PART 1
PROJECT NARRATIVE AND TECHNICAL APPROACH

NOFO # 693JJ319NF00001

AUTONOMOUS AVENUE

AUTOMATED DRIVING SYSTEM (ADS) DEMONSTRATION GRANT

ULTIMATE URBAN CIRCULATOR

JACKSONVILLE TRANSPORTATION AUTHORITY

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a) Introduction

Cover Letter

The Jacksonville Transportation Authority's (JTA's) new Mobility Optimized through Vision and Excellence (MOVE) initiative, is JTA's bold answer to advancing unprecedented change. It represents JTA's new approach to transportation, one that combines traditional mobility solutions with smart technologies, public-private partnerships (P3s) and cutting-edge autonomous vehicles to safely and efficiently transport people.

This is a bold forward-looking vision to provide JTA's customers with the outstanding service they deserve.

The U.S. Department of Transportation's (USDOT's) Autonomous Driving System (ADS) Demonstration Grant program gives JTA a grand opportunity to take this vision further, by advancing the JTA's Autonomous Avenue project that will allow for the testing of autonomous vehicles in an elevated and controlled environment in the heart of Downtown Jacksonville. The existing elevated guideway will be modified, removing the guide-beam, to create a smooth running surface to accommodate autonomous vehicles, and autonomous technology.

Autonomous Avenue is a key component of JTA's Ultimate Urban Circulator (U^2C), which is a comprehensive plan to modernize and expand the Skyway. By leveraging existing infrastructure, and integrating innovation and technology, JTA will expand the current 2.5 mile footprint to 10 miles, serving three times the capacity the system carries today.

No other project will support the ADS' key goals and advance USDOT's research in creating an autonomous vehicle implementation more than JTA's Autonomous Avenue. This project is predicated on "Safety," "Data Analysis and Sharing," and "Collaboration."

Come and join JTA on this journey as we build the first autonomous transportation network in America.

Nathaniel P. Ford Sr.
CEO
Jacksonville Transportation Authority

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Summary Table

SUMMARY TABLE	RESPONSE
PROJECT NAME/TITLE	Autonomous Avenue (Advancing the Ultimate Urban Circulator (U^2C) Program)
ELIGIBLE ENTITY APPLYING TO RECEIVE FEDERAL FUNDING	Jacksonville Transportation Authority (JTA)
POINT OF CONTACT	Bernard Schmidt-Vice President, Automation; bschmidt@jtafla.com, (904)-630-3181)
PROPOSED LOCATION (STATE(S) AND MUNICIPALITIES) FOR THE DEMONSTRATION	Florida Duval County City of Jacksonville
PROPOSED TECHNOLOGIES FOR THE DEMONSTRATION	• SAE Level 4 autonomous transit vehicle • Integrated Data Exchange (IDE) • Vehicle Charging • Communication and Supervisory Controls
PROPOSED DURATION OF THE DEMONSTRATION (PERIOD OF PERFORMANCE)	Two (continuing for the full 2.5 mile Skyway Conversion)
FEDERAL FUNDING AMOUNT REQUESTED	$10 Million
NON-FEDERAL COST SHARE AMOUNT PROPOSED, IF APPLICABLE	$22.24 Million
TOTAL PROJECT COST (FEDERAL SHARE + NON-FEDERAL COST SHARE, IF APPLICABLE)	$32.24 Million

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b) Project Narrative and Technical Approach

1. Executive Summary

The *Autonomous Avenue* Demonstration project will retrofit a 1/3 mile section of the elevated structure of the Automated People Mover (Skyway) in Downtown Jacksonville, Florida to accommodate an autonomous vehicle transit system. This project is a key element of Jacksonville Transportation Authority's (JTA) Ultimate Urban Circulator (U^2C) Program.

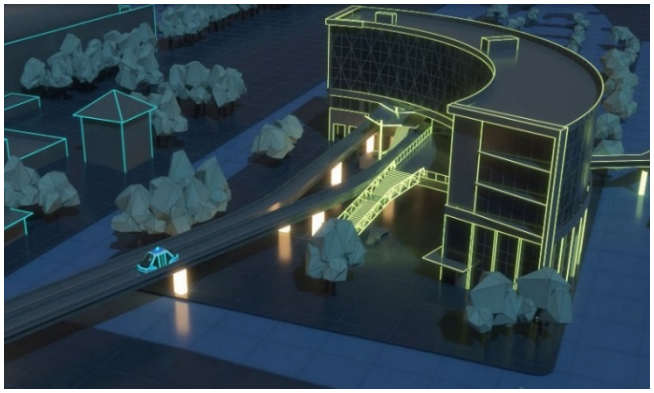
The U^2C is a comprehensive program to modernize and expand the Skyway and introduce autonomous vehicles (AVs) into JTA's transit system. The existing Skyway is a 2.5-mile, bi-directional monorail system with eight stations and a 25,000 square foot Operations and Maintenance Facility. The vision for the future of the Skyway under the U^2C Program is a 10-mile system with a fleet of autonomous transit vehicles that can operate on the existing elevated infrastructure and at the street level. With a larger fleet of smaller vehicles, the modernized Skyway would operate at higher frequencies (2-3 minutes), be able to reach into existing neighborhoods and support planned developments, and ultimately provide on-demand and point-to-point transit service in the urban core.

The *Autonomous Avenue* project that will be delivered under the **Automated Driving System (ADS) Demonstration Grant** will provide important lessons for the conversion of existing elevated systems and the establishment of new systems that can accommodate autonomous transit networks and other elevated autonomous operating domains. The project not only includes the actual infrastructure conversion, it includes an Integrated Data Exchange (IDE) and an operating demonstration for elevated transit service between the new Jacksonville Regional Transportation Center (JRTC) at LaVilla and the existing Skyway Jefferson Station.

The *Autonomous Avenue* project is scalable to other communities/agencies that have aging elevated systems and looking to deploy autonomous transit. The project envisions creating a vehicle agnostic platform that would allow different form factors of vehicles to operate on the structure and allow for the easy transition between vehicle technologies.

Table 1: Cost Share

Source	Amount
ADS Grant	$ 10,000,000
Private Sector	$ 4,200,000
Public Match (JEA)	$ 1,000,000
P3	$ 13,040,000
JTA	$ 4,000,000
Total Budget	$ 32,240,000



Rendering of new AV approach to JRTC

The U^2C is a comprehensive program that will introduce autonomous mobility

solutions to the JTA Transit ecosystem. The ADS grant funded Autonomous Avenue is an integral part of the program which will result in the deployment of the prototype future autonomous urban transit network. The overall *Build Elements Plan* and *Funding and Phasing Strategy* are described in greater detail in Section 1E.

The origins of the U²C Program can be found in the *Skyway Technology Assessment* initiated in 2014 and culminated in 2015 with the JTA Board of Directors adopting the Skyway Subcommittee and Skyway Advisory Group recommendation to keep, modernize, and expand the Skyway. In 2016, the Skyway Modernization Program (SMP) was launched to modernize and expand the Skyway utilizing next generation AV technology. This represented the formal establishment of the U²C Program. The ADS Grant funding will advance a large scale AV demonstration project and establish Autonomous Avenue as a foundational component of the U²C program.

U²C Program Build Elements Plan

The U²C Skyway Conversion and System Expansion involves multiple phases to create the prototype autonomous urban transit network of the future. Figure 1 provides a visual depiction of the multiple phases (or Build Elements) of the Skyway conversion and expansion elements of the U²C Program.

The Build Elements of the U²C Skyway Conversion and Expansion include:

The ***Test and Learn Facility*** is being utilized to demonstrate and test autonomous transit vehicles, train JTA staff, educate the public and gain critical stakeholder input and lessons learned for the development of the U²C Program vehicle specifications.

The ***Bay Street Innovation Corridor*** will include an at-grade AV transit service connecting Central Station to the Sports Complex.

Autonomous Avenue is a 1/3-mile segment from the new JRTC to Jefferson Station that will create the framework for the conversion of the elevated structure and operations on the existing Skyway infrastructure.

System Conversion and Brooklyn Extension involves the full conversion of the 2.5-mile elevated Skyway structure and a short extension of the trackway to the existing O&M center establishing a connection to the growing Brooklyn neighborhood.

U²C System Expansion includes at-grade extensions that fulfill the 10-mile U²C Program vision of connecting the urban core with key neighborhoods and destinations including San Marco, Baptist Medical Center, The District, Five Points/Riverside, Springfield, UF Health and the Sports Complex.

Figure 1: U²C System (Build Elements)

As the preeminent leader in the development of autonomous transit systems we have an obligation to share our lessons learned with industry partners and peers to ensure the safe, efficient and effective deployment of new technologies.

Nathaniel P. Ford Sr., JTA CEO

U²C Funding and Deployment Strategy

The Autonomous Avenue project and funding through the ADS grant is a critical step in the infrastructure conversion, vehicle testing, and operations envisioned under the program. Overall, the U²C Program's success relies on a mix of funding partners that are needed for the effective and timely delivery of this transformative program.

The ADS grant will build on previous activities and investments and fuel the future deployment plan. In 2017, a structural assessment of the Skyway infrastructure was conducted and a Test and Learn facility was launched. A Phase I *Transit Concepts and Alternatives Review (TCAR I)* study was initiated to position the project for state and federal New Starts/Small Starts funding for the initial Skyway System Conversion and Brooklyn Extension. A TCAR II study is underway for the System Expansion.

JTA recently received a Better Utilizing Investments to Leverage Development (BUILD) grant from USDOT that will support the launch of the Bay Street Innovation Corridor as described in page 2 of this application.

The ADS grant will be used to advance the Autonomous Avenue project which includes a conversion and an operating demonstration. The operating demonstration will run until the full Skyway System Conversion and completion of the Brooklyn Extension is implemented. JTA intends to pursue FTA Small Starts funding for the System Conversion and Expansion. The FDOT has been an active supporter of the U²C Program, has funded the TCAR studies, is providing matching funds for the BUILD Grant, and will be a matching partner in the Small Starts elements. The Funding and Deployment Strategy is depicted in Figure 2.

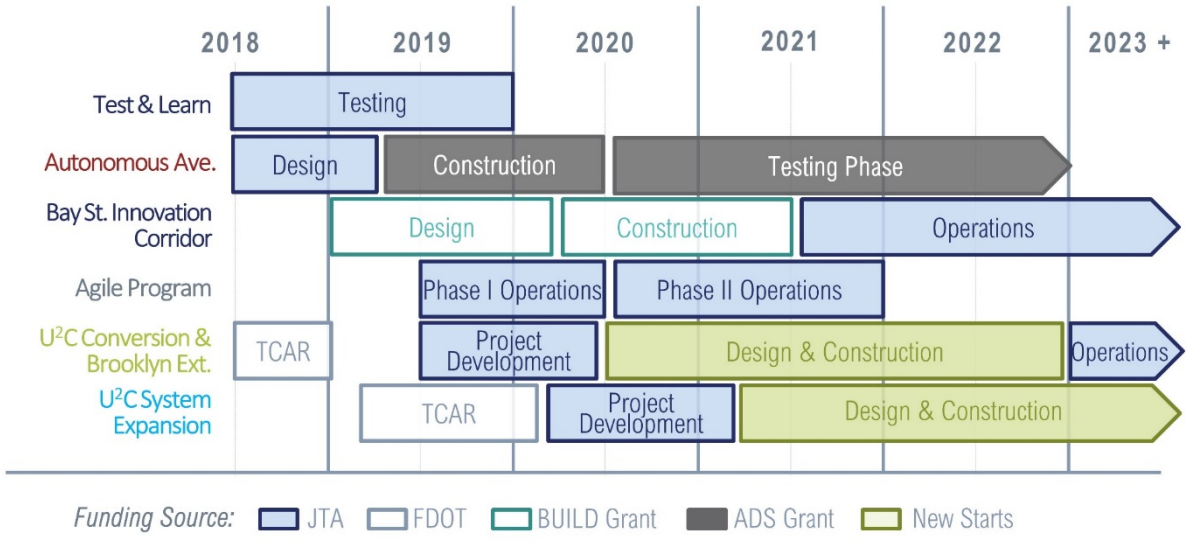


Figure 2: U²C Funding and Deployment Strategy

a. Vision, Goals, and Objectives

Vision: To create the prototype autonomous transportation system for an elevated roadway.

Goals:

- Demonstrate the safe and accessible deployment of AV transit.
- Advance beyond "novelty" demonstration to safe, meaningful and sustainable deployment of an AV transit system.
- Effective and user friendly sharing of operational, performance and customer data to generate lessons learned for JTA and the industry.
- Inform public and private agencies regarding the planning, design and implementation for conversion and expansion of existing systems and the establishment of new systems.
- Scalable and is based on AV and technology use cases that can be utilized by other agencies, cities, and regions.
- Develop set of learnings and industry guidance for the conversion of elevated infrastructure to support autonomous systems.

Objectives:

- Test integration of ADS into a multimodal transportation network.
- Create a framework for full conversion of the Skyway to a fully functional autonomous vehicle transit network connected to and supportive of the regional transportation network.
- Utilize the IDE to create a comprehensive cloud to collect, share, and analyze data.
- Advance new model for innovative partnerships which unifies expertise of multiple stakeholders.
- To develop a platform that will ensure interoperability of vehicles, systems, and communications to foster innovation and eliminate technology obsolescence.

JTA's vision is to provide universal access to dynamic transportation solutions, and the U²C program is predicated on delivering exactly that for our customers. Projects such as the Autonomous Avenue, and the Bay Street Innovation Corridor, are gigantic leaps forward in making a reality the deployment of an autonomous vehicle network. And while the U²C will be a model for the nation, our projects are providing valuable information that can begin today the development of policies, practices and rules to govern the safe deployment and operation of autonomous vehicles systems. That's why establishing a one-of-a-kind partnership with RTC Nevada to serve as peer agencies, where data and best practices sharing will be the focal point. Both our agencies are recognized as the top leaders in mobility and innovation, and this collaboration is a game-changer.

b. Key Partners, Stakeholders, Team Members and Others Proposed to Participate

JTA has a long-standing collaborative partnership with the City of Jacksonville, FDOT, JEA and the North Florida Transportation Planning Organization (North Florida TPO) to advance innovative transportation projects and initiatives in Northeast Florida. The Autonomous Avenue Demonstration project team is comprised of industry experts and community stakeholders representing transportation planning, design and engineering, autonomous technology research, academia, and advanced technology resources. JTA has created an alliance with multiple universities.

Agency Partners

- JTA
- City of Jacksonville
- Downtown Investment Authority (DIA)
- North Florida TPO
- Florida Department of Transportation (FDOT)
- JEA (Independent power and water utility)
- Jacksonville Chamber of Commerce (JAX Chamber)

Research Partners

- University of Florida (UF)
- Florida State College at Jacksonville (FSCJ)
- Jacksonville University (JU)
- University of North Florida (UNF)
- Florida Polytechnic University
- Embry Riddle Aeronautical University
- University of South Florida Center for Urban Transportation Research (CUTR)
- University of Nebraska

Figure 3: Research Alliances

c. Issues and Challenges

The Autonomous Avenue project will address several issues and challenges that deployment of an autonomous vehicles represent. The JTA has begun identifying key issues related to safety, operations and infrastructure, and is developing possible and viable solutions. AV System and infrastructure design challenges that are solved in Autonomous Avenue will have practical application in other projects across the nation that seek to implement autonomous vehicles on existing infrastructure. Representative items that have been identified area described below.

Safety Issues

- Side wall crash rating – University of Nebraska simulation to ensure safety on elevated structure.
- Americans with Disabilities Act (ADA) accessibility – automated guidance system and infrastructure modifications to ensure level boarding.
- Ingress and egress in emergency situations – considering infrastructure and AV system design to allow safe evacuation during emergencies.
- Rider comfort related to speed/acceleration and guideway curvature/super elevation and when ascending and descending steeper grades.

Operational Challenges

- Operations in narrow guideway - Lidar sensing or alternative guidance system for elevated operations.
- Technology supporting elevated operations that will enable transition to street level operations.
- Operations in inclement weather including high wind, extreme heat and cold as well as during periods of heavy rain.

Infrastructure Considerations

- Drainage on elevated structure to minimize hydroplaning and allow safe operation during heavy rainfall.
- Structural/weight loading on existing structure. Ensure that structure has capacity to accommodate additional loading.
- Location of utilities.
- Vehicle Charging.
- Level boarding at stations – adjustments needed to accommodate all passengers and meet ADA requirements.

d. Geographic Area/Jurisdiction of Demonstration

The *Autonomous Avenue* Demonstration project is located in the Jacksonville, within the limits of Duval County, in Northeast Florida as depicted in Figure 4.

The City of Jacksonville, bisected by the St. Johns River and located approximately 15 miles inland from the Atlantic Ocean, is home to more than one million people within the metropolitan statistical area.

Autonomous Avenue is a 1/3 mile segment of the existing 2.5 mile elevated Downtown Skyway as illustrated in Figure 5.

Figure 4: Project Location Map

Figure 5: Existing Skyway with U²C System

e. Proposed Period for Performance and Evaluation

The proposed demonstration period is two years, after which time the system will continue operations as part of JTA's multi-modal operation to serve downtown Jacksonville. Autonomous Avenue will be a functioning component of the existing transit system. The demonstration will continue as part of the full conversion of the entire skyway system.

The JTA has developed and initiated a project plan to ensure the timely deployment of the Autonomous Avenue operational demonstration. JTA has already developed a conceptual design for the conversion and is initiating the final design. A construction manager at-risk has been engaged to begin phases of construction concurrent with final design elements.

Autonomous Avenue Proposed Milestones

Conceptual Design	November 2018 – March 2019
Final Design	April 2019 – November 2019
Pre-Construction	March 2019 – May 2019
Demolition	June 2019 – September 2019
Station Upgrade (JRTC)	October 2019 – January 2020
Roadway Construction	October 2019 – April 2020
Station Upgrade (Jefferson)	February 2020 – May 2020
Technology Systems & Connected Infrastructure	May 2020 – June 2020
Commissioning	July 2020
Beginning of Performance and Evaluation	August 2020

2. Goals

a. Safety

Through the Autonomous Avenue project, JTA will be operating on an elevated roadway connecting to the local, regional and national transportation network through the JRTC. This operating domain allows JTA to address the safe integration of ADS in a functioning transit system. It will also allow actual transit riders to utilize the autonomous vehicle network within a working transit system. Key safety goals include:

View of existing elevated guideway

- Side wall crash rating – utilizing University of Nebraska simulation.
  - The transition from a fixed guideway system to a rubber tire virtual guideway.
- ADA accessibility – automated guidance system and infrastructure modifications to ensure level boarding.

- Ensure that the AV can safely comply with all ADA requirements.
- Automated vehicles will approach and engage riders needing ADA accessibility.
- Evaluate the need for attendants to assist people with ADA needs.

- Cyber Security.
  - Connected autonomous vehicle system must have state-of-the-art cyber security systems and must function as a fail-safe in case of cyber-attack.
- Anti-Terrorism.
  - The system design will be resistant to hijacking and remote take-over to ensure that only verified operators are capable of managing the system.
- Ingress and egress in emergency situations – infrastructure modifications to support.
  - Demonstrate that an elevated automated transit network can be designed in a manner that is safer than a fixed guideway or automated people mover.
  - Help inform the safety specifications for the newly designed automated vehicles.
- Rider comfort related to speed/propulsion and guideway curvature/superelevation.
  - Define geometrical design requirements for the speed and curvature on a raised virtual guideway.
  - Assess applicability of rail and/or roadway design standards.

b. Data for Safety Analysis and Rulemaking

JTA expects that this demonstration will help identify risks, opportunities, and insights relevant for USDOT safety and rulemaking priorities needed to refine government policies to enable the safe integration of AV-related technologies.

The Autonomous Avenue demonstration project will create data that can be used for policy development and rule-making. One of the basic design principals of the project centers on the use of connected vehicles, technologies, and devices. The data created can be analyzed to show insights and behaviors. Policy makers can use the data analysis to understand key components and features of AV systems.

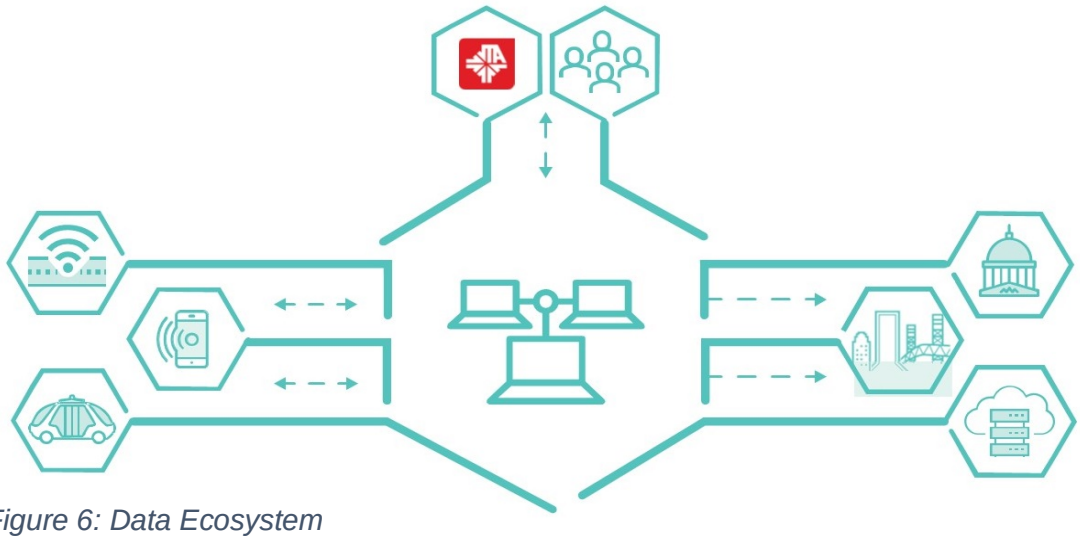


Figure 6: Data Ecosystem

c. Collaboration

The *Autonomous Avenue Demonstration* project is supported by a collaboration of multiple stakeholders which include a one-of-a-kind partnership between RTC Las Vegas, research colleges and universities, government agencies and community organizations. These different groups will collaborate with JTA on evaluating AV's for people mover use and might even inspire other agencies to join the effort.

Stakeholder engagement and community collaboration has already been initiated under the JTA Test and Learn Program. The Test and Learn Facility, launched in December 2017, is a one-third mile test track on the east edge of Downtown Jacksonville. The program has collected feedback from a variety of stakeholders including the Jacksonville Transportation Advisory Committee (JTAC). JTAC has provided important input from the transportation disadvantaged community regarding the benefits and challenges of autonomous transit, including specific feedback that will be used to develop specifications for the U^{2}C vehicle.

JTAC Tour, March 2019

As depicted in Figure 7, a collaboration of universities have been identified to actively engage in the research and demonstration for Autonomous Avenue. More details on this collaborative effort are described in ADS Grant Part 2 – Management Approach. JTA is going to make lessons learned available and has committed to share data to communities and agencies that are planning their own autonomous transportation networks.

Collaborative Research Alliance	
University Partner	**Supporting Research Role**
University of Nebraska	Infrastructure Analysis
Embry Riddle Aeronautical University	Technology Integration
Jacksonville University	Public Policy & Finance
University of North Florida	Robotics and Cybersecurity
Florida Polytechnic University	AV Pilot Testing
University of Florida	Law & Operations
Florida State College of Jacksonville	Workforce Development
University of South Florida CUTR	Transit Operations

Figure 7: University Collaborative

3. Focus Areas

The *Autonomous Avenue* Demonstration project focuses on all of the key areas defined for the ADS Grant opportunity, including:

- Public benefit, education and awareness of automated driving systems through testing, evaluation and outreach.
- Accessibility for underserved and transportation challenged populations.
- Supports economic vitality for the region and nation.
- Proving ground for advancing technology, demonstrating SAE L4 (or greater) automation technologies and complex, unique infrastructure design applications.
- Connectivity to local, regional and national transportation network.
- Defined protocols and guidance for safe deployment of AV technologies across all transportation user groups.
- Scalability to other transportation systems across the country.

a. Significant Public Benefits

The *Autonomous Avenue* project is a critical initial segment of the conversion of a 2.5 mile, bi-directional system (5 track miles) envisioned under the U^{2}C Program. The *Autonomous Avenue* project also complements the ***Bay Street Innovation Corridor*** which includes an at-grade autonomous transit section. These are both foundational projects for the U^{2}C Program which will be a 10-mile system in the future when fully built out. The U^{2}C Program is positioned to be the first complete urban autonomous transportation network in the United States.

- Modernizing existing Skyway infrastructure to take advantage of previous public investments in the age of technology obsolescence.
- Advancing a meaningful use case for autonomous transit (moving beyond a demonstration to a functioning transit service).
- Developing a new more flexible transit mode.
- Building public confidence through the deployment of safe autonomous transit.


JTA Test & Learn Test Track

b. Addressing Market Failure and Other Compelling Public Needs

There is significant investment occurring in connected and autonomous vehicles in Florida and across the nation. Major automotive companies have escalated their investment and are now pursuing aggressive strategies to deploy this technology in the next several years. Conversion of fleets, such as transit fleets, represent an early opportunity to introduce AV's into the mobility ecosystem and provide enhanced mobility to a wide range of demographic and socio-economic communities. JTA envisions the following market opportunities:

- Opportunity to develop specifications and lead vehicle manufacturers to solutions that support needs of the transit industry. Foster a domestic manufacturing and support base that is Buy America compliant.
- The Autonomous Avenue project will help ensure vehicles have key characteristics needed to support public transit:
    - Vehicle body resiliency to support every day wear and tear of public transit service vehicles.
    - Fully consider needs of the disabled and transportation disadvantaged community.
    - Propulsion and speed sufficient to support reliable and sustained service.
    - Advance a multi-agency and publicly available IDE.
    - Control Supervisory System & Software Platform – Develop necessary software layers for fleet management, command and control, supervisory, and connection to user interfaces.

c. Economic Vitality

The JTA is committed to utilizing Autonomous Avenue and the U^{2}C Program to serve as a catalyst for growing domestic production of autonomous vehicles. Autonomous Avenue and the Bay Street Innovation Corridor will be supported by a fleet of nearly 15 vehicles. The 10-mile build out of the entire U^{2}C Program will ultimately require over 100 vehicles. Unlike the typical demonstrations currently underway across the county, **the U^{2}C Program has an order of magnitude that can serve as an incentive to grow domestic capacity**. JTA is committed to advance the goals and purpose of Buy America policies by encouraging and incentivizing vehicle manufactures to build in Jacksonville, Florida.

The Autonomous Avenue project and U^{2}C Program are in line with the region's initiatives and policies to help residents, communities and businesses grow, connect and prosper. Specifically, the U^{2}C Program is consistent with JAXChamber and Florida Chamber policies:

JaxChamber Advocacy Agenda, 2017-2018:

- Support the use of new technologies, such as Unmanned Systems, in a safe and responsible manner, while safeguarding the existing right to privacy and ensuring transparency and accountability (Local, State & Federal).
- Support policies, initiatives, and regulations that will enhance Northeast Florida's ability to implement and integrate Autonomous and Connected Vehicles.

Florida Chamber's Florida 2030 The Blueprint to secure Florida's Future Targets & Strategies:

- Continue to be a leader in research and deployment of emerging transportation technologies including autonomous, connected, shared, and electric vehicles.
- Introduce and develop Internet of Things, artificial intelligence, and other emerging technology within state, regional, and local infrastructure.

d. Complexity of Technology

Because the Autonomous Avenue project will establish a controlled environment in an urban setting, it will enable the testing of SAE Level 4 autonomous transit. The autonomous transit vehicles will include an on-board "operator" functioning as a transit concierge. As the demonstration progresses, the on board "operator" will be removed from the vehicle. The on-board operator will be replaced by a fleet technician responsible for the operations and performance of multiple vehicles. The fleet technician will make the decision on when a vehicle enters or exits service. The fleet technician will communicate with riders audibly via onboard speaker or by posting a message to the display screen on the vehicles and surrounding kiosks.

The vehicles will come with hardware and sensors that will have functionality beyond the initial software functionality of the vehicle. JTA is very interested in adding vehicle functionality by upgrading software over time. In this way, JTA will be able to extend the lifespan of the vehicles and vehicle support systems by focusing on upgrading software. New features like on-demand service and automatically conserving battery power can be added to the fleet during a software update while the vehicles are out of service.

Beyond the technology of the vehicle, many support and ancillary systems are critical to the overall implementation and performance of the system. Communication systems, battery charging systems, station interfaces (light curtains and cross walks), connected devices, and user interfaces are examples of primary support systems that are required for the demonstration. Additionally, legacy infrastructure requires integration with the new system, including SCADA (PLC system), control room, fire alarm, power distribution, security/ surveillance, and train control systems all require modification with the addition of AVs. JTA is keenly aware of the necessity of designing all of the support systems for the overall performance of the autonomous vehicles.

e. Diversity of Projects

Autonomous Avenue connects to multimodal facilities, local, regional and national transit services, and includes the following unique characteristics:

- Most autonomous transit demonstrations occur in less dense environments such as business parks. Autonomous Avenue is unique in that while it is in a controlled environment, it is in the urban core of Jacksonville.
- Autonomous Avenue links the Skyway with the new JRTC at LaVilla which accommodates multi-modal transportation services (local bus, bus rapid transit, Megabus, Greyhound and the Skyway). The JRTC at LaVilla will house the main local bus terminal for the JTA when it opens in spring 2020.
- Autonomous Avenue is located in a neighborhood with rich cultural history that is currently seeing unprecedented redevelopment.

f. Transportation-Challenged Populations

The Autonomous Avenue demonstration will enable the testing and evaluation of accessibility and mobility for all transportation system user groups. Since December 2017, JTA's Test and Learn Facility has hosted more than 1700 guests representing customers of varying age and mobility capabilities. Specifically, the JTA team has invited members of the transportation disadvantaged population in Jacksonville and surrounding communities to examine and ride the vehicles at the Test and Learn Facility. JTA collected and examined feedback from the Test and Learn customers which has allowed these factors to be addressed and incorporated into the design of Autonomous Avenue. Features such as vehicle access and egress, specifically for ADA concerns, customer information, visual aids, signage and other safety and security systems, all must be considered. Planned design features of Autonomous Avenue will incorporate:

- Universal design.
- ADA access at stations and platforms.
- Existing platforms address ADA requirements (bus v automated people mover requirements).
- Experiment with different elements, such as vehicles, software, etc. to test.
- Feedback from transportation disadvantaged with test track.

AV at JTA Test Facility

g. Prototypes

Leading up to the Autonomous Avenue project JTA has been testing AV's in a rigorous testing program. Over 50 public events have been conducted where feedback from the public via formal survey has been collected. To date, JTA has tested four unique autonomous transit shuttles in the Test and Learn Program. The testing has included major AV manufacturers including EasyMile and Navya and includes domestically produced and foreign produced vehicles. The assessment of this initial testing is that the industry is rapidly evolving. No single AV manufacturer includes all of the features that a public transportation agency, like JTA, will require for full time service. JTA reports findings of vehicle testing back to the OEM's for incorporation into next generation design. The evaluation of the prototypes includes:

- Robustness of the vehicles.
- Performance of Batteries, Sensors, and Hardware.
- Reaction of the artificial intelligence driving during adverse conditions.
- Public acceptance of the vehicles and technology.
- Digital interface with vehicles from supervisory system.
- Accessibility.

JTA believes implementing AV's in a controlled environment (elevated track and dedicated lanes) will lead to vehicle performance assessments that will move the industry forward. By deploying AV's as part of revenue service, JTA, USDOT, and the FTA will be able to offer guidance to the industry on what upgrades and changes need to be made in the next generation of domestically produced public transit autonomous vehicles.

4. Requirements

Autonomous Avenue will test and evaluate the following performance and operational factors to comply with the ADS Grant program demonstration requirements:

- AV operations on elevated track.
- Impacts of weather conditions on vehicle and communications operations.
- Physical constraints that could affect performance.
- Supervisory system control and monitoring.
- Factors that could affect the USDOT/ FTA/National Highway Traffic Safety Administration (NHTSA) Policies.
- Passenger boarding, including customers with special needs and mobility challenges.
- Demand based service scenarios.
- Vehicle charging, operating longevity and storage capabilities.
- Emergency response circumstances and settings.

a. Automation and ADS Technology Research & Development

JTA's Autonomous Avenue project will exclusively focus on Level 4 automation, per the *SAE Levels of Autonomy*, depicted in Figure 8. Given that Autonomous Avenue is largely a controlled environment with beginning and ending destinations at stations, the system will function close to a Level 5 of automation. The vehicle selections will not be equipped with manual steering or maneuvering equipment (steering wheel, brake, and accelerator) during normal operations. When a JTA operator desires manual take-over of a vehicle a temporary steering device will be added to the vehicle (joystick or remote control). During manual intervention the vehicle will be out of service. When the vehicle is returned to normal service the temporary steering device will be removed and the vehicle will drive autonomously, reactive to the following methods of directing the vehicle:

Trolley Mode – the vehicle automatically starts and stops according to a pre-planned schedule and programmed dwell times – This will be used during high passenger traffic times.

Manual Mode – A passenger or operator interacts with the vehicle via push button or control screen onboard the vehicle – this will be used during low passenger traffic times.

Remote Dispatch – A passenger interacts with the vehicle via smart mobile device or on-site kiosk to summon the vehicle – this will be used on an experimental basis.

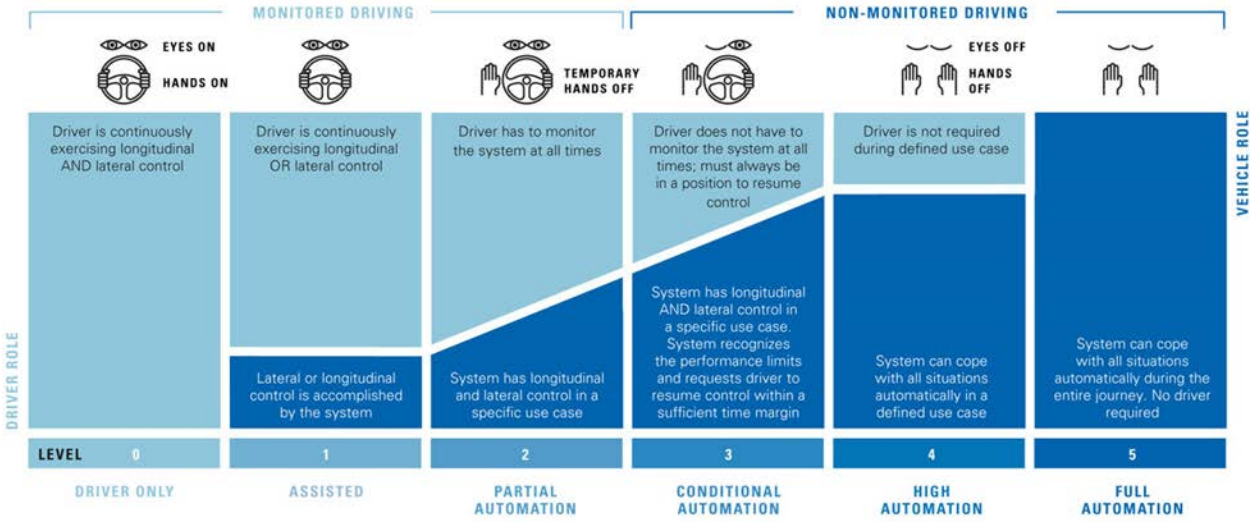


Figure 8: SAE Levels of Automation

b. Physical Demonstration

As depicted in Figure 9, the Autonomous Avenue demonstration project is located between the new JRTC at LaVilla/existing Convention Center Station and Jefferson Station. There are two elements to the Autonomous Avenue demonstration: (1) elevated infrastructure conversion and (2) elevated autonomous shuttle operations.

First, the elevated infrastructure conversion of 1700 feet of the existing Skyway will demonstrate the feasibility and evaluate issues around conversion of an elevated automated people mover into an elevated roadway for an automated transportation network. This is described in more detail in Section 5 - Technical Approach. The infrastructure conversion demonstration will address key issues associated with structural requirements, pavement types, drainage, safety elements, communications, vehicle charging, and access.

Second, the operational demonstration will test vehicle performance, impacts of weather conditions, passenger safety, and comfort. JTA will operate two autonomous shuttles from the new JRTC at LaVilla Station to Jefferson Station.

c. Shared Data

Autonomous Avenue will produce a rich amount of real-time data. Over time, the project data will aggregate to "big data" (see Figure 10) requiring special processing, computing, and storage. JTA will be implementing new data storage and retrieval methods and infrastructure, including cloud computing, to handle the data requirements of this project. JTA will make data available to the USDOT and FTA in consumable data sets, such as CSV files or databases. Additionally, data will be contributed to an Integrated Data Exchange (IDE) currently in development through the region's Smart Region Plan, where dashboards and insights can be drawn from the data. USDOT and FTA will have full access to the IDE including all source data and files.

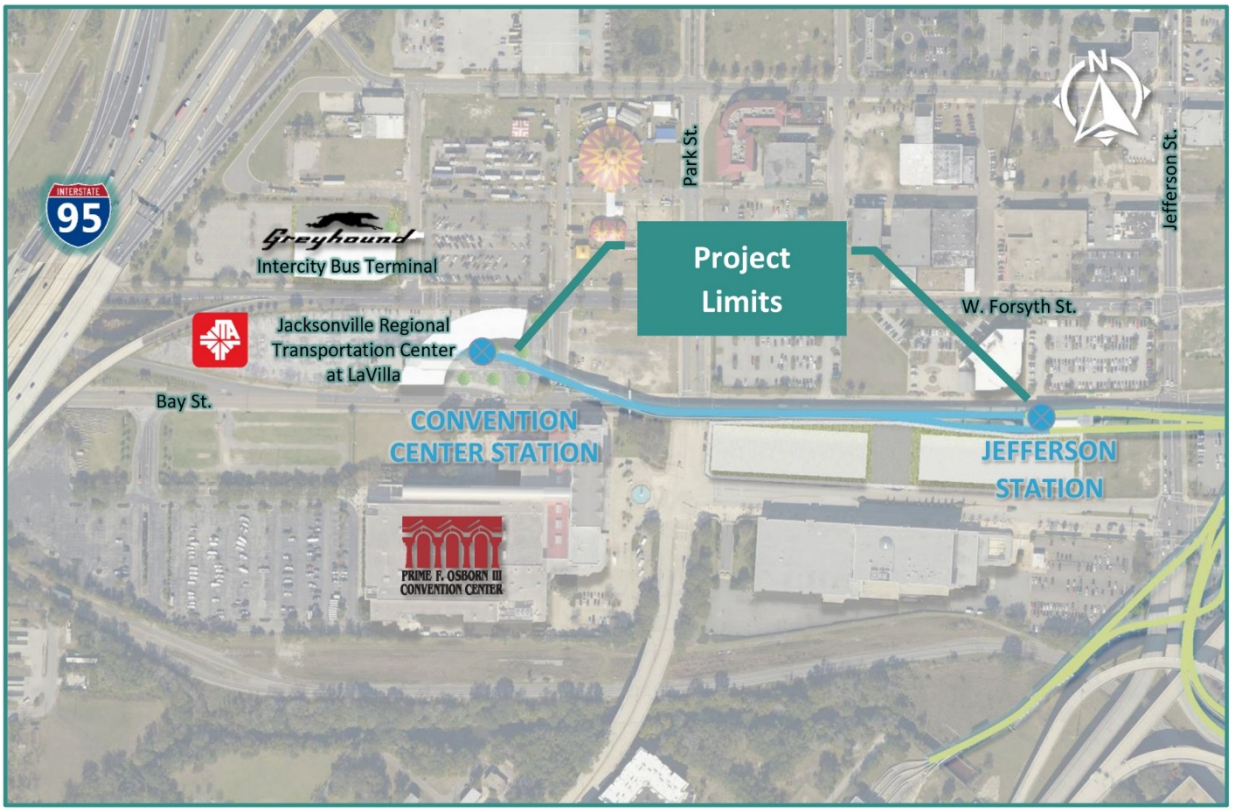


Figure 9: Project Demonstration Location Detail

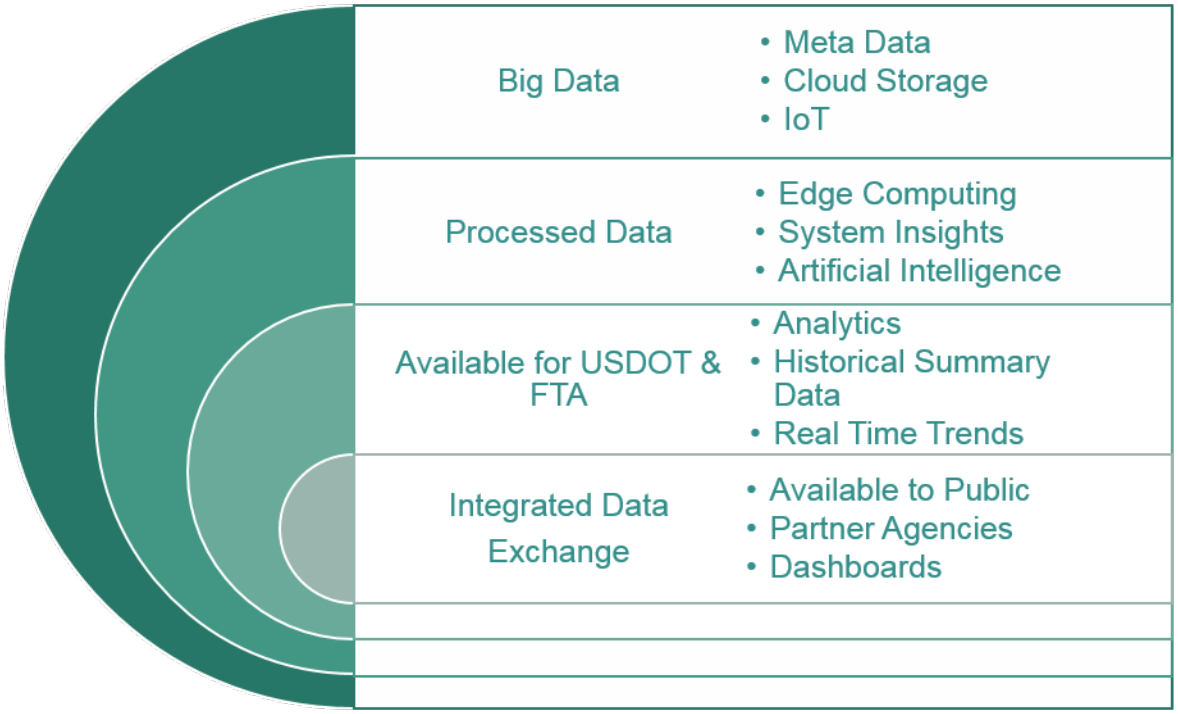


Figure 10: Data Interface

d. User Interface and Accessibility

The new JTA system is agnostic to the format of user interface for the public to interact with our system. JTA will provide our interfaces in a manner that promotes open access, while protecting the security of the system. JTA will also ensure accessibility to all of our ridership. Below are some expected user interface formats:

- Smart Phone Application – My JTA APP.
- Internet / Desktop.
- IDE.
- Kiosks, Tablets, or Totems at the station.
- Smart Screens or Human-Machine Interface (HMI's) inside the vehicles.
- Accessible features, such as brail and audible alerts.

As the functionality of the system grows over time we anticipate being able to offer enhanced functionality and data to our ridership. In time, the U^{2}C Program customer interface will offer payment, trip planning, advertising, personalized accounts, and other features.

e. Project Scalability

AV's will operate in various domains and AV technology will create new infrastructure demands, disrupt traditional project development and funding models, and transform transit service planning. The JTA's vision for the U^{2}C Program relies on the flexibility to operate in different environments specifically the elevated section in the urban core and at the ground level in nearby neighborhoods. This will result in high service efficiency in the more congested core while at-grade extensions will allow for connectivity to neighborhoods. There are dozens of elevated transit systems in the U.S. and throughout the world. These include elevated rail systems, monorail systems, and urban and airport people movers.

Jacksonville's Skyway is one of seven urban people mover systems in the U.S. There are also more than 25 airport people movers and we have identified ten entertainment-based people mover systems (e.g. Disney monorail). As these systems age, and as public and private entities explore new elevated systems, especially in congested urban areas, the lessons learned from the Autonomous Avenue will be critical for future system planning and development. The Autonomous Avenue demonstration project will provide important lessons for various approaches to elevated or hybrid elevated/at-grade autonomous transit that including retrofit of existing systems, extension of rail transit networks, and development of new systems. As an example, in the initial concept development, JTA has identified key areas that could provide industry guidance on conversion projects:

- Utility relocation.
- Geometric requirements.
- Power and communications.
- Drainage requirements.

- Side wall evaluation for collisions and height requirements.
- ADA egress on elevated guideway.

Conversion Scalability to Other Systems

The concept planning design work invested to date and completed as part of Autonomous Avenue will serve as an industry framework for design criteria and key considerations for converting an existing elevated automated people mover system into a track that will allow autonomous transit shuttles to operate. Additional details of the design considerations are discussed in Section 5 – Approach, a. Technical Implementation and Evaluation. The following are examples of where lessons learned from Autonomous Avenue can be applied to other projects in the planning phase. While the demand for information to support these systems is growing rapidly, there is little or no practical applications to guide planning and project development. JTA will make available lessons earned from the conversion project.

Miami Dade North Corridor Extension

In December 2018, the Miami-Dade Transportation Planning Organization (TPO) endorsed the elevated fixed guideway extension of the North Corridor of the Miami Metrorail as the locally preferred alternative. This project is part of the Strategic Miami Area Rapid Transit (SMART) program. After extensive debate, the Miami-Dade TPO Governing Board specifically excluded "rail" as the preferred mode in the LPA despite the fact that the corridor would extend the existing elevated Metrorail. This will allow the project team additional time to further evaluate new technologies that could be more cost effective and flexible. Issues such as cost, community impacts, system flexibility and technology obsolescence are driving policy-makers and planners to explore how new technology can mitigate or address issues raised in the planning and engagement process.

Port Authority of New York and New Jersey (PANYNJ)

The proposed LaGuardia AirTrain would connect Queens Airport to the Long Island Railroad's Mets-Willets Point Station via a new 1.5-mile corridor. In identifying alternatives to a people mover system for the LaGuardia Airport, the Port Authority determined an AV (with elevated and at-grade elements) could generate sufficient capacity with an AV system instead of a rail system at about a quarter of the $1.5 billion cost. This option is currently being evaluated further as part of the Environmental Impact Statement which is underway. PANYNJ hopes to break ground in 2020.

Austin "Project Connect"

CapMetro's "Project Connect" is the High Capacity Transit System Plan for the Texas Central Region, (Austin Metropolitan Area). CapMetro will soon enter project development and environmental review for the Orange Line and the Brown Line. The Brown Line is contemplating an elevated Autonomous Rapid Transit line as an option to be evaluated. JTA's plan for the U^2C were presented during the development of Project Connect. The next 18 months will be dedicated to adopting the Locally Preferred Alternative after which the CapMetro anticipates pursing a design-build delivery.

Las Colinas Area Personal Rapid Transit -- North Central Texas Council of Governments (NCTCOG)

The Las Colinas Area Personal Transit (APT) System serves as a circulator in the Las Colinas Urban Center in Irving. Originally opened in 1989 with a 1.5-mile first phase, similar to the Skyway. The system was never fully built out and has not met ridership expectations largely due to lack of development. However, with the extension of Dallas Area Rapid Transit's (DART) Orange Line through Las Colinas in 2012, the Las Colinas APT now has a direct connection to broader regional transit. Increased ridership, new development in the area and the connection to DART has led to consideration of expanding the system. NCTCOG has been researching various applications of AV's including transit and freight on elevated systems. **The lessons of the Autonomous Avenue project could be used to inform future decisions and NCTCOG and JTA have discussed potential peer exchange opportunities.**

Westshore Multimodal Center Connector Tampa Airport Connector

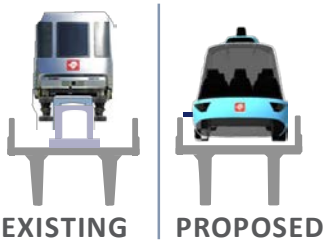
The Westshore Multimodal Center (WMC) is envisioned to provide connectivity for all existing and future planned modes of transportation in the Tampa Bay region and to improve the quality of the intermodal passenger connection in Tampa Bay. The WMC will be a central hub for public and private local and regional transportation services, including rail, buses, taxis, hotel shuttles, bicyclists and pedestrians. Plans for the multimodal center may include a park-and-ride facility, bus layover zone, kiss-and-ride facilities, operations control center, operator lounges, police substation, retail development (as a part of a WMC joint development effort), public restrooms, and a customer service center that could provide information about local and regional public and private transportation services and to purchase transit passes. A key element of the WMC is a Tampa Airport Connector. Initial planning focused on a traditional elevated people mover. AV could serve as an option to traditional APM for this and other airport people mover projects.

5. Approach

a. Technical Implementation and Evaluation

The conceptual planning and design work invested to date for the Autonomous Avenue project will serve as an industry framework for design criteria and key considerations for converting an existing elevated automated people mover system (APM) into a track that will allow autonomous shuttles to operate. The conversion of the existing system will address:

Structural: The existing structure will be modified to remove the guidebeam and barrier walls will be modified or replaced to meet crash resistance requirements. In sections with paired guideways within two feet, a single bi-directional "double tub" will be created to enable ADA egress in case of emergency.



Roadway: The roadway surface design will be coordinated with drainage and vehicle requirements. The project will provide testing for multiple pavement surface treatments, vehicle path correction and pavement markings.

Electrical: The project will include relocation of power elements, lighting, a new power source, panel upgrades and backup power. The modified system will evaluate charging for multiple types of battery powered electric AVs.

Drainage: An elevated roadway places a greater importance on the effective removal of water compared to the existing monorail. The Autonomous Avenue design will address existing drainage challenges as well as those presented by the operation of an elevated roadway.

Communications: Vehicle to infrastructure, user connectivity, station communication, safety and security and fire safety will be addressed to allow coordinated communication between local providers, vehicles, and JTA operations. Features, such as a utility chase including multiple conduits and mini access points, will be implemented to ensure system flexibility for evolving technology.

Architectural: Standard station themes will be designed with a focus on boarding areas, passenger egress, guideway egress, train maintenance facility reconfiguration and signage. There will be unique elements in the finishes of each station to evaluate user experience to ensure the full conversion is developed with highest level of service and accessibility, including ADA.

From an overall structural perspective there are three main elements as shown in Figure 11. One of the first main concerns is the load bearing capacity of the super structure, sub structure and foundations.

The second area of concern is the engineering treatment of the side walls and "tub" design that sits on top of the structure systems. Structures and foundation considerations include:

- When was the original system built?
- What design code was it designed to?
- What are the new code requirements?
- Are the systems uniformly designed or are the uniquely designed? (The existing system has numerous custom designs that need to perform differently given changing sub surface conditions and needs for straddling roadways and making connections).

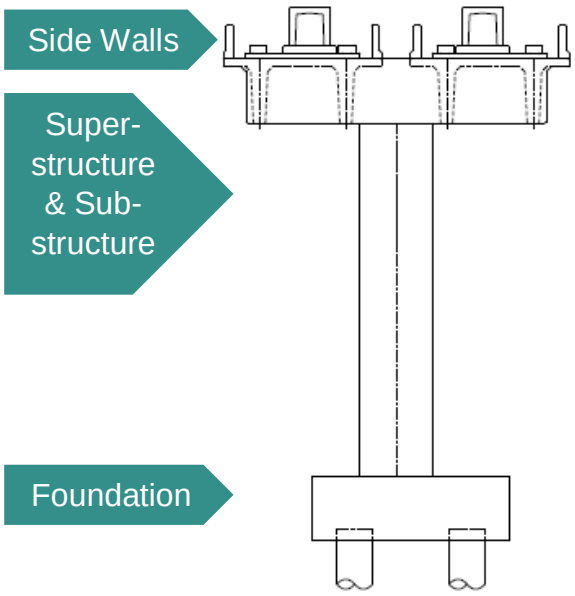


Figure 11: Structural Schematic

Primary criteria for determining design includes:

- **Width of the operating roadway** (distance between side walls) is there enough space to operate the vehicles and allow for adequate space between the vehicle and wall (assuming vehicle can pull over to one side) to allow for safe ADA access?
- Desired **operating speeds** and **existing horizontal curvature** will drive the design of the typical section. Key question - Will super elevation benefit the operation of vehicles enough to incorporate into the design? Super elevation could impact the side wall minimum height.
- **Side Wall strength and height**. What was the original side wall deigned for? What is the test level strength? The strength of the wall is also based on a minimum height of 27 inches. Wall height is critical in considering what demolition is conducted and what road surface and typical section is considered.
- **Drainage**. Drainage becomes critical in a conversion from an APM to an AV system because the AV system relies on a friction-based approach for performance. Removing water effectively is paramount. The JTA APM system rides well above the base surface and drainage seldom is a concern for the operation.

Operating Plan

The Autonomous Avenue operational demonstration will begin once the conversion of the elevated structure is complete and will help the JTA examine autonomous vehicle technology in a real world, elevated environment. The operational plan will introduce concepts utilizing new technology to identify and solve important technical issues that may be present before we get to full system build out. Autonomous Avenue will be operated in conjunction with the current system during the same operational timeframes in an effort to identify similarities in technologies as well as modifications needed to establish clear performance goals and proceed

with AV's. The operational activities will focus on performance benefits as well as conducting integrated and coordinated advanced validation activities to demonstrate readiness for deployment. The activities will also aid the JTA in developing an efficient plan for the operational and/or technological transition to the full build out of U²C System.

b. Legal, Regulatory, Environmental, and/or Other Obstacles

The conversion of the existing Skyway to Autonomous Avenue required NEPA approval. The class of action was a Categorical Exclusion C8 (23 CFR 771.118 (c) (8). and was approved by FTA on April 7, 2017. Project review and approval requirements will involve compliance with the following legislation, policies, and programs.

- Federal Motor Carrier Administration
- NHTSA
- FTA/FDOT SSO
- Buy America
- American Association of State Highway and Transportation Officials (AASHTO)
- City of Jacksonville
- City of Jacksonville Fire and Rescue

Navya Vehicle at JTA Test & Learn

JTA understands the importance of Buy America. JTA's management team has worked to create a procurement list of qualified suppliers and bidders that are 100 percent compliant with Buy America. There are some technology components, such as AV's, where it can be challenging to find a domestic production base to form a bid list of qualified suppliers that can be 100 percent compliant with Buy America. JTA was proud to be the receiver of one of the first domestically produced AV's, which JTA has operated through the testing program for six months. This vehicle was produced in Michigan.

c. Data, Evaluation, and Measures of Effectiveness

For Autonomous Avenue, JTA will gather data from autonomous vehicle vendors, the Skyway's Supervisory Control and Data Acquisition (SCADA) system, adjacent infrastructure, the IDE and cybersecurity resources. Data will be compiled to provide accessible datasets for project evaluation and monitoring. Data will showcase:

- Operational data (vehicle system data and roadway conditions).
- Skyway station, elevators, and alerts.
- Conventional safety incident data.
- Blocking of cyber threats and exploits.

Data will be collected in near real-time and will be stored and made available to the USDOT or the public for at least five years after the award period of performance expires. If the USDOT makes available a secure data system to store data, JTA will make data available on the USDOT platform. Otherwise, JTA will work with its data gathering and storing partners to provide a

third-party system that stores data securely and provides convenient access to data. JTA will budget for the costs of data storage and sharing as needed. Depending on the data measures, data will be streamed or provided as periodic batch updates.

Data will also be gathered from public feedback opportunities throughout the process to determine if opinions change as exposure to autonomous technology information is dispersed into the community. More details on data collection, processes and storage are contained in Part 3 – Draft Data Management Plan.

d. Risk Identification, Mitigation, and Management

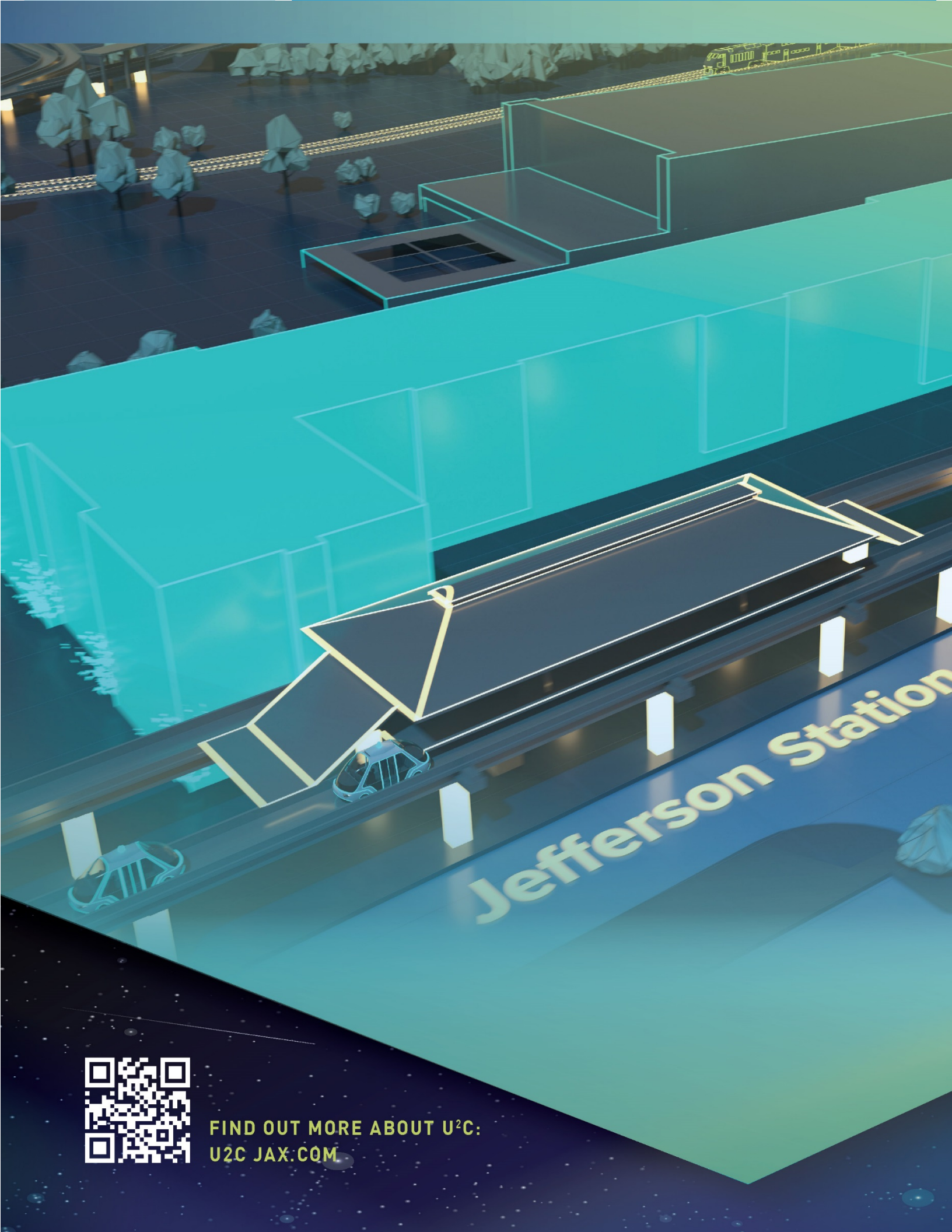
The JTA strives to provide value for its stakeholders, who include our customers, employees and vendors. In the pursuit of this value, the Authority faces risk which may affect JTA's ability to achieve its strategy and objectives. These risks are identified at multiple levels via departmental meetings, cross functional team meetings, and executive level meetings on an on-going basis. Risks are prioritized based on likelihood of occurrence and potential impact. We then, implement strategies to properly mitigate these risks. The most urgent risks are handled immediately and reported at executive leadership meetings.

e. Cost Share

JTA has created a project funding structure where less than 32 percent of the project will be funded by funds from the ADS Demonstration Grant. To diversify funding, JTA is self-funding and using funding from public and private sector partners. JTA's self-funded portion, a major portion of the estimated cost, includes detailed design work currently underway. A significant public sector partner is the local public utility, JEA, who will be installing electrical infrastructure to support charging and fiber optic cabling. The private sector matching funds are partially secured by commitment letters and the remaining portion will be bid out via Request for Proposal (RFP) process. JTA has received enough inquiries from private sector companies offering funding that we are confident that private sector companies will offer funding solutions to meet the project budget. The Budget Detail is provided in Part 6 of this application.

Source	Amount
ADS Grant	$ 10,000,000
Private Sector	$ 4,200,000
Public Match (JEA)	$ 1,000,000
P3	$ 13,040,000
JTA	$ 4,000,000
Total Budget	$ 32,240,000

Table 2: Cost Share by Funding Sources



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