service once the necessary infrastructure improvements have been made. Overall, the route requires only modest infrastructure improvements for implementation and connects key destinations with places of residence and employment. Operational details for the extended route are shown below.

Figure 5. SAV Route at Chamblee Tucker Rd and Peachtree Rd Intersection

- Extended Route Total Distance, one-way: 2.1 miles
- Headway (2 vehicles in service): 15 minutes at operating speed of 12 mph
- System Capacity: 51 persons/hour

Chamblee plans to maintain three EZ10 vehicles, supplied by EasyMile. The use of three vehicles provides redundancy and is intended to ensure that two EZ10 vehicles are available for City transport operations while one is used in additional testing scenarios.

1.4.3 EZ10 Vehicle

The City's preferred vendor is EasyMile due to the capability of their vehicles to be ADA accessible. EasyMile is required to get a federal exemption from NHTSA to operate on public roads (as no autonomous shuttle complies with the current FMVSS standards). In October 2018, NHTSA updated their process for granting these approvals and EasyMile was the first to apply and be approved for projects via this new process.

EasyMile was at the forefront of this change with the federal government during this process. This is a testament to the level of experience that EasyMile has deploying the autonomous technology around the world, resulting in being recognized as the leader in this space. EasyMile continues to work closely with NHTSA, Federal Transit Administration (FTA), Federal Highway Administration (FHWA), Volpe, and other branches of the federal government, and continue to work with California, Colorado, and other states as driverless regulations are developed and refined.

Figure 1.6. Proposed SAV Stop along Peachtree Rd

The updated federal process requires the importer to submit vehicle and project-specific information. To date, EasyMile has successfully imported around 20 vehicles and received approvals for all of projects (over 30 project-specific approvals).

EasyMile's EZFleet system compiles thousands of data points throughout the EZ10s' operations and, as such, can be quite informative for reporting purposes. EasyMile will share many of these data points with the City via its APIs in addition to training the City's Customer Service Ambassadors on how to collect useful operating data throughout the service. In addition, the City is partnering with Georgia Tech to add additional equipment onto the shuttles to fill data gaps.

EasyMile's EZ10 are manufactured by Ligier on a dedicated assembly line in its Vichy, France factory. Therefore, Chamblee will be applying for an exemption from the Buy American Act and hope to be approved by the Agreement Officer before purchasing these vehicles.

1.4.4 Secondary Sensor Network

The purpose of the secondary sensor network is to collect incident data without directly interfering with the safety critical primary sensor network of the EZ10. With this goal in mind, the secondary sensor network will not be directly designed to match the sensors of the EZ10, but instead will be configured to best capture the operationally relevant incident data for future L5 deployment.

Georgia Tech will outfit the vehicle with a broad range of representative sensors including: LIDAR, radar, cameras, IR/Multi-spectral imagers, and additional AV sensors that may become available in the timeframe of operations. This will go beyond the sensors currently used by the EZ10 to drive autonomously and will provide AV researchers and commercial entities a database of on-road vehicle interactions for use to investigate where sensor and data processing failures are likely to occur. Furthermore, the inclusion of these additional sensors and the associated stored data is intended to help the USDOT in determining potential windows for mandatory and regulated data sharing around AV accidents enabling all vehicle manufacturers to learn from incidents, and to assess the minimum sensor configuration requirements for safe operation.

An initial task for the proposers will be to work with the USDOT to optimize the secondary sensor network to best capture L5 relevant data for storage on the USDOT's Secure Data Commons. Georgia Tech is nominally planning a sensor network with the following components: 2 velodyne LIDAR, 2 Ouster LIDAR, PointGrey equivalent forward and rearward looking stereo vision, Bosh Mid and Long range automotive radar, 360 degree video assembled from multiple feeds, two Novatel GPS receivers, a FLIR IR camera, and potentially a Georgia Tech AESA imaging radar borrowed from a UAV to represent the types of data likely to be available in the near future. These sensors can be utilized to build a rich picture of the operating environment at any given moment.

Based on experience at Georgia Tech in outfitting similar sets of sensors to vehicles, it is anticipated that the secondary network will be capable of generating gigabytes of data per minute. As a result, a significant data storage solution will be required on and off board the AV to house the raw and processed sensor data being generated by this array.

1.4.5 Data Sharing

The City is committed to gathering and sharing all relevant and required data with the USDOT throughout the project, in near real time. Data will also be made available to USDOT and the public for at least 5 years. Through partnerships with the Georgia Institute of Technology, EasyMile, and others, the City is committed to furthering the availability of data related to ADS technology prior to, during and after the implementation of project. Details related to data collection are outlined in Part 3 of the City's application. The City has a vested interest in improving the technology through testing, data collection, data sharing and collaboration with similar groups to create a long-term alternative mode of transportation for City residents and visitors nationwide. Currently, the City feels that the future removal of the on-board attendant and consequent reduction in operating costs is a viable means in which the City can permanently operate the Peachtree Road shuttle.

1.4.6 Vehicle Input / Output

Through partnership with EasyMile, the City is committed to including interfaces that are accessible and allow various types of users to utilize the information/technology. However, this proposal is focused on municipal vehicles, and as such the input interfaces are not intended to be tailored to the general public, and the output interfaces are to be tailored toward vehicle localization and safe operation on public roads.

For example, the City proposes to equip other vehicles such as police vehicles with related connected vehicle technology that can communicate with the shuttle to test how it reacts to emergency vehicles. In addition, the Georgia Institute of Technology will be leading the effort to test which connected vehicle technologies are necessary to ensure safe operation in emergency and road construction scenarios. Any updates to the routing of the vehicle will be performed at the municipal level, and output interfaces will be focused on how this information is presented to the public.

1.4.7 Scaling the Effort and Outreach

As one of the first mixed-traffic SAV routes in North America, Peachtree Road will be unlike any other, and as such, needs to orient users to the new operating conditions. We believe the City of Chamblee's self-driving shuttle is a representative SAV implementation in a municipality that is both scalable and relatable to other government organizations/transit agencies. The lack of efficient, safe and affordable first and last-mile connectivity is a problem throughout the country. Based on the analysis and studies conducted by Chamblee in conjunction with Georgia Tech, a self-driving shuttle appears to be one of the more sustainable methods of providing this missing link. Therefore, similar treatments may be very attractive to other places throughout the country.

The proposers are enthusiastic partners in helping the USDOT share lessons learned throughout the demonstration. By partnering with the Atlanta Regional Commission and the Georgia Institute of Technology, the City will have a local, regional, and national forum to share information and lessons learned to transfer knowledge throughout the country. The proposers anticipate publication and presentation at national conferences and forums. Furthermore, the proposers plan on supporting any USDOT outreach that may occur during the life of the program.

To ensure broad exposure, the City will host a webpage regarding the project and host an annual site visit and education program to highlight the demonstration project in tandem with these partners.

1.5 Approach

1.5.1 Chamblee is Demonstration-Ready

Figure 1.7. Future SAV Streetscape along Peachtree Rd

The City of Chamblee has already laid the groundwork for this project, as it is truly shovel-ready. In May 2018, the City adopted a *Self-Driving Shuttle Feasibility Study & Concept Plan*. In September 2018, the City received a grant to partner with Georgia Tech to develop an Operations Plan, the next step in the implementation process that determines the alignment, priority treatment, schedule, number of vehicles, and storage solutions. Additionally, the City is working with a Georgia Tech team to research and develop a report on best practices for implementing a shuttle that is not only utilitarian, but can also be a model for deployment with mobility, economic, equity, and place-making benefits. Chamblee is in a unique position to demonstrate an ADS on our public roads from early on in this project.

The City of Chamblee would purchase an SAV for its pilot shuttle. EasyMile, an internationally known company with regional offices in Denver, CO, will sell three EZ10 shuttles to the City of Chamblee to implement this project. EasyMile provides a 100% driverless, electric vehicle that can carry up to 15 passengers. One challenge that the City of Chamblee found when looking at potential manufacturers was finding vehicles capable of providing accessibility accommodations to all individuals that may wish to ride the shuttle. The EZ10 Driverless Shuttle provides a built-in access ramp. Additionally, this shuttle is advertised to “operate on existing roadways with no additional infrastructure required” (http://www.easymile.com/#About). This will lead to a relatively short period between project initiation and day one of operation.

EasyMile will provide a shuttle capable of L4 autonomy. The current federal requirement for there to be an individual on the shuttle during operation restricts the ability for the proposed shuttle to be fully automatic, however, Chamblee will designate the individual on the SAV during operation to serve as a “City Concierge” as has been done in other cities like Las Vegas. The “City Concierge” would be a good resource for both individuals who are visiting the area as well as citizens that may not know the rich history of the City of Chamblee.

1.5.2 Technical Approach to Improving AV Safety

Human drivers are susceptible to distraction, miscalculation, or the same from other drivers on the road, leading to serious collisions. AVs which mimic a human driver's sensory inputs will be ever-vigilant, but similar to human failure, sensors can fail, have interference, or even be hacked. All current AVs failsafe response to a situation where the vehicle becomes confused is to either disengage self-driving and return control to a human in the driver's seat or to simply come to a stop. Neither scenario is an acceptable answer on the path to reaching L5 autonomy. Without additional information to supplement and confirm on board sensors, there may be situations AVs encounter that cause them to have low confidence in their path determination and lose full autonomy.

AVs use a variety of sensor technologies to map their surroundings including LIDAR, radar, visual cameras, infrared, and ultra-sonic. Each sensor type has its advantages and disadvantages and it is the combination of sensors that AV developers hope to use to build a complete and redundant picture of their environment. Single sensors are not perfect, and it requires the algorithmic integration of numerous sensors for AVs to build a complete picture of the world around them. AVs need as much information as possible to ensure a high confidence path determination and maintain high levels of safety. AVs counter individual sensor failure by having redundant sensors and sensor types as well as pre-populated databases of route features produced by AV manufacturers. These pre-populated databases are first and foremost proprietary and second static. Therefore, there is no way for regulators to access, inspect, or augment that data, especially in real-time.

Therefore, the project team proposes to outfit an EZ10 shuttle with an array of sensor classes to gather non-proprietary data for use in determining situations and scenarios when AV sensors produce low confidence in path determination. The team will purchase and outfit the shuttle with a LIDAR, radar, visual cameras and IR cameras to gather and store sensor data as an AV travels through mixed-traffic in Chamblee and on closed courses at L3 and higher autonomy. This data will be linked with how the AV responds to driving situations it encounters and the high-level data that is provided by EasyMile.

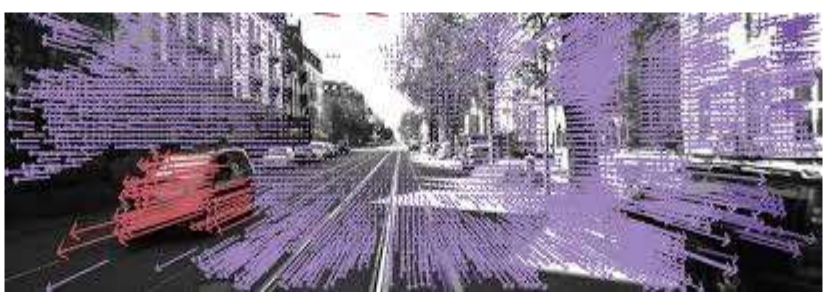

Figure 1.8. Representative image of research Georgia Tech has performed in 3D sensor data collection and visualization.

The team will investigate what and how external information can act as both a trigger for how an AV responds to its on-board sensors as well as verification for situations when those sensors fail to produce a confident result on their own. The team will investigate situations such as adverse weather conditions, temporary construction zones in the vehicle travel lane, vehicles stopped in the travel lane, vehicle collisions blocking the travel path, pedestrians, and other scenarios which will strain the current state of the art autonomous systems.

1.5.3 A Phased Approach

The proposing team plans to approach this project in multiple phases over the project timeline:

Phase 1: Collect sensor data from an AV driving a closed course and in mixed traffic on a fixed route. Investigate failure mechanisms of those sensors which can lead to vehicle stops or disengaging of autonomy. Investigate driving situations and the types of communication from a vehicle's external environment that will be required to be delivered from infrastructure and other vehicles that may increase autonomy in those situations in pursuit of L5 autonomy.

Phase 2: Model and simulate real world driving conditions, including when a high percentage of cars are connected vehicles (can be AVs). Investigate how the behaviors observed on the closed course will translate into on-road operations with other vehicles present. Looking toward future L5 autonomy, further investigate the situations and messages required between connected vehicles (leading to regulation recommendations) to increase safety and autonomy of AVs based on knowledge gained from Phase 1 research. This is a purely a modeling and simulation task which looks at a more holistic driving environment beyond 1 vehicle. This task will use an existing Georgia Tech policy-based simulation framework called F2.

Phase 3: Develop a framework and proposed standard for governments to implement supporting the necessary V2V and V2I messages to increase safety of AVs based on Phase 1 and Phase 2 research. Investigate a framework and proposed standard for governments and vehicle manufacturers to implement outlining what and how messages are passed, stored, and processed between vehicles and infrastructure, including who is mandated to pass what messages, when, and with what priority in pursuit of increasing AV safety on our roads, including who owns and maintains the data required to perform these tasks.

Phase 4: Implement a demonstration of an AV (EasyMile) driving at Level 3 or greater which integrates external messages from both infrastructure and other vehicles on the road. Demonstrate that messaging leads to better decision making, safer driving, and brings AV's closer to L5 autonomy in a peri-urban environment (Chamblee).

Figure1.9. Implementation Schedule

1.5.4 Risk Mitigation and Technical Competence

The proposing team has a variety of knowledgeable and experienced professionals who have worked in extremely relevant areas which will contribute to the success of this project. Specifically, the research team at Georgia Tech has years of experience in sensor systems, data analysis and data storage, and has developed autonomous vehicles (cars, boats, helicopters, planes) under several government contracts. The experience gained will support the research to be performed on this contract.

Figure1.10. Georgia Tech's autonomous Porsche Cayenne.

During Phase 2 of the project, Georgia Tech plans to reduce risk by using an established policy based simulation framework, called F2 developed in house at Georgia Tech, to perform the modeling and simulation F2's simulation framework is designed to allow users to analyze and optimize scenarios wherein agents (vehicles/infrastructure) interact in a complex and dynamic manner. The most critical component of the F2 framework is the concept of policy-based decision making, where agent decision-making nexuses are identified and coded in the software as interfaces. For each decision-making nexus, developers and analysts can determine one or more ways in which that decision could be made and add a model for that decision-making option. At runtime of a scenario, the user is able to configure on a per-agent basis how these decisions are made to simulate the complex interactions between agents. Within the framework, agent communication is governed by a directional graph, where each agent stores a list of other agents to which it is allowed to communicate. This can be either a non-directional communication line (where two agents know nothing about each other), a uni-directional communication line (where one agent knows about another, but not vice versa), or a bi-directional communication line (where both agents know about each other). A common message passing interface allows agents to trigger commands to each other, which can in turn create events within the simulation to which the agents react.

One key feature of F2 that has been developed and demonstrated is the notion that transport of components between agents within a simulation requires physical movement through some type of vehicular transport. F2 supports modeling of both independent (wherein the vehicle is effectively moving itself through the environment) and dependent motion of vehicles (where a central controller is responsible for instructing vehicles as to their motion). Models have been developed for both freeform motion where vehicles are allowed to travel in any direction they wish and restricted motion where vehicles must maintain pathing on defined rails, paths, or roads. Transportation networks can be as simple as all vehicles have access to all paths and as complex as restrictions of vehicles onto a certain subset of paths. Vehicles currently have policies governing how they communicate and how they should route themselves from their current location to their destination. Vehicle destination is currently governed by the message passed to the vehicle from some other source, which can be configured to trigger vehicle motion in any number of ways. As an example of the effect of policy, consider the routing problem. One option for vehicles is to use static routing, where the vehicle looks at the configured transportation network when it starts moving and determines the best path (akin to looking at Google Maps on your computer before you head out the door). Another option is to use dynamic routing, where the vehicle is able to update its route continuously as it is in motion (such as would be experienced with an onboard navigation system with live traffic updates). Each of these methods for making the decision on how to get from the originating location to the destination can result in different dynamic behavior, particularly when considered at the scope of tens, hundreds, or thousands of vehicles.

1.5.5 Commitment to Open Data

The city of Chamblee understands the desires of the USDOT in this notice of funding opportunity to acquire data from autonomous vehicles for use in populating a secure data commons for transportation researchers. Our proposed team consists of experts from local government, private industry, and academia whose combined expertise can produce the types of data beneficial to the investigation and advancement of AV safety on our nation's roads. Georgia Tech will make all relevant data accessible to the government with no restriction. It is assuming that not all raw sensor data collected over the life of the project will be stored or accessible by the government or public, however, the team is committed to providing access to interesting and meaningful data from incidents at levels i – iii (as defined previously in section 1.2.2-4a) which can be used to drive lessons learned and advance autonomy.

1.5.6 Cost Share

In addition to an over-$4,000,000 investment in preparing the Peachtree Road route for SAVs, the City of Chamblee is committing $100,000.00 of its own resources to this program. This is no small commitment from a metro-Atlanta community of approximately 30,000 residents. The funds will be allocated by the City Council in support of this program and will be used to support municipal operations of the shuttle, infrastructure improvements, and communications equipment installations on city vehicles and city infrastructure.