Miami-Dade County Digital Platform for Integrating ADS

Leveraging Technology, Collaboration and Data-Sharing for Better and Safer Roads

Submitted by: Department of Transportation and Public Works (DTPW)
Miami-Dade County, Florida
Opportunity Number: 693JJ319NF00001
March 21, 2019

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March 20, 2019

U.S. Department of Transportation (DOT)
Federal Highway Administration (FHWA)
1200 New Jersey Ave. S.E.; Mail Drop: E62-204
Washington, DC 20590
Attn: Sarah Tarpgaard, HCFA-32

Subject: USDOT, FHWA's Automated Driving System (ADS) Demonstration Grants, Funding Opportunity No. 693JJ319NF00001

Dear Ms. Tarpgaard,

Miami-Dade County is thrilled with this opportunity provided by the U.S. Department of Transportation. We are ready to translate this funding opportunity into a successful program for automated systems where decisions are data driven, ensuring the safe application of ADS to improve the current transportation systems. Additionally, we have nurtured important relationships with both private and public stakeholders in relation to ADS; this will allow us to be in optimum position to get a head start.

Our program application proposes the creation and deployment of a data management platform that enables safe data exchange between connected and automated vehicles (CAVs), and city infrastructure. The proposed demonstration project seeks to integrate ADS and ITS technologies to demonstrate cooperative ITS (C-ITS) capabilities in real-world environment and to evaluate how C-ITS can facilitate the connectivity, accessibility, data sharing, safety and electrification of ADS. Specifically, this project will demonstrate on-demand ADS service for the elderly and differently abled people, combined with signal priority for on-demand ADS shuttles and dynamic curbside management for automated shuttles and trucks to improve accessibility and test C-ITS.

Additionally, our program application is a model collaborative effort between Miami-Dade County, our Transportation Planning Organization (TPO), our biggest university, Florida International University (FIU), local municipalities within Miami-Dade, and private industry leaders such as Xtelligent, Ford Motor Company, Volvo Group, Ridecell and the Society of Automotive Engineers (SAE).

Our ultimate goal is to create livable streets in our County through the safe, efficient and sustainable application of innovative transportation systems, and we believe that the integration of ADS and ITS systems is part of the critical path to get us there. We truly appreciate this opportunity and look forward to fulfilling U.S. DOT's vision of a smart and connected county where everyone can safely enjoy mobility freedom.

Sincerely,

Alice Bravo

Alice N. Bravo, P.E.
Director

C: Honorable Carlos A. Gimenez, Mayor

Project Name	**Miami-Dade County Digital Platform for Integrating ADS**
Eligible Entity Applying to Receive Federal Funding	Miami-Dade County Department of Transportation and Public Works 701 NW 1st Court, 17th Floor Miami, Florida 33136
Point of Contact	**Alice N. Bravo, P.E.,** Director, MDC DTPW Email: alice.bravo@miamidade.gov Phone: (786) 469-5307
Proposed Location (State(s) and Municipalities) for the Demonstration	City of Miami, Miami-Dade County
Proposed Technologies for the Demonstration (briefly list)	*Deployment:* • ADS Vehicles • Cooperative -ITS (C-ITS) • ITS infrastructure (Adaptive Traffic Signals with CV Capabilities) *Use case:* • On-Demand ADS Shuttle Service • Automated Urban Delivery Truck Last-Mile Delivery • Dynamic Curbside Management • ADS Signal Priority
Proposed Duration of the Demonstration (period of performance)	4 years
Federal Funding Amount Requested	**$9,956,266**
Non-Federal Cost Share Amount Proposed, if Applicable	$12,715,018
Total Project Cost (Federal Share + Non-Federal Cost Share, if Applicable)	$22,671,284

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PART 1- PROJECT NARRATIVE AND TECHNICAL APPROACH

INTRODUCTION

The Miami-Dade County Department of Transportation and Public Works (DTPW), Miami-Dade Transportation Planning Organization (TPO), Florida International University (FIU), Xtelligent, Ford Motor Company, Volvo Group, Ridecell, and Society of Automotive Engineers (SAE) International are pleased to partner on this Automated Driving System (ADS) Demonstration program. It is becoming increasingly clear that autonomy without connectivity and cooperation with roadway infrastructure network is sub-optimal, and may significantly delay the wide adoption of ADS technology. This demonstration project targets connectivity between ADS and Intelligent Transportation Systems (ITS) infrastructure to address this critical and catalyzing component that can enable rapid and safe deployment of ADS in the Nation's roadways.

The vision for this deployment is to leverage technologies that enable connectivity and cooperation between ADS and Miami-Dade County's traffic signal control system, dynamic lane blockage system, and dynamic curbside assignment system to research the benefits of how system integration of ADS with city infrastructure can have public benefits, including safety, energy efficiency, mobility, accessibility, and environmental impacts. The Cooperative Intelligent Transportation System (C-ITS) involving the integration of ADS and ITS infrastructure will be able to adjust and adapt its traffic signal timing based on the movement of the ADS vehicles. Conversely, the C-ITS system will have the ability to provide critical signal timing data to the ADS platform to help with safe operations of ADS vehicles. This will contribute to lay the foundation for additional cooperation between ADS and C-ITS, including sharing information in regards to dynamic lane closures, curbside management, and urban freight last-mile delivery that can further support the integration of ADS into the Nation's transportation network.

The proposed ADS and C-ITS deployment will take place at Downtown Miami and Health District areas in the City of Miami, where disproportionate benefits will be felt by large pedestrian crowds, bikes, and disabled communities, along with city departments that provide emergency services. Specifically, this project will demonstrate on-demand ADS service for the elderly and differently abled people, combined with signal priority for on-demand ADS shuttles and dynamic curbside management for automated shuttles and trucks in the Health District to improve accessibility and test C-ITS. The project also aims to research user behavior in presence of ADS, public response to dynamic curbside management services, and ADS challenges with differently abled populations.

About Miami. Miami-Dade is Florida's largest metro area with Downtown Miami as its hub, which is an economic engine and the cultural, financial, and commercial center of South Florida. Miami is the 12th large metropolitan area with the worst traffic congestion in the nation and 14th most dangerous metropolitan area for pedestrians. Additionally, older adults (65 years and over) make up over 15% of the County's population and 45% of the older adults have some form of disability. As the population continues to age, and with the likelihood of having a disability increasing with age, the number of individuals with disabilities in Miami-Dade is expected to accelerate in the coming decades. This project aims to address these pressing challenges, and will include a number of innovative applications to be developed with scalability, reliability, and adaptability.

1. EXECUTIVE SUMMARY

VISION, GOALS, AND OBJECTIVES

The vision for this Automated Driving System (ADS) Demonstration program is to leverage technologies that enable integration and cooperation between ADS and city infrastructure to enhance vehicle awareness on dynamic network conditions and improve ADS and overall system performance. Demonstration of technologies enabling Cooperative Intelligent Transportation System (C-ITS) has been limited. This program will introduce a platform that supports cooperation of ADS and ITS to facilitate the safe development and deployment of ADS technologies and services in real-life roadways. In addition, the program will demonstrate C-ITS capabilities for providing on-demand automated driven shuttles for elderly, differently abled people and last-mile freight delivery.

The following section establishes the goals and objectives that will support the vision of the proposed demonstration project.

Goal 1: Enable integration and cooperation between ADS and city infrastructure
This project will directly leverage existing and planned investments in Miami-Dade County and deploy a data management platform to demonstrate C-ITS capabilities in real-world environment. The following objectives will support this goal:

- Leverage and expedite the roll-out of both, the on-going upgrade of 3,000 traffic signals to adaptive traffic signals with Automated Traffic Signal Performance Measures (ATSPMs) capabilities and the planned 26,400 Light Emitting Diode (LED) streetlight conversion and integration with Internet of Things (IoT) Mobility Solutions
- Create a digital data management platform to enable information exchange between Connected and Automated Vehicles (CAVs) and city infrastructure.
- Lay the foundation for connectivity that can enable data exchange between automated vehicles and city infrastructure.
- Test vehicle-to-infrastructure (V2I) communication that enables infrastructural adaptability (i.e., traffic signal timing considering the ADS approaching the signal)
- Enable infrastructure-to-vehicle (I2V) communication that enhances vehicle awareness, thereby improving safety and efficiency of ADS (i.e., communicate signal information, dynamic lane closures, dynamic presence of pedestrians, and dynamic curb space information).
- Utilize C-ITS as a demonstration case to test the data management platform concept.

Goal 2: Improving ADS and Transportation System Performance
This goal is to improve ADS and transportation system performance for Miami-Dade residents and visitors. The introduction of ADS, in collaboration with the local governments, will ensure that the safety, mobility, efficiency, energy, and environmental benefits are maximized. The following objectives will support this goal:

- Test V2I communication that would enable Miami-Dade to make real-time (or near real-time) infrastructural decision to enhance performance.
- Test I2V communication providing greater situational awareness to ADS, including CAV operation support and dynamic network change awareness.

- Test I2V communication providing dynamic curbside space information to ADS to allow optimal last-mile freight delivery and pick-up and drop-off of passengers, particularly differently abled people.
- Demonstrate and evaluate operations and safety performance of AV shuttle serving disadvantaged populations, particularly people with disabilities.
- Study interactions and identify challenges for ADS operations in urban areas with micromobility services and large pedestrian crowds.

Goal 3: Data Collection, Testing and Sharing

This project seeks to collect, share significant data and test ADS in support of its development and advancement. The following objectives will support this goal:

- Identify metrics to assess the performance of ADS technologies and services.
- Identify data and data sources associated with the performance metrics.
- Collect, archive, and share the required ADS data and city infrastructure data that allow the estimation of the metrics.
- Host demonstration events that showcase/exhibit ADS technologies and services to the public, decision makers and policymakers.

PROJECT TEAM, ROLES AND RESPONSIBILITIES

The project team includes government, research, and private entities that bring complementary capabilities and expertise.

Key Partners: DTPW will be the lead agency for the deployment of the proposed ADS demonstration program from the government side. DTPW, the agency responsible for the management of traffic control devices and transit systems serving all 34 cities within the County, will be responsible for the long term operations and maintenance of the equipment. DTPW will be custodian of the collected data and responsible for the data management. FIU will lead the project evaluation process, provide project management support, and support DTPW with data management efforts. Xtelligent, a Department of Energy (DOE)-funded V2I and C-ITS venture will be providing technology, engineering, and Research and Development (R&D) capability. Ford Motor Company, Ridecell and Volvo Group will support testing the impact of ADS when integrated into road traffic management infrastructure. SAE International will be supporting technical standards development, data sharing and information dissemination. Miami-Dade TPO will coordinate stakeholder engagement and review project plans to ensure consistency with local planning activities and regulations.

Other local partners and stakeholders such as Florida Department of Transportation (FDOT), City of Miami, Miami Downtown Development Authority (DDA), Health District business and healthcare centers, fire and police departments, and underserved communities, will further support the program.

ISSUES AND CHALLENGES TO BE ADDRESSED

Below are the challenges and issues to be addressed.

ADS Needs for Connectivity: It is becoming increasingly clear that autonomy without connectivity and cooperation with road infrastructure is sub-optimal, and may significantly delay the wide adoption of ADS technology across the U.S. This demonstration project specifically targets connectivity between ADS and ITS as a way to address this critical and catalyzing component that can enable rapid and safe deployment of ADS in the Nation's roadways.

Congestion and Economic Cost: Congestion is the most pressing challenge faced by Miami-Dade County. Miami is Florida's largest metro area with Downtown Miami as its hub, which is an economic engine in Miami-Dade and the cultural, financial, and commercial center of South Florida. In 2018, the cost of congestion was estimated at $4 billion, making Miami the 12th large metropolitan area with the worst traffic congestion in the nation. Commuters spend 105 hours in congestion, costing an average of $1,470 per driver. This project aims to demonstrate how the integration of ADS and C-ITS can reduce congestion and congestion costs through travel time savings and reduced crashes resulting from optimal AV routing and optimal signal control for the general traffic.

Environmental Impacts: Southeast Florida region is one of the most vulnerable places in the world when it comes to climate change impacts. By 2060 the sea level is projected to rise anywhere between nine (9) and twenty-four (24) inches. Tidal related flooding has already been a problem in the City of Miami Beach. Salt water intrusion is occurring at a fast rate, endangering our supply of freshwater from underground. Since congestion has a considerable impact on GHG emissions, this project deployment aims to demonstrate how connectivity between ADS and traffic management infrastructure can help reduce emissions by optimizing traffic management infrastructure operations, reducing stop-and-go conditions, gas consumption, and travel time among others.

Accessibility and Safety: Florida has the largest percentage of 65-and-older population (19%) in the U.S. In Miami-Dade County, older adults (65 years and over) make up over 15% of the County's population and 45% of the older adults have some form of disability. As the population continues to age, and with the likelihood of having a disability increasing with age, the number of individuals with disabilities in Miami-Dade County is expected to accelerate in the coming decades. Additionally, Miami has been ranked as the 14th most dangerous metropolitan area for pedestrians[1]. According to the most recent published data, 285 people died in Miami-Dade County due to a traffic-related crash, including 58 pedestrian fatalities and 13 bicyclist fatalities.

This project seeks to research user behavior and interaction of disadvantaged population, particularly the elderly and differently abled population with automated vehicles with the demonstration of an on-demand ADS service that is integrated and cooperating with ITS traffic management infrastructure. If curbside space is allocated and dynamically monitored by infrastructure sensors, information on availability of space and special needs of the users can be provided to on-demand ADS service and freight delivery trucks to minimize delay (i.e. pick-up/drop-off time, wait time, in-vehicle time) and improve safety

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[1] 2019 Dangerous by Design. Smart Growth America and the National Complete Streets Coalition, January 2019

and accessibility. Conversely, information such pick-up location and wait time can be provide to users via smartphone app.

TECHNOLOGY TO BE DEPLOYED

This project seeks to enable connectivity and cooperation between ADS and Miami-Dade County's traffic signal control system, dynamic lane blockage system, and dynamic curb assignment system. The C-ITS which will represent this integration will be able to adjust and adapt its traffic signal timing based on the movement of the ADS and other traffic, including pedestrians and bikes. Conversely, the C-ITS system will have the ability to provide critical information to ADS. As part of the project, the project team will deploy a system of complementary traffic management infrastructure, automation, and connectivity between the vehicles and the infrastructure aimed at facilitating ADS integration and cooperation with ITS infrastructure. The deployment will leverage significant funding by the DPTW to install state-of the-art infrastructure component. The technology deployment will be based on a system engineering approach that base the deployment on a concept of operations (ConOps) and requirements in accordance with USDOT guidelines. The technology solutions that best meet the requirements will be selected for deployment and the deployment design, deployment plan, testing, verification, operation and management plans, and evaluation plans will be submitted to the USDOT for review.

ADS and C-ITS Technology: The ADS technologies proposed to be tested as part of this project will include Ford Motor Company automated vehicles, Ridecell automated vehicles, and Volvo Group automated trucks. For the past year, Ford Motor Company have worked closely with Miami-Dade County in their deployment of AV fleet and have tested novel business pilots from their terminal located in the City of Miami. Ford has partnered with Domino's Pizza, a delivery company Postmates and Walmart for their current pilot in Miami-Dade. Ridecell, a mobility platform provider, has vast experience operating on-demand and ridesharing services in U.S. including transportation services for the elderly and disadvantaged populations. Ridecell's self-driving car division is currently testing the integration of its mobility platform with ADS technology from Auro Robotics for autonomous ridehailing services. This project proposes for Ridecell to provide on-demand ADS services within the area of Health District. The deployment aims to serve users, particularly disadvantage population (i.e. elderly, disabled people, and low income population). Users will be able to request rides via a smartphone, and information will be provided to automated vehicles. ADS vendor will share significant ADS operational data with the project team to allow detailed assessment of system performance. Volvo Group will provide an automated urban delivery truck for the deployment and will be assembled in the U.S. for Buying America requirement.

Traffic Management Infrastructure: The traffic management infrastructure components will include technologies funded by DTPW including intersection controller replacement with 2070LX controllers, intersection detection replacement, and fiber-optic communication system to the County's Traffic Management Center (TMC). The new signal controllers will have adaptive signal control capabilities, processors to interface with the roadside equipment (RSE) of connected vehicles, and high resolution controller data for Automated Traffic Signal Performance Measures (ATSPMs). In addition, the system will include microwave detectors (for traffic volume measurement), Bluetooth readers (for travel time and origin-destination measurement), and CCTV cameras installed at the project sites, and funded by DTPW. Additional DTPW funding that will support the project deployment is to convert all existing High Pressure Sodium (HPS) streetlight luminaires into energy efficient LED throughout the County, deploy video cameras with configurable frame rate cameras to count vehicle, micro-mobility and pedestrians, and Bluetooth readers for Active Arterial Traffic Management and to monitor travel time and speed at a minimum of every half mile along the priority corridors. County specific 5G and/or fiber optic infrastructure network, CO2 emissions sensors, and parking space sensors for on-street parking monitoring will be also deployed. This deployment will complement the traffic management infrastructure in the project areas.

The infrastructure will send automated vehicles information on signal phasing and timing, lane closure, curb space availability. This infrastructure will also collect information from the vehicles using the Society of Automotive Engineers (SAE) standards. The RSEs will interface with the signal controllers utilizing the National Transportation Communications for Intelligent Transportation System Protocol (NTCIP) to allow the signal controller to adjust the signal timing considering the approaching ADS. This will include the extension of green time and truncating the red time to accommodate the approaching ADS resulting in increase of safety and mobility. Smartphone apps will be deployed considering curbside space availability to allow optimal ADS users pick-up/ drop-off and freight delivery.

Infrastructure sensors will be installed to support the determination of lane blockages, curb space availability, and pedestrian and bicycle presence. Pedestrian and bicycle sensors will be installed at critical crossing locations and the information will be provided to the ADS by the RSE. Technology will be installed for work zone lane closure detection and communication to the center including installing GPS-equipped flagging baton and arrow panel and send the information directly to the center. In-pavement and/or non-intrusive detection technology will be installed to detect the availability and conditions of the curb spaces for broadcasting to shuttles and delivery trucks.

Analytic-Based and Modeling-Based Decision Support System: An existing data analytic-based and modeling-based decision support system developed for the region will be extended to support the pre-deployment and post-deployment assessment of system performance. This will include performance dashboard and analysis component that will collect data from multiple sources, and estimate ADS and system performance (in terms of mobility, reliability, safety, and emission). In addition, the information collected from the ADS and communicate to the controllers will be utilized to support the signal control in a simulated environment since the market penetration of the ADS is not expected to be high enough to completely evaluate the impacts of ADS on intersection performance in real-world conditions.

PERFORMANCE IMPROVEMENTS

This study will evaluate traffic efficiency benefits resulting from this ADS demonstration project. Efficiencies in travel from mobility investments accrue as a result of changes in travel characteristics. The performance improvements will be evaluated by comparing current conditions (i.e. without the technology deployment) to conditions after the technology deployment utilizing an approved evaluation plan that comply with USDOT guidelines. Efficiencies imply that congestion reductions, along with improved flow, in the roadway corridors can be achieved, producing users' benefits such as savings in: travel-time, fuel consumption, emissions, and safety. The anticipated key performance improvements are:

- **Travel time savings:** Travel time savings resulting from the reduced stopped delays stemming from the real-time communication between ADS and traffic management infrastructure (traffic signals, dynamic curbside management system, lane blockage monitoring). V2I connectivity and bi-directional data sharing for L3 or greater ADS will facilitate optimal AV routing and optimal signal control for the general traffic, reducing travel time and enhancing AV operations.
- **Emission savings:** The smooth driving profile of ADS, Signal Phasing and Timing (SPaT) information and optimal routing, as well as, optimal signal control for the rest of traffic are expected to produce significant reduction in the emission and fuel consumption.
- **Safety Benefit:** Connected ADS are expected to benefit significantly from cooperative perception that can provide safety redundancies. In-vehicle sensors have limitations when it comes to recognizing traffic signals, bikes, and pedestrians. Similarly, disadvantaged populations such as the differently abled people and elderly might experience difficulties recognizing AVs. The demonstration of ADS that is integrated and cooperating with the city infrastructure would contribute to reductions in the number of accidents and incidents in the project area.
- **Improved Accessibility:** The deployment of on-demand ADS service combined with dynamic curbside management and ADS signal priority in Health District is also expected to improve access, especially for the elderly, differently abled people, healthcare and public services, and freight delivery. This improvement will be measured based on the number of users, retention, on-time arrival to destination, and user experience.

GEOGRAPHIC AREA OR JURISDICTION OF DEMONSTRATION

The proposed ADS demonstration is planned to take place in the Downtown Miami and Health District areas in the City of Miami, see Figure 1. The project team has specifically selected locations in the Health District area and the core of Downtown Miami where disproportionate benefits can be felt by large pedestrian crowds, bikes, and disabled communities, along with city departments that provide emergency services.

Figure 1 ADS Demonstration sites in Miami-Dade County.

Health District

Health District is the center of the County's medical, research and biotechnology industries. Major employment, healthcare, rehabilitation and education centers in Miami are located in the Heath District. Four major rehabilitation and training centers for people with disabilities are located within the area. The Special Transportation Services (STS) transport an average of 240 paratransit riders to and from these centers every day. This project will deploy on-demand ADS service, particularly for differently abled people traveling to and from the healthcare and rehabilitation centers within the project area, signal priority for on-demand ADS shuttles and dynamic curbside management. The project also aims to research user behavior and interaction with ADS services and dynamic curbside management services.

Project Site Boundaries: The project site within Health District is bounded by NW 20 St. to the north, NW 14 St. to the west, the Dolphin Expressway and the Miami River to the south, I-95 to the east. The street network within the project site counts with 30 signalized intersections. Figure 2 illustrates the roadway network and traffic signal system.

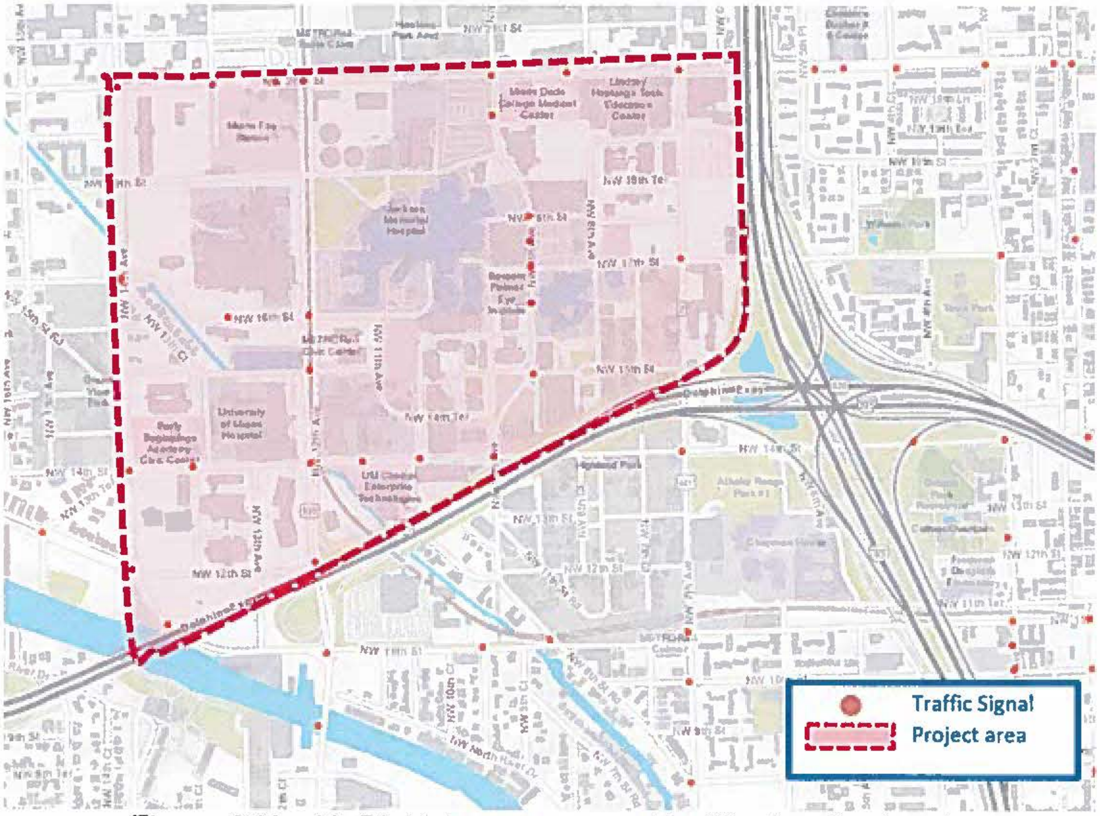

Figure 2 Health District area map and traffic signal network.

Downtown Miami Area

Downtown Miami is an economic engine in Miami-Dade County and the cultural, financial, and commercial center of South Florida. More than 88,540 people live in Downtown Miami (33 % increase from 2010), and is expected to exceed 100,000 by the year 2020[2]. With a density of 23,300 persons per square-mile and over 235,000 people coming into Downtown daily, proximity to the PortMiami and access to main waterway, the Downtown area attracts high volumes of vehicular and pedestrian traffic. Approximately 66 % of Downtown traffic is generated as a result of the nearly 148,000 people working in the area, in addition to increasingly dense high-rise residential zones. This project aims to demonstrate ADS operations and C-ITS capabilities, and research interactions with large pedestrian crowds, bikes and other micromobility.

Project Site Boundaries: The project site is bounded by NE/NW 14 St. to the north, NW/SW 2nd St. to the west, the NE/SE 1st to the south, NE/SE 2nd to the east. The street network within the project site counts with approximately 75 signalized intersections. Figure 3 illustrates the roadway network and traffic signal system.

[2] Miami Downtown Development Authority, Annual Report 2015-2016, January 2017.

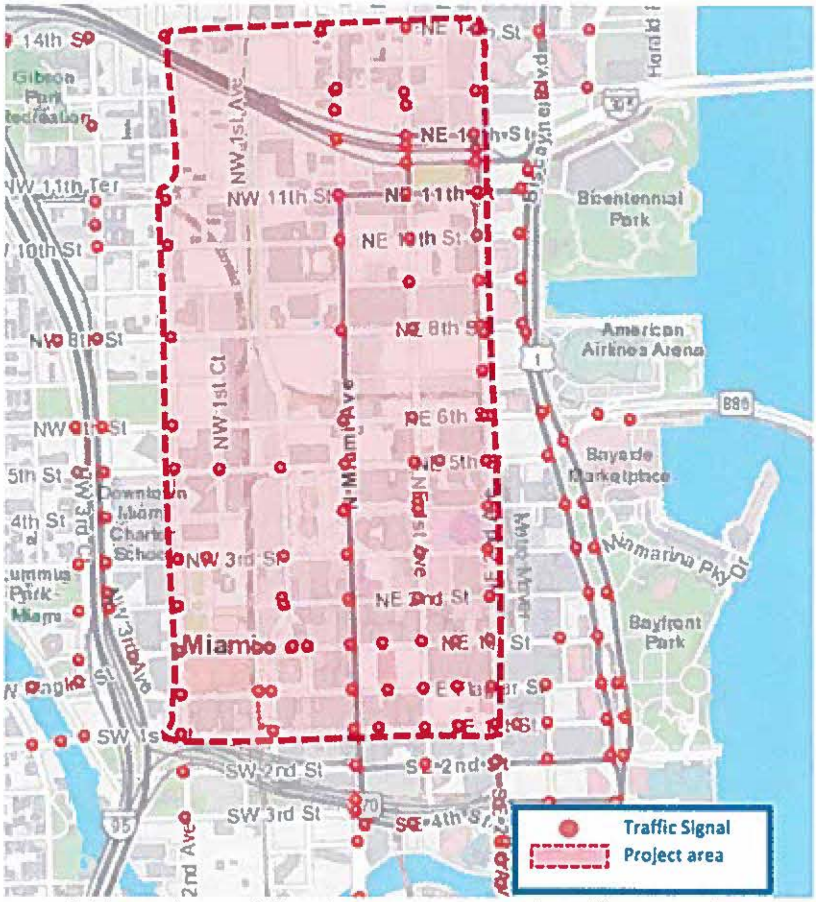

Figure 3 Downtown Miami area map and traffic signal network.

PROPOSED PERIOD OF PERFORMANCE

The four (4) year-project is scheduled to commence in 2020 with the first year used for producing the system engineering documents (ConOps, system requirements, system design, evaluation plan, final data management plan, etc.). The first and second years will involve testing the ADS (from Ford Motor Company, Ridecell, and Volvo Group), the connectivity between the ADS and the infrastructure and an off-the-road test track. Once the testing is done, the actual installation and testing of the devices in the project test site will be conducted in the second year and an initial operation of system components will be conducted in the second year. The third year and fourth year will focus on the operation and evaluation of the system. Final reports will be produced based on the demonstration and evaluation in the fourth year. Table 1 shows the project components and proposed period or performance.

Table 1: Project Deployment and Schedule

Project Task	Timeline
Preparation, Deployment and Testing of C-ITS Technology: This component includes producing the system engineering documents (ConOps, system requirements, system design, evaluation plan, final data management plan, etc.); upgrades to traffic signal infrastructure; testing of ADS, C-ITS, etc.	December 1, 2020
Integration of ADS and C-ITS Demonstration (Year 1): Actual installation and testing of the devices in the project test site. Deployment of proposed technology applications (on-demand ADS shuttle service, ADS signal priority, automated urban delivery truck, and dynamic curbside management.); and technology testing; and initial operation of system components.	December 1, 2021
Integration of ADS and C-ITS Demonstration (Year 2): Operation and initial evaluation of the system.	December 1, 2022
Final Evaluation and Maintenance: System evaluation (data analysis, performance assessment), data sharing, standards development, information dissemination, production of final report and documentation.	December1, 2023

2. GOALS

a) SAFETY

Connectivity between ADS and traffic management infrastructure is expected to significantly benefit vehicle and pedestrian mobility, micromobility, and safety. It is well known within the ADS development circles that realizing and dealing with traffic signal control, lane blockages, pedestrian/bicycle traffic, and curbside space are key challenges in integrating ADS into city road infrastructure. By establishing connectivity and enabling both the vehicles and the infrastructure to communicate and cooperate, traffic safety can be significantly enhanced, not to mention enhance energy efficiency, mobility, accessibility, throughput, and economic benefits.

Traffic Signal Infrastructure Support of ADS: By having the traffic signal communicate directly with the vehicle through wireless communication, ADS would not need to rely solely on its own sensors to discern greens, yellows, and reds. Especially given the variety in traffic signal infrastructure (i.e., location, and height) and weather patterns (i.e., rain, sun and glare), direct communication between the traffic signal infrastructure and the vehicle has potential to significantly improve the safety of ADS in real-life roadways. This can include holding reds longer when a vehicle is in the dilemma zone, rerouting vehicles around incidents and work zones, warning vehicles of red signals and pedestrians on crosswalk, informing vehicles of gaps in the opposing traffic when making permissive turns, and using signal timing to enable smoother flow to minimize stop-and-go vehicular movement. Some of these applications has been included as part of the Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT) for connected but not automated vehicles. This project will extend the applications to ADS.

ADS Support of Signal Control: By having vehicle communicate data directly with the signal infrastructure, the signals can also optimize its timing for safety, mobility, and efficiency considering the presence of ADS. In addition to information that can be obtained from connected non-automated vehicles, ADS can provide additional microscopic traffic data that will allow the calculation of new performance metrics that can support transportation system management.

ADS Signal Priority: The project will research the provision of conditional ADS signal priority under certain ADS and signal operational conditions in the Health District area.

Curbside Space Management: Curb spaces will be allocated for vehicles to pick-up and drop-off passengers in shared mobility, with consideration of the special need population in Health District area. In addition, this application will support last-mile delivery of freight using automated trucks.

Lane blockages and Work Zones: Lane blockages and workers in work zones will be detected for dissemination to ADS in real-time using sensor on construction and traffic maintenance equipment and mobile devices held by workers in Downtown Miami area.

Florida Intelligent Transportation systems Evaluation Tool

The FIU team has recently developed a tool for Florida Department of Transportation (FDOT) to allow agency to assess the pre-deployment mobility and safety performance and anticipated impacts of connected and automated vehicles based on the analysis of existing conditions using data from multiple sources and anticipated impacts based on modeling. Figure 4 shows an example of the user interface that show the performance with and without deployment. This tool will support this project team in identifying the optimal implementation and evaluating the deployment and will be extended for post-deployment project evaluation based on the identified performance metrics.

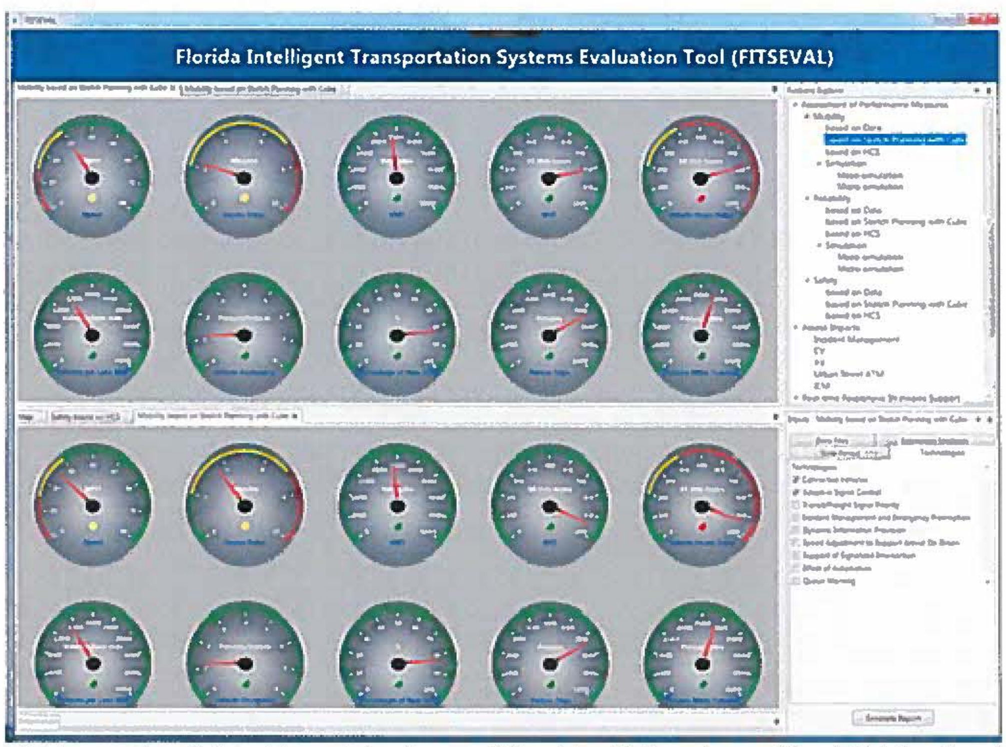

Figure 4 Example of the User Interface of the Tool Developed by FIU for the FDOT.

b) DATA FOR ANALYSIS AND RULEMAKING

The project team will identify safety, mobility, and environmental metrics to allow assessing both ADS performance, and transportation system performance based on data. Each of these metrics will be associated with the required data and data sources, calculation formula, unit of measurement, benchmarking values and targets, frequency of update, method of presentation and archiving to the end user, and connection to the strategic goals of the USDOT and the region. For example, surrogate measures to safety will be identified and assessed in real-time and off-line to support traffic management operation and will be shared with ADS to adjust the driving parameters when the values of the surrogate metrics exceed thresholds determined based on off-line analysis of the measures. These same metrics will be archived and used in off-line to evaluate and fine-tuned system parameters.

The FIU research team has recently recommended the use of surrogate safety measures and mobility measures based on fine-grained connected vehicle data, as part of a USDOT funded University Transportation Center Project. An example is shown in Figure 5. Some of the data required for the assessment will be obtained from the connected on-board equipment. Others will be collected using infrastructure sensors such as video image detectors, microwave detectors, and/or Lidar that are able to provide the required data. Both vehicle trajectory-level information and well as pedestrian on crosswalk trajectories will be collected and archived for the assessment. The research team has discussed with ADS-provider partners the provision of fine grained ADS data for use in this research.

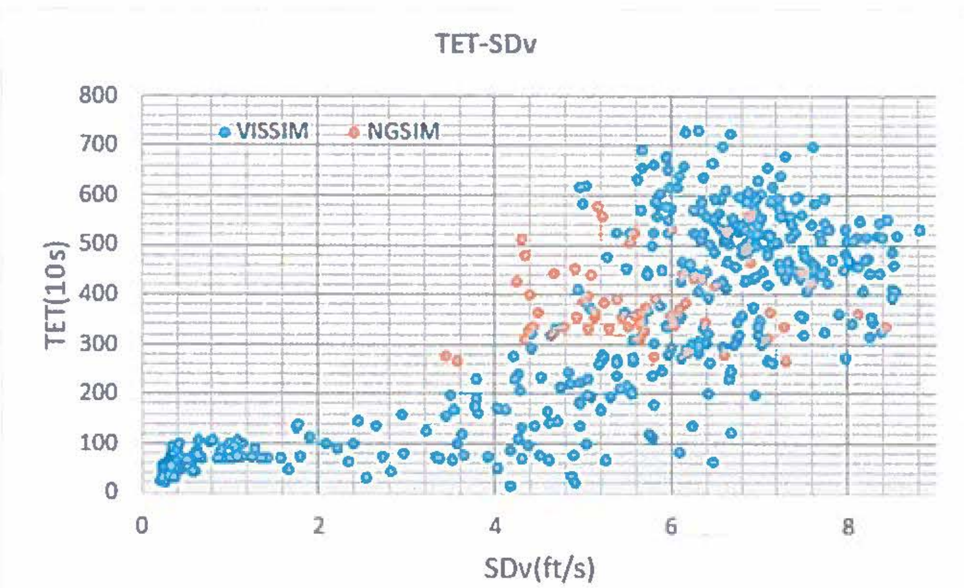

Figure 5 Relationship between the Standard Deviation of Vehicle Speed and Surrogate Measure to Safety from FIU Research.

The program will share significant project data with USDOT and the public including other researchers and analysts throughout the project in near real time, either by streaming or periodic batch updates. The data will be collected and shared utilizing platform independent and ITS standards for the project demonstration period. The collected data and information will be shared for five years after the project end. This will enable demonstrations that can provide data and information to identify risks, opportunities, and insights relevant for USDOT safety and rulemaking priorities needed to remove governmental barriers to the safe integration of ADS technologies.

c) COLLABORATION

The project team includes government, research, and private entities that bring complementary capabilities and expertise.

DTPW will be the lead agency for the project from the government side, and will be complemented by the City of Miami. DTPW will be custodian and responsible for data management. FIU research team will provide technical expertise for the implementation of the proposed project elements including the development of ConOp, technology selection, evaluation plan, data collection and analysis, diversion analysis, and modeling support. More specifically, the research team will be providing data analysis, pre-deployment and post-deployment evaluation and project management support. FIU will be also supporting the data management efforts. Xtelligent: a DOE-funded vehicle-to-infrastructure (V2I) and C-ITS venture will be providing technology, engineering, and R&D capability. Ford Motor Company, Ridecell and Volvo Group will be providing the vehicles for testing the impact of ADS when integrated into road traffic management infrastructure. SAE International will assist with technical standards development and implementation, data sharing and information dissemination. TPO will coordinate stakeholder engagement and review project plans to ensure consistency with local planning activities and regulations.

Additionally, various local stakeholders, including FDOT, City of Miami, Miami Downtown Development Authority (DDA), Fire and Police Departments, underserved communities, particularly the Health District in the City of Miami, and other non-governmental organizations will further support the project. Specifically, the stakeholders are expected to convene on a monthly basis to ensure early and consistent stakeholder engagement, and to ensure that all stakeholders' interests are sufficiently addressed.

3. FOCUS AREAS

a) SIGNIFICANT PUBLIC BENEFITS

Real-time communication between ADS and city traffic infrastructure can have significant public benefits in the form of safety, mobility and efficiency, environmental, and economic gains. For instance, connected ADS are expected to benefit significantly from cooperative perception that can provide safety redundancies, which is especially important since in-vehicle sensors have limitations when it comes to recognizing traffic signals. Conversely, potential conflicts and difficulties for differently abled people at pedestrian crossings and curbside space. In addition, mobility and surrogate safety measures will be estimated in real-time based on infrastructure sensor, vehicle, mobile, incident, construction, and weather data and provided to ADS, allowing the adjustment of its operation to maximize safety and mobility.

Data from ADS will help the County better manage traffic signals, curbside space, and other critical roadway infrastructure that can improve safety, optimize traffic flow, reduce travel time and greenhouse gas (GHG) emissions. It is becoming increasingly clear that autonomy without connectivity and cooperation with road infrastructure is sub-optimal, and may significantly delay the wide adoption of ADS technology across the U.S. This demonstration project specifically targets connectivity between ADS and ITS as a way to address this critical and catalyzing component that can enable rapid and safe deployment of ADS in the Nation's roadways.

Reduced Congestion and Cost of Congestion
Information from ADS will inform transportation system management and operations (TSMO) by providing additional data for optimizing system performance. Miami-Dade County has already invested in state-of-the-art signal control system that collect information from multiple sources including point sensors, Bluetooth readers, and high-resolution controller data. This project will allow the examination of how additional information from mobile units will further inform off-line analysis and real-time operations of signal control. The impacts will be assessed using field evaluation, data analytics, and microscopic simulation. The additional value of using ADS data in traffic control and the introduction of ADS in the traffic stream will be assessed. It is anticipated that based on the limited number of ADS in the traffic stream mobility impacts on the system performance will be difficult to evaluate. However, operational parameters such as time headway, start-up lost time, vehicle-rerouting, and speed will be collected and used as inputs to simulation modeling to measure congestion impacts. Simulation will also be used in combination with field measurements to assess safety impacts. The FIU research team has recently utilized simulation to evaluate the safety impacts of connected vehicle (CV) applications to support intersection safety.

Reduced Environmental Impact of Traffic
The smooth driving profile of ADS, SPaT information and optimal routing, as well as optimal signal control for the rest of traffic are expected to produce significant reduction in the emission and fuel consumption. This study will use actual fuel consumption data from on-board vehicle equipment as well modeling using the US Environmental Protection Agency's (EPA's) Motor Vehicle Emission Simulator (MOVES) based on drive schedule or profile method. The drive schedule method uses second-by-second speed profiles of vehicles as an input to estimate emissions. The operating mode distribution approach estimates emissions based on the Vehicle-Specific Power (VSP), vehicle speed, and vehicle acceleration. The FIU research team has used these models to estimate the impact of signal control on emission.

b) ADDRESSING MARKET FAILURE AND OTHER COMPELLING PUBLIC NEEDS

Although there has been significant advancements in the vehicle itself, there has been a market failure in the development of road infrastructure technologies that can support the deployment of ADS other than in a few limited cases. Specifically, enabling data sharing from ADS to the traffic management infrastructure and vice-versa has been overlooked, in spite of significant benefits that can be achieved when road infrastructure can cooperate with, adapt to, and enable ADS. There has been implementations of V2I communication where Signal Phasing and Timing (SPaT) from traffic signals to non-automated vehicles are being enabled. Few deployments are also investigating the use of CV-data to support traffic management, although much more can be done to investigate the potential of this sharing. There are significant public benefits where certain vehicle data is shared between ADS and city infrastructure, including safety, efficiency, and environmental benefits as articulated in previous sections. In addition, significant benefits are expected from additional infrastructure information to the ADS such as lane blockages, and curbside space availability. This demonstration project focuses on enabling both sides of the equation for the benefit of all parties.

Furthermore, some of the key challenges of integrating ADS with city infrastructure has been concerns regarding cybersecurity. By enabling an opportunity to fund, deploy, and test the real-life integration and communication between ADS and city infrastructure, the project team will help identify best practices for future integration methods that can help mitigate concerns regarding security in other locations throughout the nation.

c) ECONOMIC VITALITY

Recognizing Executive Order 13788, our project will support economic vitality at the national and regional level, including advancing domestic industry and promoting domestic development of intellectual property. Specifically, all involved companies such as Ford, Ridecell, Xtelligent are American companies that are supporting the U.S. industrial base. The exception is Volvo Group, which will supply an automated delivery truck that will be assembled in U.S. The team is also committed to Buy American and other requirements that can support American economic prosperity. The funding from the project will provide resources for critical R&D, deployment, and testing opportunities that can benefit American technological innovation for the coming decades in a critical mobility space that's becoming increasingly critical for global competitiveness, American prosperity, and U.S. global leadership. Some of the key technological innovation areas include automated vehicles, cooperative intelligent transportation systems, decision support systems, artificial intelligence, Internet of Things, edge-computing, swarm intelligence, and autonomic computing, among others. The intellectual property being tested have already been funded by the U.S. government's the National Science Foundation (NSF), Department of Transportation, and Department of Energy. Additional intellectual property generated will be either added on to university IP inventory or commercialized through the aforementioned U.S. companies or others that may benefit from the public knowledge generated to compete globally in increasingly competitive mobility and smart infrastructure spaces.

Specifically, this demonstration project will be testing latest tools and methods such as the NSF funded distributed network control algorithms from research centers such as FIU, MIT, University of Southern California (USC), and University of California (UC) Berkeley to assess how ADS data integration can enhance the throughput in the areas studied. Based on preliminary PTV VISSIM modeling of one class of distributed algorithms (Proportionally Fair Algorithm by Ketan Savla), the throughput for the deployed networks can be enhanced by approximately 50%. This can be critical in further supporting economic prosperity in a region that is increasingly burdened by congestion. Furthermore, we will test freight prioritization schemes to enhance the movement of goods, which can be critical for economic development purposes.

d) COMPLEXITY OF TECHNOLOGY

The technology components this project specifically aims to address targets the V2I connectivity and bi-directional data sharing for L3 or greater ADS on Miami-Dade County's roadways. There have been demonstrations of V2I communication of connected vehicles in the way of SPaT messaging, such as in the SPaT Challenge and CV-pilots. However, the novelty in this project is to extend this to include additional information to L3 or greater ADS and also enabling data from the ADS vehicle to the infrastructure, and in the process genuinely enabling bi-directional cooperation. In combination with L3 or greater ADS, there are multiple complexities that the project will address, including:

- Deployment of a distributed C-ITS network across Miami-Dade County that can lay the foundation for infrastructural dynamism.
- Data Fusion layer that can support the integration and standardization of ADS data into single, standardized layer, which will make it possible for easy digestion by city infrastructure.
- Real-time cooperation between ADS and C-ITS enabling greater safety, efficiency, and energy benefits.
- Security and privacy protection in an environment where vulnerabilities can be exploited in a high-risk transportation environment.

e) DIVERSITY OF PROJECTS

Miami-Dade County provides an opportunity for USDOT to fund a collection of projects that serve a variety of communities, including urban and suburban, that serve a variety of transportation markets including freight, personal mobility, public transportation, and delivery services. The common theme for this project is the integration of ADS with C-ITS. This concept will be applied across multiple environments and is expected to be impactful across urban, suburban, and rural environments. Furthermore, the connectivity and cooperation enabled can allow significant benefits whether ADS technology is deployed in freight, personal mobility, or public transportation applications.

The applications to be tested as part of this project includes:

- Utilizing of connected ADS data to support traffic management and signal control.
- Off-line processing of ADS data to assess ADS and transportation system performance and visualizing the performance utilizing dashboards including newly derived metrics.
- Providing of infrastructure signal information to Connected ADS to support its operation at signalized intersection approaches.
- Real-time provision of segment mobility and safety performance measures to support setting ADS parameters.
- Providing lane closure information and impacts to ADS to allow it to select new route or change lane in advance of the lane closure locations.
- Support of users of different capabilities in their sharing of automated vehicles in the Health District area in the City of Miami.

- Support of dynamic pick-up and drop-off of ADS users of different capabilities with the utilization of a dynamic curbside information system.
- Support of last-mile freight delivery using automated trucks.
- Provision of conditional priority to ADS.
- Enhancing safety and efficiency of pedestrians, bicycles, and crowd movements.

f) TRANSPORTATION-CHALLENGED POPULATIONS

This project will provide on-demand ADS shuttle service particularly for differently abled people traveling to and from healthcare and rehabilitation centers within the Health District area, signal priority for ADS shuttles providing on-demand services, and dynamic curbside management. The provision of on-demand ADS shuttle service for transportation-challenged populations along with signal priority and dynamic curbside management is expected to improve user experience, reduce travel time, improve accessibility, reduce operating costs and provide better understanding of how ADS combined with C-ITS can improve access to disadvantage communities in the County.

In addition, the project will provide dynamic curbside space information for on-demand ADS shuttle to allow optimal pick-up and drop-off with minimal delay and maximum safety for the users. Curbside spaces will be allocated for this purpose and will be dynamically monitored by infrastructure sensors. Information will be provided to the ADS about the availability of space and the special needs of the users. At the same time, information will be provided to the users at the location and time of pick-up via a smartphone app.

g) PROTOTYPES

This project is focused on technologies that have been deployed in real-world environments. Xtelligent has been working on their distributed C-ITS technology over multiple years and have conducted extensive testing in California and Colorado with the first and second generation prototype to ensure smooth deployment and safety. The Ford Motor Company, which has been testing ADS technology in Miami-Dade County since February 2018, has extensive experience deploying ADS and is supported by decades of experience deploying vehicles that are road worthy. Ridecell, a mobility platform provider for ridesharing and carsharing services, acquired Auro Robotics in 2017 and is currently testing autonomous ridehailing services. Volvo Group is producing an automated truck for urban freight delivery.

4. DEMONSTRATION REQUIREMENTS

a) ADS TECHNOLOGY RESEARCH AND DEVELOPMENT

This demonstration focuses on V2I connectivity that can help ADS technology better cooperate with traffic infrastructure and also enable better cooperative perception, enabling safer and speedier deployment of ADS in the coming years. The vehicle by themselves are often capacity constrained when it comes to recognizing proper lights (green/yellow/red) and are often adversely affected by their capability to perceive traffic signals and other signage in challenging weather conditions.

b) PHYSICAL DEMONSTRATION

This project is planned to take place at Downtown Miami and Health District area in the City of Miami. The project team has specifically selected locations in the Health District area and the core of Downtown Miami where disproportionate benefits can be felt by large pedestrian crowds, bikes, and disabled communities, along with city departments that provide emergency services.

This project will deploy interface devices in the traffic signal control cabinet across selected locations at both project sites to create a distributed network of intelligent control nodes that can enable vehicle connectivity. It is expected for Ford Motor Company, Ridecell, and Volvo Group to provide vehicle data that would enable cooperation between the city traffic infrastructure and the vehicles. This demonstration will take place primarily in year one (1) to three (3), followed by a final evaluation in year four (4) of the project timeline.

c) DATA GATHERING AND SHARING

The project team has developed an initial data gathering and sharing plan, as part of a data management plan, that will be developed further as part of the initial project activities. The project will share significant project data with USDOT and the public including other researchers and analysts throughout the project in near real time, either by streaming or periodic batch updates, with the protection of personal identifiable information (PII). The data will be collected and shared utilizing platform independent and ITS standards for the project demonstration period. All data will be accessible to USDOT and the public for a minimum of five (5) years after the end of the project performance period.

All data are open and follow the industry standards. A user guide will be created for each type of data, which provides a description for each attribute of data. The name of the user guide will be selected to make it easy to be identified by the user. The metadata and data documentation will be according to the standard format utilized by the USDOT pilot sites to allow a consistent manner of understanding the data. This can be based on ASTM E2468 - 05(2018) -Standard Practice for Metadata to Support Archived Data Management Systems. In addition to the standard specifications, additional metadata will be used. The USDOT CV Pilot metadata schema will be used as a starting point. Metadata will be stored in the same folder as data files and will be managed by the same file system on the same machine. The research team will conduct manual and automated data quality assurance during each stage of this project. The Data Steward will be responsible for the data quality and the processes to ensure the quality.

SAE International will engage project partners in SAE consensus-based standards development that utilizes this project's learnings and outcomes to address ADS safety, testing and deployment. SAE in collaboration with the demonstration project partners will host SAE Demo Day events in the Health District area to demonstrate the ADS technologies and services developed and deployed in this project to the public and policymakers. In addition, SAE will assist promoting utilization of ADS safety data generated in this project with its global membership via workshops, symposia and conferences.

Input/Output User Interfaces

A smartphone app will be used to allow the user to input their origin, destination, and prefer time for pick-up from Health District locations and special needs for varying ability users. The dynamic curbside management system developed as part of this project in communication with the ADS will select the optimal location and time for pick-up and drop-off of passengers.

Scalability and Applicability

The project will benefit both Miami-Dade County directly as well as the national transportation community, and is intended to be replicable and scalable to a larger area. This demonstration project seeks to focus on addresses a key question relevant for the Nation as a whole: how can city infrastructure best enable the safe deployment of ADS technology in its roadways. Specifically, this project aims to utilize the city's ITS infrastructure to enable deploy and test addresses many of the key challenges that cities today face when it comes to ADS—how best to prepare city infrastructure to bring more control and maximize data opportunities to enable better infrastructure related decision-making, i.e., signal operations, dynamic roadway management. Additionally, this demonstration project will also contribute to define the role of mobility management agencies in the integration of ADS into the nation's roadways system.

5. APPROACH

Leverage Existing Assets

This project will directly leverage a number of existing and planned investments in the County, including traffic signal technology upgrade and the conversion of existing street lights into a networked Smart LED energy saving/revenue generating system with connected devices.

Miami-Dade County is in the process of upgrading its traffic signal technology as part of a five (5)-year project to improve traffic signalization and reduce congestion throughout the County. The County has approximately 3,000 signalized intersections, which are monitored and controlled from the County's Traffic Management Center (TMC). The ongoing effort will upgrade the existing model 170 controllers to CV application-ready 2070LX traffic controllers at key signalized intersections that will be connected to an advanced traffic management software at the TMC operated by DTPW. DTPW is already deploying and testing the functionality of the new controllers and supporting ITS infrastructure, which will lead to the upgrade of the entire signal system throughout the County. The ongoing upgrades to the County's traffic signal systems will introduce a number of new technologies and capabilities.

In addition, the County is planning the conversion and asset management of approximately 26,400 existing HPS streetlight luminaires to energy efficient LED throughout the County and integration with Internet of Things (IoT) Mobility Solutions. This will allow for a more broad and accurate coverage in the County. This will allow to upgrade and expand the County's connectivity infrastructure that will support the improvement and expansion of the initiatives described in this application, and allow for a more broad and accurate coverage in the County. As the County continues roll-out of signal upgrades and street light LED light conversion, this proposed deployment will serve as a mechanism for evaluating integration of ADS and C-ITS capabilities.

a) TECHNICAL APPROACH

The project team will take a multi-level technical approach to implementing and evaluating the demonstration:

This project proposes to demonstrate ADS deployment that's integrated and cooperating with ITS infrastructure. Specifically, this project seeks to enable connectivity and cooperation between ADS and Miami-Dade County's traffic signal control system, dynamic lane blockage system, and dynamic curb assignment system to research the benefits of how system integration of ADS with city infrastructure can have public benefits, including safety, energy efficiency, mobility, and environmental impacts. The Cooperative Intelligent Transportation System that will represent this integration will be able to adjust and adapt its traffic signal timing based on the movement of the ADS. Conversely, the C-ITS system will have the ability to provide critical signal timing data to the ADS platform to help with safe operations of ADS. This will help lay the foundation for additional cooperation between ADS and C-ITS, including sharing information in regards to dynamic lane closures and curbside management that can further support the integration of ADS into the Nation's transportation network.

The demonstration will a) deploy a distributed and decentralized network of edge-computing nodes at every intersection in the demonstration areas, b) deploy a Data Fusion Layer to act as an intermediary for communication between ADS vehicles and C-ITS, c) deploy and integrate ADS into the project site, d) develop communication capabilities and test cooperation between ADS and C-ITS, e) research and identify best approach for privacy and cybersecurity for such ADS/C-ITS integration, and f) evaluate the impact of the integration on performance from the perspectives both on an on-going basis and after the completion of the project.

- **Deployment of Decentralized Nodes at Signalized Intersections:** The deployment of decentralized nodes at the signalized intersections will be completed by Xtelligent. Interface devices housing decentralized, edge-enabled algorithms and communication capabilities will be deployed in traffic cabinets at each of the intersections. The devices will communicate with the existing traffic controllers through NTCIP protocol. A VPN tunnel will be created to enable communication with the traffic management center, as well as the internet to enable remote monitoring. Cellular connection will be established directly from the devices to the Cloud.
- **Deployment of Data Fusion Layer Enabling ADS to Communicate with C-ITS Infrastructure.** A Data Fusion layer enabling the ADS will be deployed to establish communication between the vehicles and the infrastructure via cellular for this project. The layer will be hosted in the Cloud. Bench, safety, and integration testing will be conducted to ensure that the layer is implemented in safe and incremental manner.
- **ADS Deployment Across Project Sites.** ADS will be deployed across the project sites with the support of Ford Motor Company, Ridecell and Volvo Group and integrated into the decentralized network of C-ITS platform. The vehicles will be first

deployed without any communication with the Data Fusion layer and baseline data concerning safety and mobility will be captured at this juncture.

- **ADS Integration into Data Fusion Layer.** ADS will be integrated into the Data Fusion layer to enable cooperation with C-ITS. The ADS movement data will be captured and utilized to dynamically enable infrastructural cooperation, specifically signal timing. Conversely, communication back to the vehicle will be also tested, providing safety-critical information such as SPaT data on a real-time basis. The communication integration is expected to occur utilizing the Smart Device Link portal, utilizing cellular connectivity into the Data Fusion layer for communication. If possible, other forms of communication will be considered and tested for evaluation.
- **Privacy and Security.** One of the key hurdles preventing ADS/C-ITS integration has been concerns around privacy and security. Especially as vehicles and infrastructure becomes increasingly connected, concerns around malign actors and misuse of private data is becoming increasingly critical. The project team has deep expertise in privacy and security, including experience leading cybersecurity teams, and will be utilizing its capabilities to test, research, and refine the best-of-kind approach to ensure privacy and security protection for the proposed ADS/C-ITS integration demonstration.
- **Testing and Evaluation Process:** Evaluation will be on-going throughout the project timeline. There will be several technical evaluations to ensure that the technology integration at the control cabinets, the Cloud, and the ADS systems is sound. Hardware integration, safety protocol, and communication testing will be conducted also. Data will be collected before, during, and after deployments to help assess the impact of system integration on ADS and transportation system process. The project team will develop an evaluation plan at the start of the project that will establish the performance indicators that are related to the project goals and objectives, the experimental design, hypothesis setting, data collection plan, testing procedures, and statistical analysis. The experimental design will ensure that confounding factors that are not related to the deployment but may affect the results of the analysis are accounted for. In addition to the assessment based on data collected from the infrastructure sensors, controllers, roadside equipment, and on-board equipment; the research team will conduct a perception survey of the users of the system. It is expected that the evaluation process be an ongoing one throughout the project timeline and expect formal quarterly assessments to be completed regarding project and technical progress. A final, comprehensive evaluation in the final year of the project will be developed to extract lessons learned and to disseminate key findings that can benefit the Nation in integrating ADS in the transportation infrastructure.
- **Deployment of On-Demand ADS Services:** On-Demand ADS service will be provided to users in the Health District using a Smartphone app.

b) APPROACH TO LEGAL, REGULATORY, ENVIRONMENTAL OBSTACLES

The proposed demonstration project will not require any exemption from the Federal Motor Vehicle Safety Standards (FMVSS), Federal Motor Carrier Safety Regulations (FMCSR), or any other regulation.

The project team does not expect the demonstration to require an exception under the Buy American Act or an exception to the terms of the NOFO Clause at Section F, Paragraph 2.J. entitled BUY AMERICAN AND DOMESTIC VEHICLE PREFERENCES.

c) COMMITMENT TO DATA SHARING

Recognizing the importance of national, statewide, and regional public-private partnerships in successfully navigating the sea of changes that are already well underway, DTPW project team is fully committed to employing and promoting open source data protocols wherever possible, and share the project data, outcomes, products and applications from the proposed project in accordance with USDOT guidance and methods. This project will document the data, processes employed, benefits, costs and constraints as well as the lessons learned. A data sharing plan will be documented as part of a performance measurement plan. The generated data (performance and evaluation data) and new applications developed will be shared with the Community of Practice, USDOT and posted at the specified frequency of reporting as needed by the USDOT on resources such as the USDOT Open Source Application Development Portal (OSADP). The project team will meet all policy and governance requirements of the RDE. The research team will deliver webinars for progress updates. The project team will meet all policy and governance requirements of the RDE. The research team will deliver webinars for progress updates.

All data collected by the C-ITS system relevant for evaluation will be made available to USDOT for rule making purposes and for sharing with the independent evaluator (IE), if designated by the USDOT. The project team will also conduct its own evaluation by FIU, as discussed earlier.

Specifically, the following data will be provided subject to privacy consideration to remove any PII in the data. This will be based on the availability of the data from the city and ADS providers.

- Status of vehicle systems (wiper status, light status, braking status)
- Dynamic Work Zone Information
- Pick-Up and Drop-Off Information Database (including disadvantage, disabled, and venerable users)
- Dynamic Curb Information
- Signal Phasing and Timing (SPaT) messages
- MAP Messages and Data
- Radio Technical Commission for Maritime Services (RTCM)
- High Resolution Controller Data
- Participant Attributes
- User Survey Responses
- Traffic Counts
- Static Traffic Signal Data

- Incident Data
- Crash Data
- Weather Data
- Safety-Related Event Data
- Safety Device Event Data
- Derived Mobility Metrics
- Derived Safety Metrics
- Street Network for Simulation (if used)
- Simulation Model Outputs (if used)

d) APPROACH TO RISK IDENTIFICATION, MITIGATION, AND MANAGEMENT

The project team has gone through a risk identification, mitigation and management exercise to ensure that the project would be successful. The following are the key risks that we seek to manage:

- **Roadway user buy-in:** To ensure that other users of the roadway are brought into the demonstration, the project team has begun to socialize the project with all relevant government and community organizations.
- **ADS technology provider buy-in:** Integrating ADS data from multiple vehicles may be a challenge, but the project team has already demonstrated its ability to overcome this challenge by securing data-sharing commitment from several key partners, including the Ford Motor Company, Ridecell, and Volvo Group (commitment and support letters attached in Part 4 of this application).
- **Technical risks:** The technical aspect of integrating myriad ADS data sources could be challenging and rewarding. Each of the myriad data streams exhibit different precision, latency, reliability, and % adoption across actual vehicles on the roadway. Its anticipated that considerable data science efforts, statistical analysis, and AI/machine learning will be required to correlate various data streams' behaviors with each other to remove duplicates, realign temporal displacements, anticipate pending conditions, and "plug holes" to provide a usable and continuous set of data to the optimization algorithm. To maximize the chances of success and mitigate risk, a world-class data/technical team and advisors have been assemble. For example, the project team has multiple expertise that can support the project:
  - Artificial Intelligence (ML/Neural Networks)
  - Autonomic Computing
  - Cybernetics
  - Dataflow/Reactive Programming
  - Information-centric Networking
  - Software-defined Networking
  - Swarm Intelligence.

Beyond the main partnerships articulated in this application, there is access to data fusion and integration experts from the National Renewable Laboratory that will be available on an as-needed basis during the project lifetime.

There are also significant risks associated with manufacturing, supply chain, and scalability of the proposed technology. To manage these risks, along with market risk, the project team has partnered with multiple industry incumbents and cities to leverage external know-how and expertise.

e) CONTRIBUTIONS

The project time proposes to provide a total Non-Federal matching fund of $12,715,018, which represents 56% of the overall funding needed to deploy the proposed ADS demonstration project. DTPW will provide financial contribution in the amount of $12,715,018 through the implementation of traffic signal network upgrades at the project sites and technology transfer efforts. Additionally, the total Non-Federal share will include in-kind contributions of $400,000 from Xtelligent in V2I integration and C-ITS technology deployment and development activities, $60,000 from FIU in data analysis and evaluation work, and $255,000 from Volvo Group in technical support related to the automated delivery truck application. This will be provided in the form of project management, engineering, and research support to ensure that the project is successful.