
1ST EDITION
U2C
INNOVATIVE &
AUTONOMOUS
ULTIMATE URBAN CIRCULATOR
JACKSONVILLE
TRANSPORTATION
AUTHORITY


UF Health & VA
8th & Main
2nd & Main
Rosa Parks
Hemming Park
Central
Jefferson
Convention Center
Skyway O&M
Brooklyn
Riverside
Riverside Arts Market
Five Points
JRTC
DOWNTOWN
BROOKLYN
CUMMER
ART & GARDENS
BAPTIST
MEDICAL
CENTER
RIVERSIDE
ST. JOHNS RIVER


LEGEND
Existing Skyway Route/Stations
Existing Skyway Destination Stops
Potential Extension Route/Stations
Potential Extension Destination Stops
Laura Street
Old City Hall
Shipyards
Sports Complex
FSCJ
CITY HALL
VETERANS MEMORIAL ARENA
BASEBALL GROUNDS
TIAA FIELD
THE JACKSONVILLE LANDING
METROPOLITAN PARK
The District
Kings Avenue
Riverplace
San Marco
Medical Complex
San Marco East
SAN MARCO

MESSAGE FROM THE CEO

The Ultimate Urban Circulator (U^2C) program will modernize and expand Jacksonville's Automated Skyway Express (Skyway) using next generation autonomous vehicle technology. The U^2C program is unique, transformative and well-positioned to be a national leading-edge transformational program. The "Information Age" is driven by technology and big data. The whirlwind speed of change is transforming the way we do business. The rapid development of leading-edge technology presents unique and exciting opportunities to modernize the way we move people and goods.

Because the pace of change threatens to make technology obsolete before a project has been launched, Jacksonville Transportation Authority (JTA) is shifting the paradigm of traditional public transportation project delivery to a model that is nimble and flexible. Our driving principles are scalable, flexible, modular, speed-to-market and proven return on investment. We believe we can demonstrate a national model that utilizes those principles, incorporates technology and innovation into transportation systems and is replicable across the country.

The plan is to leverage previous and current federal investments in the Skyway and the First Coast Flyer BRT to build a system that is interconnected, dynamic and sustainable.

We request the U.S. Department of Transportation (USDOT) be our partner as we continue to plan, develop and implement the first autonomous transportation network providing more accessible and efficient public transportation services. By modernizing the Skyway using autonomous vehicle technology, we can create the framework for the future of transportation. Thank you for the opportunity to present this concept.

Nathaniel P. Ford Sr.

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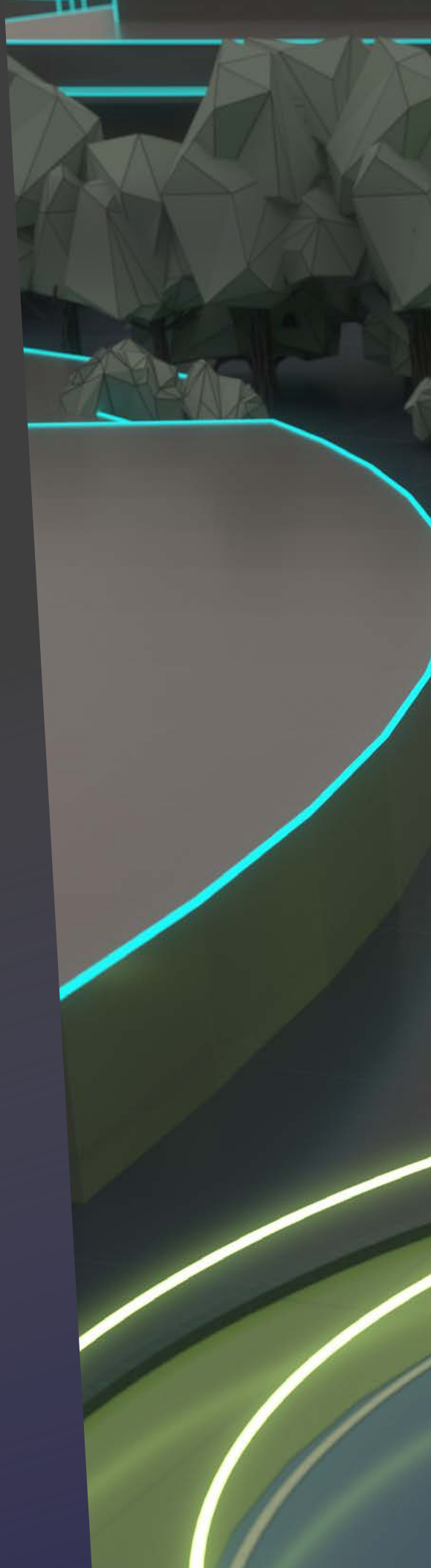
EXECUTIVE SUMMARY

Request to Partner in a Transformational Program for an Autonomous Transportation Network

The Jacksonville Transportation Authority (JTA) is seeking a partnership with the U.S. Department of Transportation (USDOT) to advance research, development and deployment of an Autonomous Transportation Network (ATN) transformational program. This innovative and pioneering program involves the conversion of Jacksonville's elevated automated people mover system, the Automated Skyway Express (Skyway), to accommodate next generation autonomous transportation shuttles, utilizing emerging technologies.

BY BUILDING ON OUR PAST, EMPLOYING CUTTING-EDGE TECHNOLOGY AND WORKING WITH OUR PARTNERS AND THE COMMUNITY, JTA WILL ADVANCE TRANSPORTATION'S VERSATILITY AND CONTINUE TO INVIGORATE THE CITY'S ECONOMY WITH TRANSPORTATION OPTIONS THAT WILL ALLOW OUR CITIZENS TO LIVE, WORK AND PLAY WELL INTO THE FUTURE.



ADVANCING THE INNOVATIVE AUTONOMOUS TRANSPORTATION NETWORK

JTA is proposing the USDOT and JTA enter into a partnership for the continued research, development and deployment of an Autonomous Transportation Network. Furthermore, JTA seeks USDOT's support, paired with dedicated USDOT staff, to test streamlined program development and expedited delivery as a model for new infrastructure projects. All in an effort to continue to rebuild and expand America's transportation system.

JTA believes a partnership to demonstrate the potential application of an autonomous transportation network using the existing elevated infrastructure would have tremendous benefits to the USDOT and JTA. Deployment of the U^{2}C as a transformational program will provide important insights for application of new and emerging technology in the transportation industry and help inform federal policy development.

This program can be advanced in a new infrastructure bill focused on accelerating the deployment of emerging technology, with inherent risks, but promises significant benefits to not only the Jacksonville community but to the transportation industry at large.

BENEFITS OF A PARTNERSHIP

- JTA's program provides a unique setting and circumstance to evaluate automated vehicle (AV) deployment, utilizing an existing federal investment that needs modernization
- Opportunity to inform updates of federal programs and regulations to address the demands of fast-paced technology and innovation
- Provide guidance to transportation industry regarding safety standards, regulatory framework and digital architecture necessary to meet service delivery requirements
- Commitment to address workforce impacts and the development of strategies to create new jobs and provide training to adjust to new technology needs of the future


N
NTS
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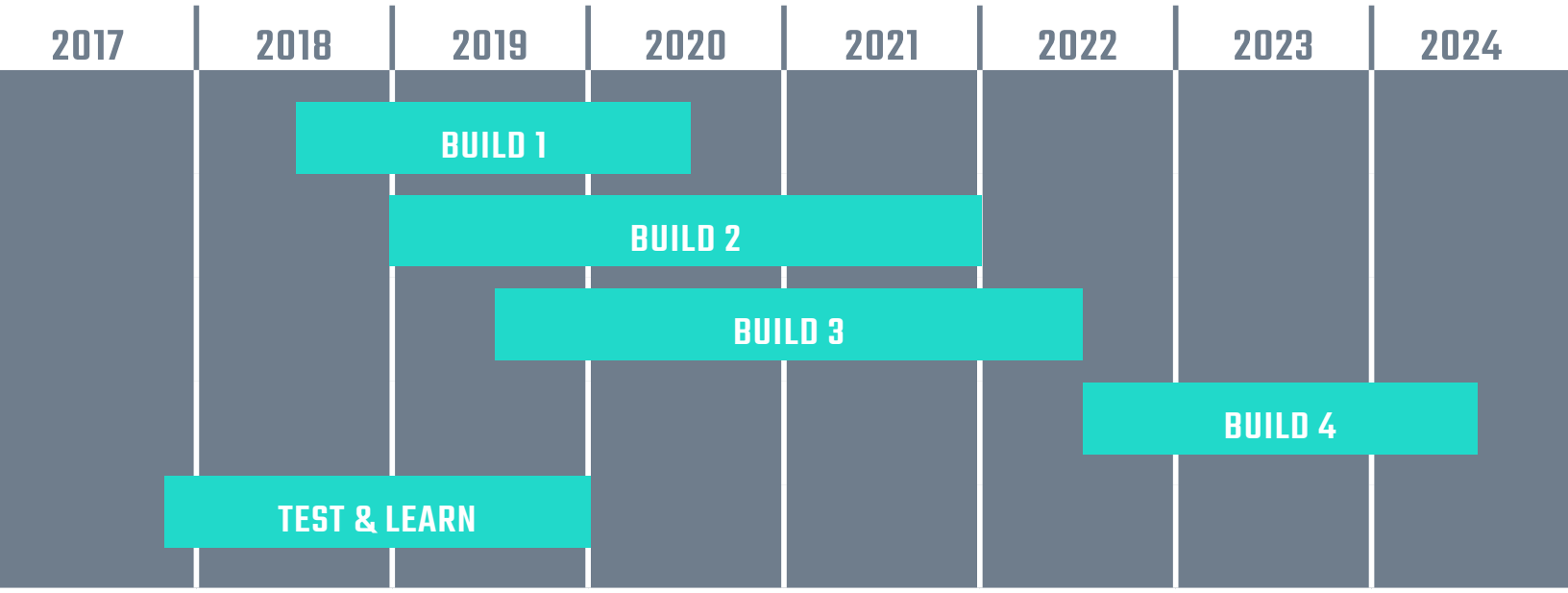
Five Points
Medical Complex
Jacksonville
St. Johns River
East San Marco
INTERSTATE 95

PROGRAM TIMELINE WITH PARTNERSHIP



NAMED THE ULTIMATE URBAN CIRCULATOR (U²C) PROGRAM, THIS PROGRAM INVOLVES:

- Modification of the existing elevated structure
- Deployment of autonomous shuttles
- Transition to the street level and expansion to serve additional destinations

As technology matures, the U²C seeks to expand mobility options and deploy on demand and point-to-point transportation service.

The U²C partnership program moves beyond the exploratory operations of individual autonomous vehicles to a fleet of managed autonomous shuttles. This will change the paradigm of traditional public transportation service delivery. The deployment of an autonomous network will require the development of systems to ensure connectivity between Vehicles and Infrastructure (V2I) and Vehicles to Vehicles (V2V), as well as associated supervisory control systems and a fully integrated digital architecture to manage the network of U²C vehicles.

From infrastructure, to technology, to ridership modeling, the U²C program encompasses a wide range of implementation considerations. The challenges are significant, the opportunities are immense, and the implications are far-reaching. For JTA and Jacksonville, this journey has begun!

THE U²C PROGRAM

- Leading-edge program intended to shift the paradigm of transportation service delivery
- Seeking USDOT assistance to accelerate U²C project development and delivery options
- Utilize U²C project as a proving ground to identify and develop solutions to advance autonomous technologies in public transportation

JTA Skyway over Bay Street and Hogan Street

CONTEXT

The Skyway is a 2.5 mile, elevated bi-directional, downtown people mover system. It includes eight stations, 10 two-car trains and a 25,000 square foot operations and maintenance facility. While the infrastructure remains sound, the vehicles are due for overhaul, but, are no longer supported by the original equipment manufacturer. This results in increase costs and will compromise service reliability if not addressed.

Through extensive technology review and engagement with the public and key stakeholders, in December 2015, JTA's board of directors adopted a policy direction to **KEEP**, **MODERNIZE** and **EXPAND** the Skyway. After detailed analysis in February 2017, the JTA board adopted a vision for achieving this policy direction by using next generation autonomous vehicle technology.

Under the new service delivery vision, an expanded larger fleet of smaller vehicles would operate on the current elevated structure then ramp down to ground level for extensions in dedicated lanes and/or mixed traffic as technology and conditions permit. The new operating system would allow for more frequent service – one to three minute headways instead of the current six to eight minutes. Vehicles could platoon and form virtual train sets to address demand during peak hours and events. Operational flexibility would allow the system to better respond to service demands. In the future, it is envisioned that the technology would enable point-to-point and on demand service.

The current system provides last mile connectivity from the fixed route bus system and offers peripheral parking for downtown businesses. The Skyway also connects to the Jacksonville Regional Transportation Center, currently under construction. Its effectiveness as an urban circulator is limited because the it was never fully built out. The new vision will build on the existing asset and create a true urban circulator system that will connect employment, residential and commercial developments.

Beyond the U²C, JTA is developing a **Future Transportation Vision** which looks to incorporate autonomous shuttles and connectivity with public-private sector mobility options. The experience with the proposed U²C program will inform and accelerate the deployment of AV technology throughout Jacksonville and the transportation industry.

A Florida Monorail Makes Way for the Robot Bus of Tomorrow

Ryan Beene, February 8, 2017
Bloomberg

> Jacksonville's initiative, dubbed Ultimate Urban Circulator, is the most visible endorsement yet of autonomous vehicles by a public agency at a time when cities around the world are just beginning to experiment with the nascent technology.

Future of Transit JTA Opens Test Track for Self-driving Electric Shuttles

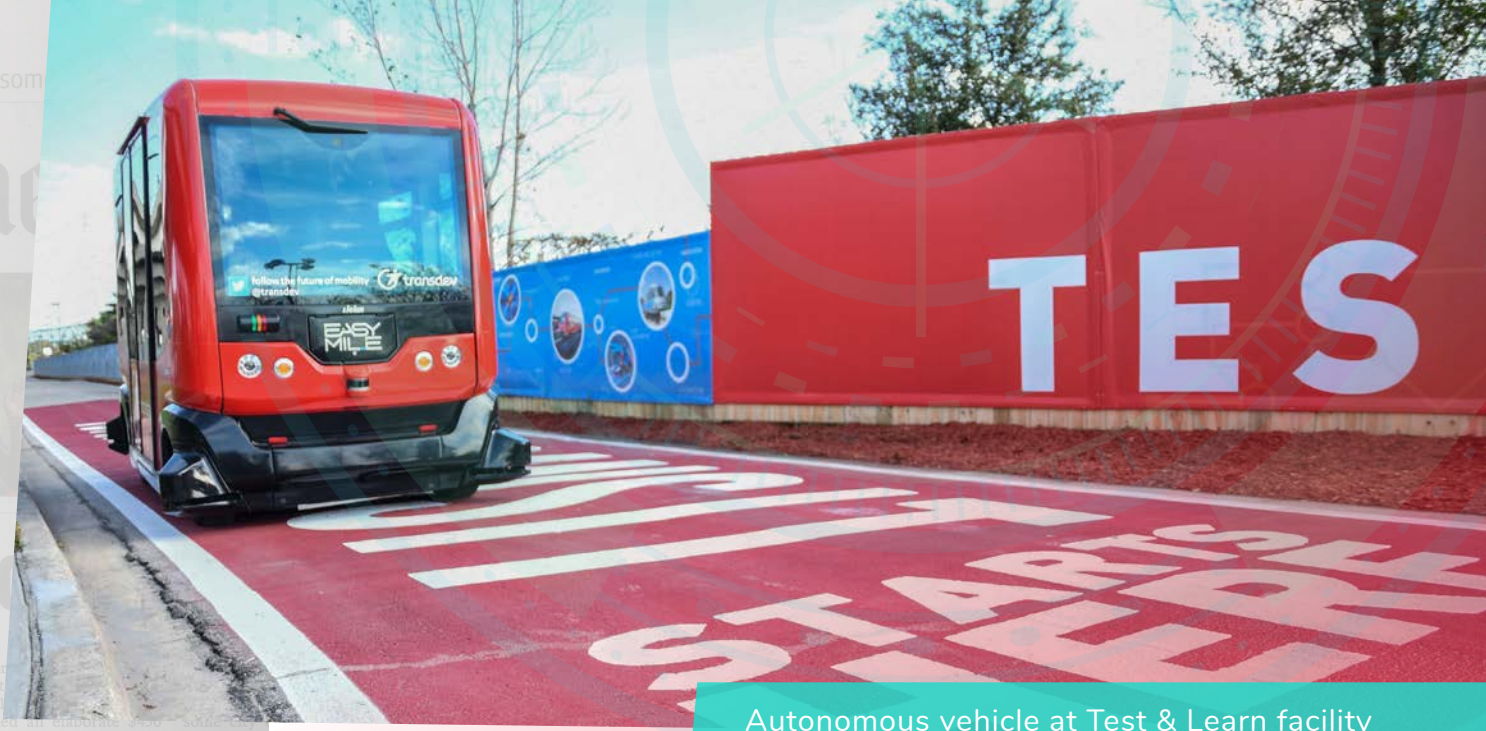
David Bauerlein, December 21, 2017
The Florida Times-Union

> ...the JTA test track is the prospect that eventually hundreds of them could be shuttling passengers around downtown in a technologically sophisticated network using the existing Skyway structure.

Smart Skyway Plan Must be Supported

December 16, 2016
Jacksonville Business Journal

> We applaud the approach JTA has taken to this point, and urge the business community to support this plan as it moves forward.



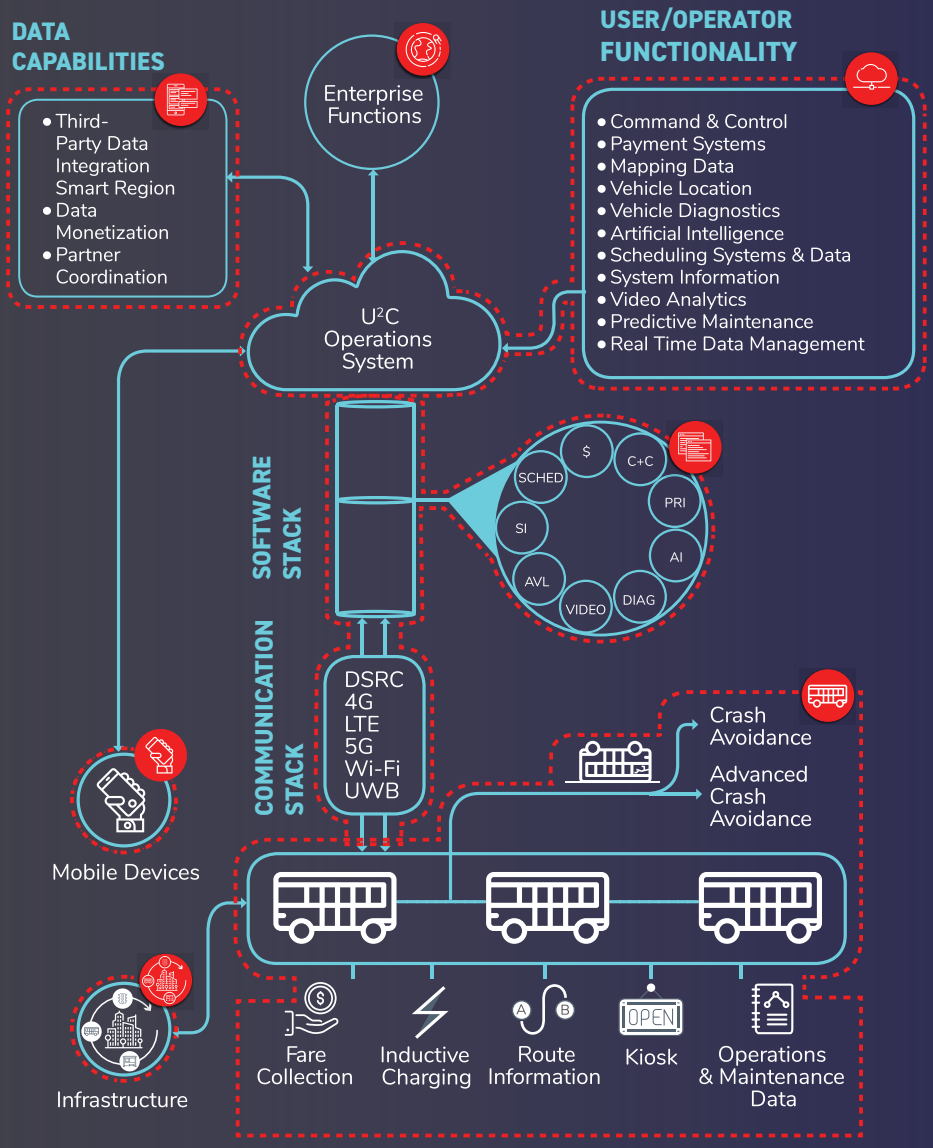
Autonomous vehicle at Test & Learn facility

EDUCATION AND OUTREACH

Critical to the implementation of autonomous technology is public acceptance and understanding customer mobility needs. Building upon the community and stakeholder outreach conducted during the initial Skyway studies, JTA has embarked on creating an "AV Experience" for the public to see, ride and provide feedback on autonomous vehicle technology. Launched in December 2017, the U²C Test & Learn facility was developed in cooperation with agency partners. The one-third mile test track provides a venue for testing autonomous vehicles from multiple vehicle manufacturers. The Test & Learn facility will also be used to assess customer perception and accessibility for persons with disabilities, as well as other passenger information technologies.

Industry professionals, community leaders, school groups, elected officials and the general public will have the opportunity to ride autonomous vehicles. JTA will collect and analyze feedback which will span all ages and mobility levels. This hands on experience will introduce youth and the community at large to this new and exciting transportation initiative.

TECHNOLOGY ROADMAP



NEW TRANSPORTATION MODEL

- Scalable to all cities
- Uses automation to lower cost structure per passenger mile
- Enables “smart corridors” to facilitate shared mobility services and smart city initiatives
- Improves service in underserved communities

TECHNOLOGY INNOVATION

Significant progress has been made in recent years advancing autonomous and connected vehicle technology. This technology promises to revolutionize transportation, however, public and private sector entities are challenged to adapt to rapidly approaching disruption.

JTA has created a comprehensive vision of a fully built out autonomous transportation network. To create this vision we conducted a thorough study of current and anticipated technology, technology gaps and our own unique infrastructure assets in Jacksonville. We have devised a plan that can be built methodically in phases. We rely on a mix of proven and energy technologies. We view cybersecurity, data transparency and anti-terrorism as built-ins of the system that must be present at every level.

As illustrated in the Technology Roadmap, on page 13, a critical element that does not yet exist in the industry is a software platform and operating environment to enable autonomous public transportation. A phased implementation will allow us to engage the industry in the development of the software capabilities and vehicle fleet functionality that will be required to create a dynamic and futuristic system.

In the transportation industry, the discussion regarding autonomous technology has generally focused on low speed shuttles. Furthermore, most attention is centered on where, how and when vehicles can operate in various conditions. Insufficient attention has been given to the requirements of operating an autonomous transportation network.

While the automotive industry is making important vehicle and technology advancements, the industry must determine how to transition to a new system of automation that has remarkable potential to enhance flexibility, efficiency and responsiveness of public transportation.


JACKSONVILLE

SUMMARY: A NEW TRANSPORTATION PARADIGM

The Federal Transportation Authority (FTA) and the current leadership at the USDOT have expressed interest in revamping the structure of federal programs to allow faster program delivery, encourage public-private partnerships, foster innovative solutions and technology and require greater local investment of major capital projects. All of these elements could be achieved and demonstrated through this U^{2}C partnership.

The USDOT can lead the development of critical policies and standards to guide the development of Autonomous Transportation Networks. FTA is already considering how federal investments, regulations and guidelines need to be updated to enable the public transportation industry to capture the potential of new technology, and possibly, at the pace of the private sector.

Ultimately, how public entities like the USDOT and JTA respond to new technology, will affect the ability to effectively capture the positive benefits, mitigate adverse impacts and create a safe, seamless and a cost effective mobility ecosystem.

JUST IMAGINE THE POSSIBILITIES...


PASSENGER
INFORMATION
DISPLAYS

EXPLORING A NEW PARADIGM

We live in a technology and information driven age. New technologies create exciting opportunities to improve mobility, make more cost effective investments and save lives. But the speed of change requires us to rethink the way we plan, develop, deliver, fund and operate transportation projects and services. In short, we need to redefine the transportation paradigm for public agencies.

Today's "leading-edge" technology soon becomes old technology. Complex transportation projects are particularly vulnerable to this pace of change, and in some cases, technology can be obsolete before a project has been launched.

JTA seeks to shift the paradigm of traditional planning and project delivery. We are paying close attention to technology clockspeeds. In order to remain relevant, our planning and program development approach must align with the emergence of new technologies. **INSTEAD OF WAITING FOR INNOVATION, OUR PROJECTS MUST DRIVE INNOVATION.** We need a transportation system that is flexible, scalable and able to respond as technology innovation changes the playing field.

OUR VISION FOR A NEW PARADIGM

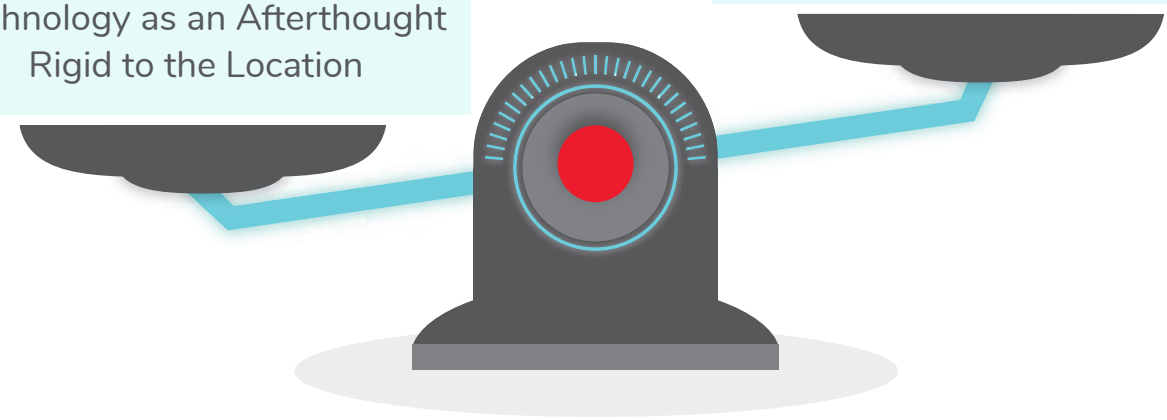
- Utilizing new technology to maximize the value of public investments
- More responsive and expedited delivery of planning and program development
- Scenario planning with concurrent program phasing
- Public-private partnerships that share risk and foster innovation
- Nimble and responsive funding programs focused on innovative solutions
- New funding strategies that encourage public-private partnerships and strategies to support long-term operations

NEW PARADIGM

Speed-to-Market
Economic Impact
Agile Implementation
Flexible and Customizable
Technology Focused
Optimize Existing Infrastructure

OLD PARADIGM

Time Intensive
Capital Intensive
Constrained by Critical Path
Lagging Behind Innovation
Technology as an Afterthought
Rigid to the Location



Our driving principles are: scalable, flexible, modular, speed-to-market, and a proven return on investment. By combining all of our driving principles into one new framework and exhibiting that model in a revolutionary project, **WE BELIEVE WE CAN DEMONSTRATE A NATIONAL MODEL FOR THE INCORPORATION OF TECHNOLOGY AND INNOVATION INTO TRANSPORTATION SYSTEMS**.

JTA believes these principles and vision for a new transportation paradigm align with proposals set forth by the USDOT.

THE CLOCKSPEED DILEMMA

Various industries move at different paces creating the Clockspeed Dilemma.

The robust U²C vision, paired with the accelerated pace of new technology, positions JTA to be at the forefront of assessing organizational and implementation clockspeed to integrate innovation and technology into transportation service delivery.

The private sector moves at the speed of consumerism and innovations are rewarded by the market place. LEAN techniques and agile scheduling allow for successful projects to emerge at a rapid-fire pace and be justly rewarded by the consumer. Public sector projects are hampered by general risk aversion to failure, leading to an over-reliance on older “proven” technologies. This risk aversion has the effect of creating overly cautious designs with safety factors multiplied and increases project budgets. Regulatory and compliance issues are more complex in public sector projects, extending timelines. When each of these factors is considered in totality the result is a project delivery paradigm that offers less innovation at higher project cost and longer project timelines. In order to stay relevant, we must create a new model for public sector delivery, while still championing the causes we hold dear, such as public safety and smart regulation. The JTA model allows for constant testing, learning and refinement.


JACKSONVILLE
JAZZ
FESTIVAL

SUSTAINABLE PUBLIC TRANSPORTATION

Traditionally, transit operations thrive when providing high frequency service in densely populated areas. Transit has been less productive providing low density service, first and last mile connections, late night and entertainment based-services without regular schedules. This results in a model plagued by lower cost recovery than desired from public investments.

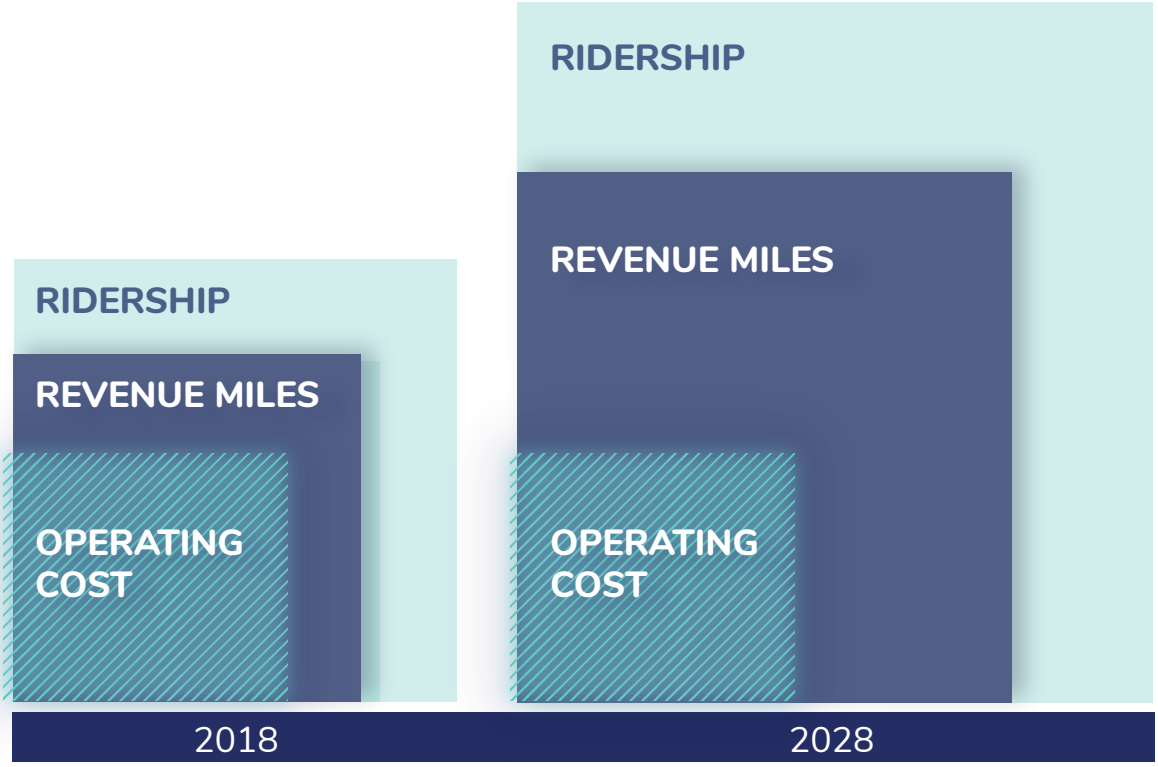
New technologies hold the promise of making transit services more efficient, flexible and productive. Ideally, this results in cost efficiencies allowing deployment of more frequent service on heavily traveled corridors. At the same time, we may be able to incorporate demand responsive or dynamically scheduled services to allow more effective feeder services and first and last mile connections. By leveraging 'Big Data,' we may open up new funding opportunities.

In the end, how the transit industry captures new technologies will help define transit's place in the emerging mobility ecosystem. With that in mind, the JTA, through the U²C program, is looking to assist in establishing the roadmap to the future of public transportation.

UTILIZING AV TECHNOLOGY HAS THE POTENTIAL TO ADVANCE TRANSPORTATION SERVICE OBJECTIVES INCLUDING

- Ability to reduce the cost per revenue hour of service
- Enhance service and accessibility without increased operating costs
- Provide service frequency and flexibility
- Address first and last mile connectivity, generate new operating revenue sources
- Provide operational funding sustainability by improving fare recovery

EFFICIENCY AND PRODUCTIVITY




SECURITY
CAMERAS

TRANSFORMATIONAL PROGRAM

Original JTA Skyway

- Technology Assessment
- Policy Development/ Skyway Advisory Group
- Skyway Modernization Program
- **U²C Program Development**
- Design and Construction

Since the late 1980s, the Skyway has carried passengers to work, school and to other daily activities in and around Downtown Jacksonville, seamlessly gliding above the urban street network. Today, the Skyway supports approximately 5,000 passenger trips per weekday.

From the Super Bowl to One Spark, a crowd funding festival, some of the Skyway's best moments are transporting customers to Jacksonville's special events. It is at these times when customers, agency personnel and community leaders ponder; can the Skyway be extended to more popular destinations on the periphery or just outside of downtown? Can the vision of a fully built urban circulator be realized?

To build upon years of studies aimed at a possible extension of the Skyway, JTA advanced more extensive technical analyses over the past three years to more fully evaluate the modernization of the Skyway. Recent assessments have focused on the vehicle replacement primarily due to ongoing issues with obsolescence of vehicle parts and supplies no longer supported by the manufacturer.

With the elevated people mover system more than 25 years old, a new regional transportation center under construction and an expanding bus network, a decision point concerning the future of the Skyway was reached to continue to deliver safe, efficient and reliable public transportation.

SKYWAY TIMELINE

1971 City of Jacksonville Decision to Pursue Downtown's People Mover

1980

Draft Environmental Impact Statement **1983**

1985 FTA (UMTA) Grant to Jacksonville

Construction of Starter Line Begins **1987**

1990

1989 Automated Skyway Express (ASE) Starter Line Opens for Service, Convention Center to Central Station

Development of Second Phase Begins **1992**

1998 Completion of River Crossing via Acosta Bridge to Complete the System

2000

Various Studies for Riverside Extension **2005 - 2009**

2010

2013 - 2014 TIGER Grant Application for Overhaul and Riverside Extension

JTA Skyway Celebrates 25 Years **2014**

Skyway Technology Assessment **2014 - 2015**

2015 Skyway Advisory Group

2020

2016-2017 Skyway Modernization Program

U²C Development
2017 - 2030

2030

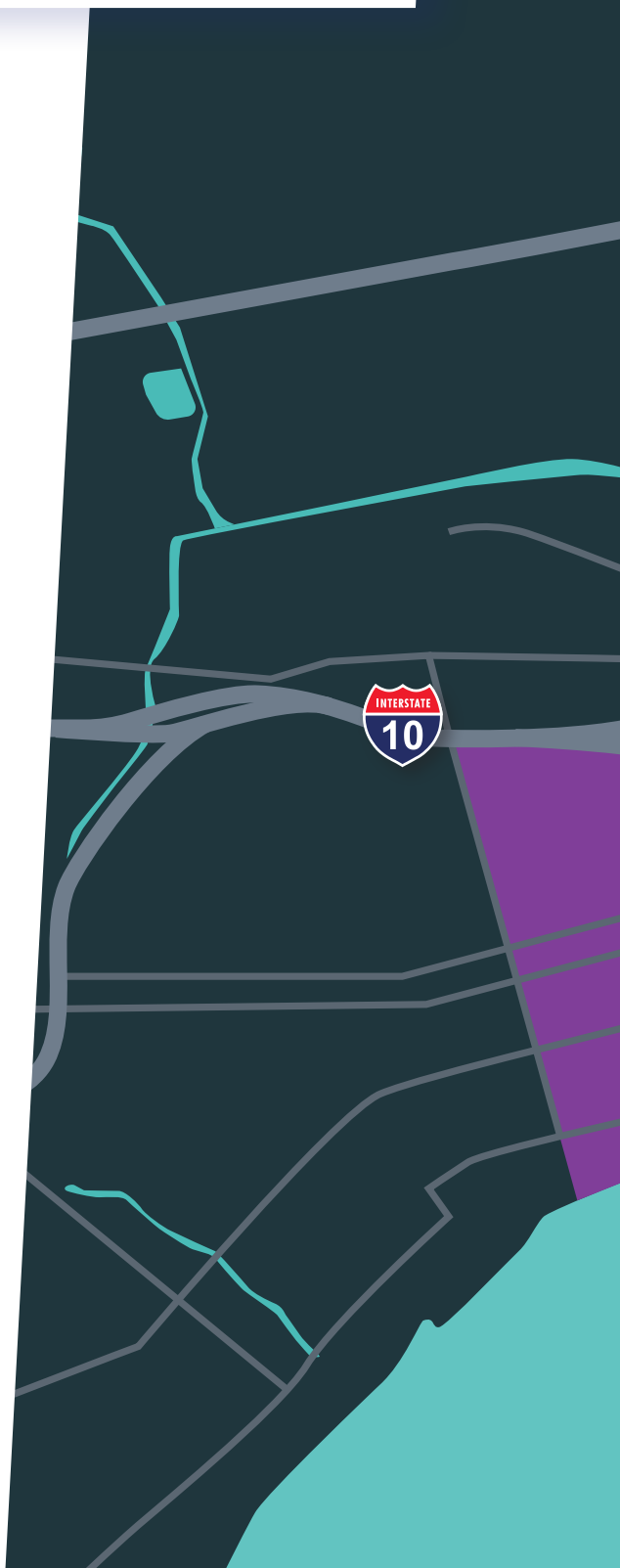
2040

ULTIMATE URBAN CIRCULATOR

SYSTEM PLAN

The U²C plan envisions expanding the area the Skyway serves today. The system expansion will connect to the sports complex, revitalized Brooklyn community, historic Riverside and Springfield areas. Other connections will serve the expanding medical complex in San Marco and UF Health, connecting people where they want to go.

To enhance connectivity, the plan recommends a new crossing of the St. Johns River be constructed to join the developing areas on the eastern ends on the Northbank and Southbank of the river. This new bridge will be for public transportation, bicycles and pedestrians only, connecting the Northbank and Southbank Riverwalk would create an inner loop for the future U²C service and enhancing accessibility of the downtown circulator.



JTA VISION STATEMENT

Universal access to dynamic transportation solutions


N
NTS
LEGEND
Existing Route/Stations
Potential Extensions/Stations
SPRINGFIELD
UF Health and VA
8th and Main
INTERSTATE 95
2nd and Main
LAVILLA
Rosa Parks
JRTC
Convention Center
Central
Hemming Park
Jefferson
SPORTS/ ENTERTAINMENT
Laura St.
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Old City Hall
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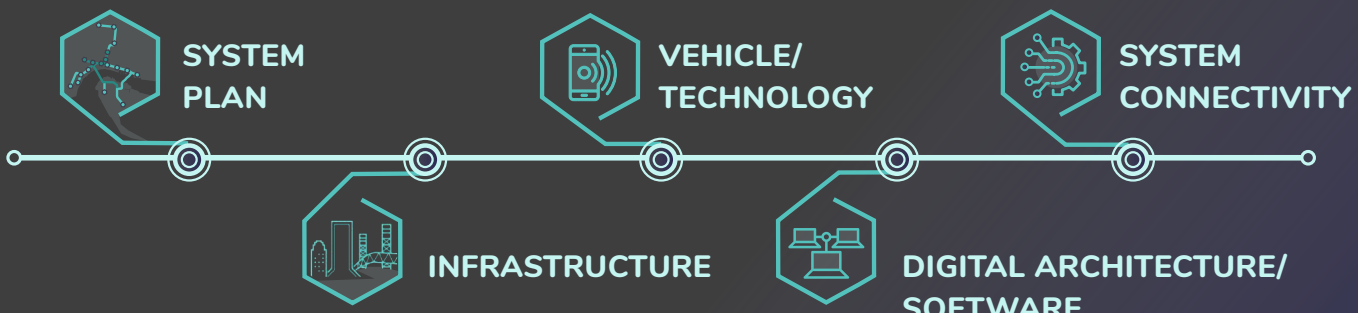
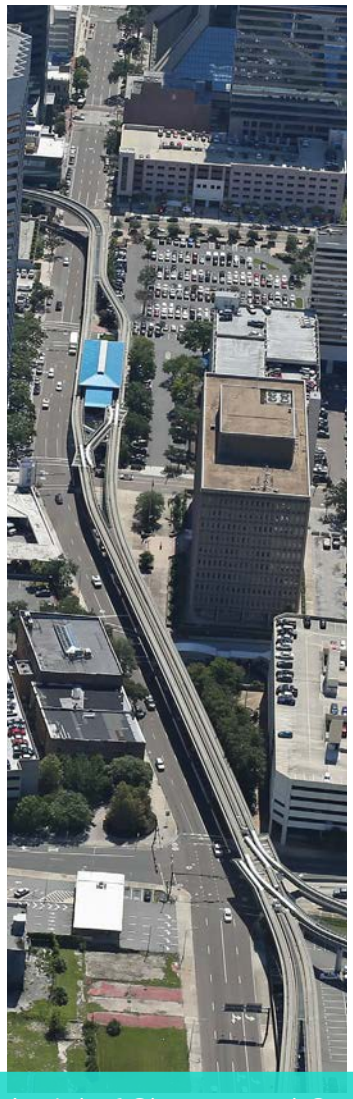


U²C PROGRAM ELEMENTS



Aerial of Skyway and Central Station

INFRASTRUCTURE

The existing automated people mover operates on a guidebeam along the 2.5 mile system. The guideway connects eight elevated stations and crosses the St. Johns River, linking existing and new residential and business developments along the North and South banks of the river.

The transformation requires removal of the guidebeam to create a smooth running surface for new vehicles. Additional modifications are necessary at the stations to allow for the storage and passing of vehicles due to the on demand nature of the AV system operations for more vehicles.

Utilizing the existing elevated structure will maintain a high level of reliability in the urban core. The elevated structure creates the ideal platform to deploy technology, initially serving as a safe proving ground.

EXISTING

PROPOSED

VEHICLE/TECHNOLOGY

Based on research and meetings with multiple vehicle manufacturers, AV technology has the greatest potential to achieve the desired features for the future downtown circulator. AV technology is advanced enough to operate on the existing elevated guideway today and at the street level in the future.

The conversion of an automated system (connected) to an autonomous system (independent) necessitates a new level of operational functionality, system interoperability and performance standards.

DIGITAL ARCHITECTURE/SOFTWARE

Like any public transit system, an autonomous transportation system must network its operational, customer-facing and vehicular technology to be successful. The purpose of the system architecture is to clearly lay out the environment of the project as well as the main infrastructure, operations and management layers contributing to the system.

For this project, JTA will need to develop a new system architecture that, at a micro level will govern each autonomous vehicle, and at a macro level will tie into JTA's operational systems.

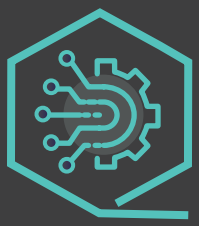
Top: AV Examples

EVALUATION PROCESS

To provide the widest array of funding opportunities from both state and federal sources, JTA has embarked on a Transportation Concepts and Alternatives Review (TCAR). The TCAR process is a uniform approach for evaluating alternatives and advancing transportation projects by linking early planning work to the Florida Department of Transportation (FDOT) Project Development and Environment (PD&E) and FTA's project development processes.

The purpose of the TCAR is to confirm mode and alignment and facilitate appropriate levels of effort to bring the project to major decision points defined in the federal funding process, the first of which is to fully qualify the project for entry into the project development phase. The TCAR process brings together not only funding partners to consider the overall transportation investment, but also engages decision makers in the community, and the public, early in the planning process and throughout project development.

The TCAR will utilize previous planning work and further document potential impacts to land use, traffic circulation, environmental conditions and existing/planned development.

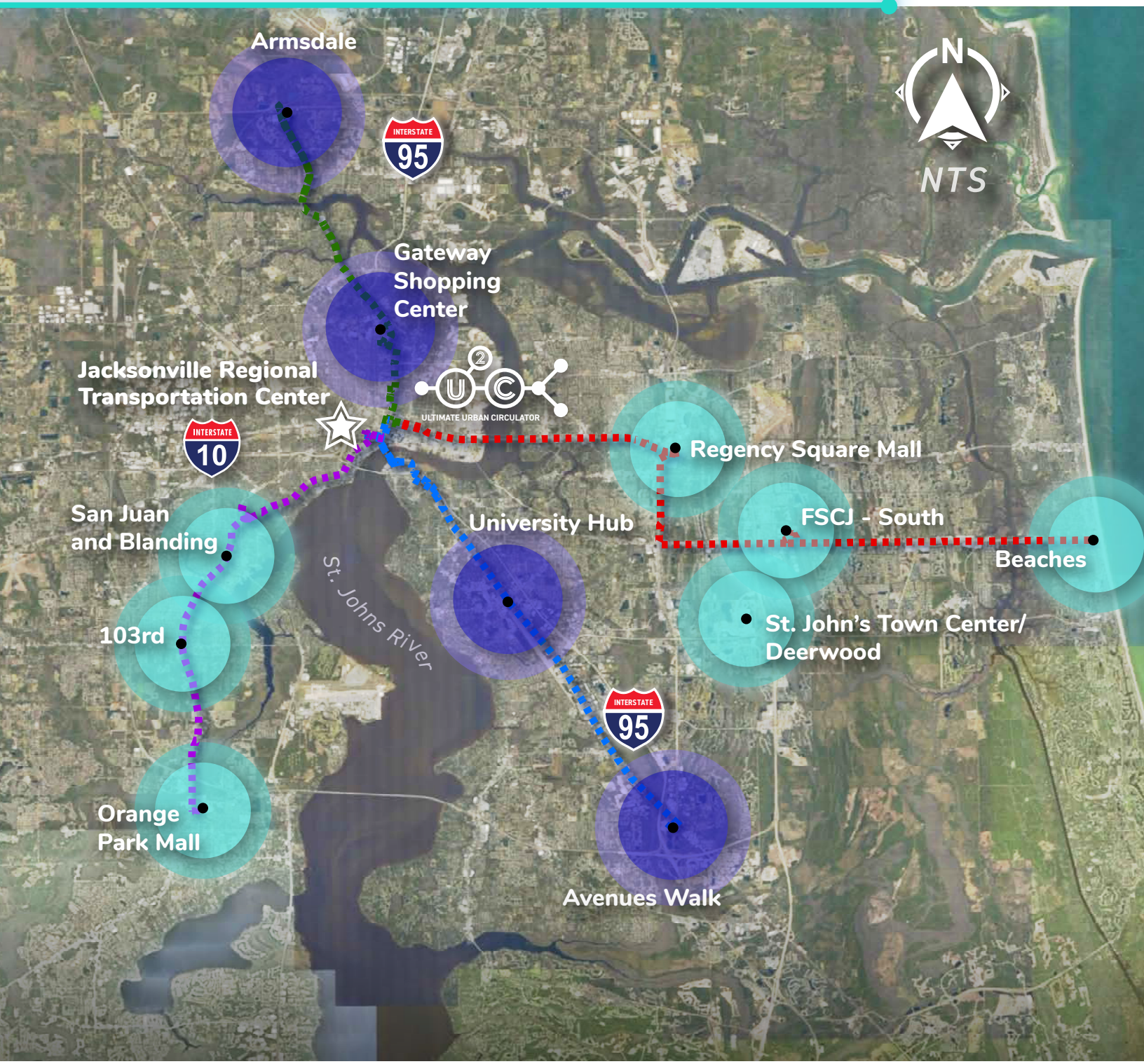


SYSTEM CONNECTIVITY

The U²C is more than a project. It is a program that is causing JTA to rethink the future of public transportation. While transit has excelled with big buses and rail in high density corridors with frequent service, it has struggled to reach acceptable levels of productivity in low density areas, first and last mile connections, and late night and entertainment-based trips. Autonomous technology and new transportation service like micro-transit and transportation network companies provide an opportunity to rethink the vision for public transit.

JTA is developing that future vision which includes building on the high frequency First Coast Flyer Bus Rapid Transit corridors, feeding those corridors with new connection options, possibly linking at mobility hubs; including AV transit and private sector partnerships to improve productivity, efficiency and accessibility. Modernizing the Skyway under the U²C program will provide the framework for future system enhancements.

REGIONAL CONNECTIONS/MOBILITY HUB



LEGEND

- Phase I
- Phase II
- First Coast Flyer North Corridor
- First Coast Flyer Southeast Corridor
- First Coast Flyer East Corridor
- First Coast Flyer Southwest Corridor


ADVANCED SAFETY
CONTROLS

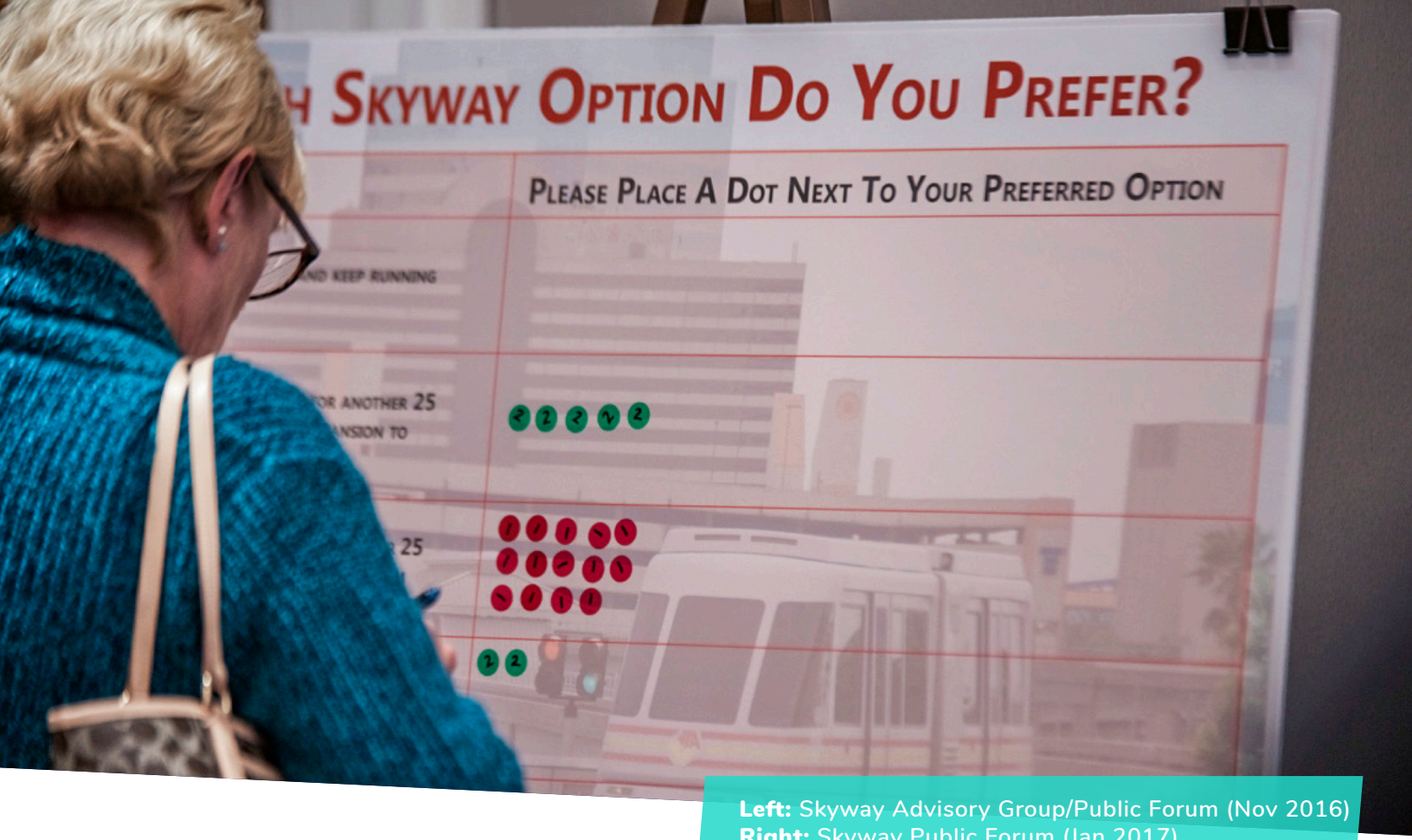
RESEARCH & OUTREACH

For nearly 30 years, an iconic feature of the downtown skyline, the Skyway, has intrigued the community, while transporting Jacksonville's residents, commuters and visitors throughout the urban core. The modernization of the Skyway will better connect people and places with frequent and flexible service while taking advantage of new technologies in automated vehicles.

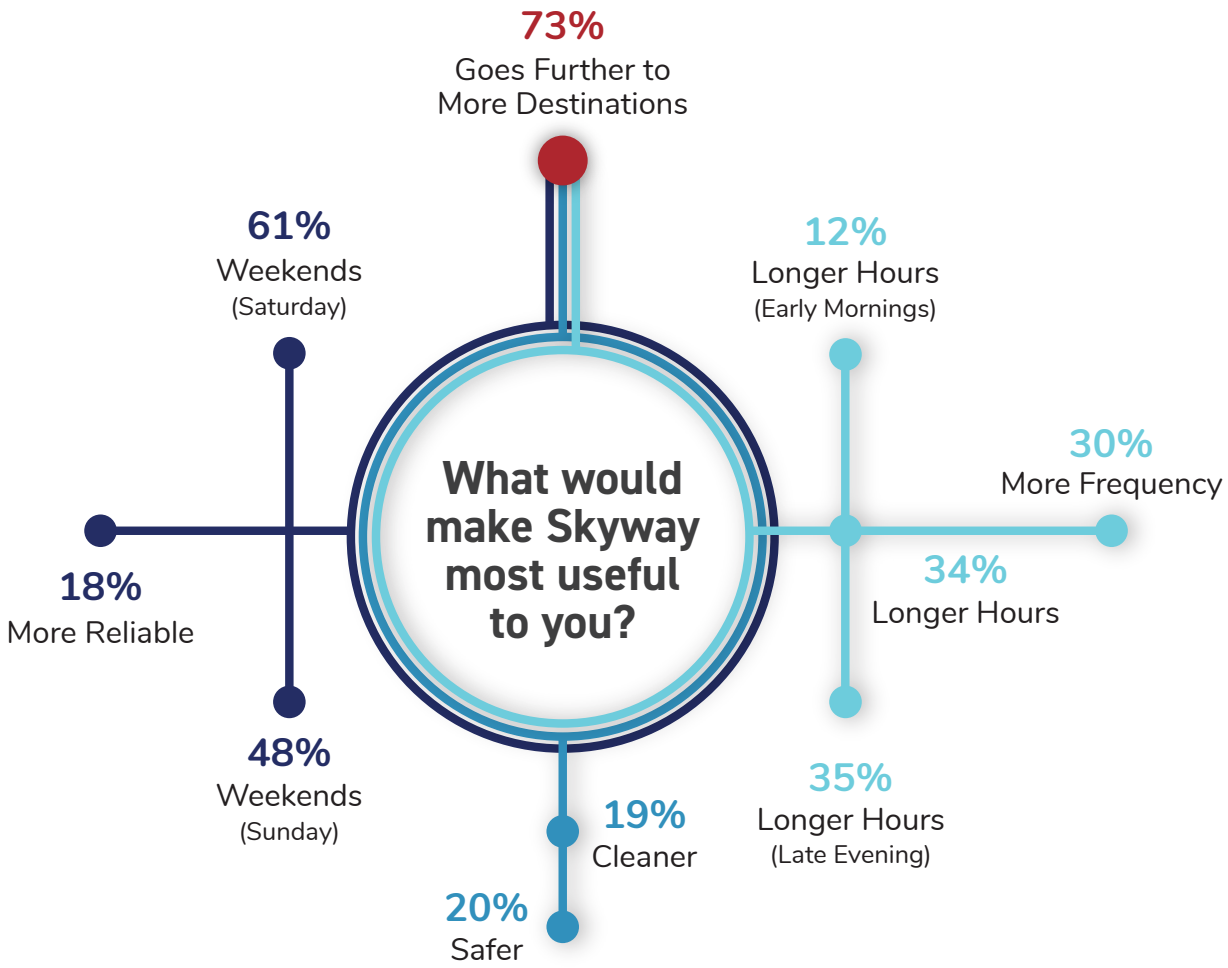
The development of the U²C is a multi-phase program scheduled to occur over the next several years. Major transportation investments like the U²C program require extensive support of community leaders and the public to achieve success. Implementing a multi-faceted public engagement plan, JTA has afforded the public numerous opportunities to learn about the U²C and Skyway Modernization Program to provide input through public forums, online surveys and community-wide presentations and participation at events.

The JTA board of directors established a Skyway subcommittee and convened a group of 20 community and business leaders as the Skyway Advisory Group. The group met six times over a three month period, serving as a sounding board for the technical analyses and assessment results, providing essential input to the JTA board on the future investment in the Skyway.

The community shared opinions on service operations and where the system should be expanded to meet their mobility needs. A majority of the survey respondents indicated that the highest priority would be to extend the Skyway to the expanding Sports and Entertainment District adjacent to TIAA Bank Field, home of the NFL's Jacksonville Jaguars.



Left: Skyway Advisory Group/Public Forum (Nov 2016)
Right: Skyway Public Forum (Jan 2017)

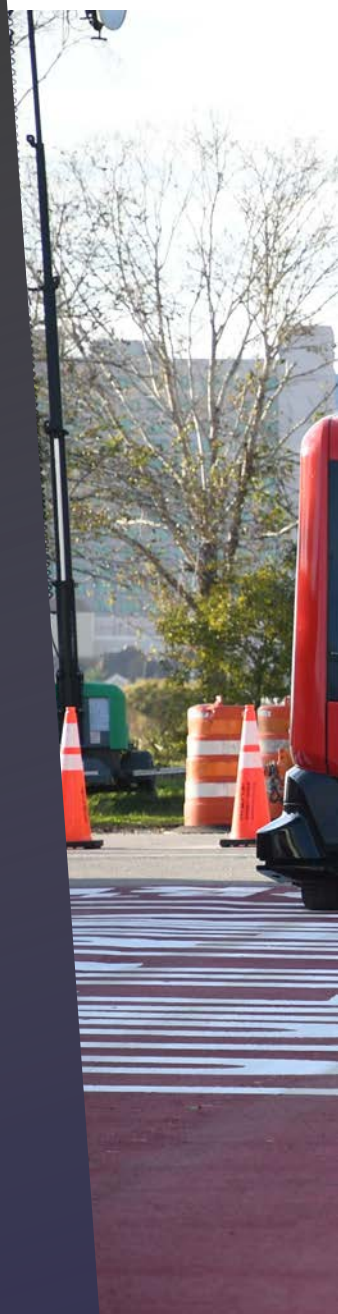


TEST & LEARN

The JTA has taken its outreach efforts and "learning" to a new level with the U²C program. Concurrent with the evaluation of the infrastructure and system planning, JTA worked with agency partners to define a location for an experimental test track to evaluate various autonomous transportation vehicles in development. JTA provided a venue to conduct on-site testing, and invited decision makers and the community to ride and tour the test track.

The Autonomous Vehicle Test & Learn will test and evaluate multiple vehicles from the AV shuttle industry. This process will enable JTA to learn how to operate and plan for AV shuttles as part of its overall public transportation system. JTA is inviting professional organizations, school groups and other community groups to have a chance at first-hand experience with meeting the AV operators and riding the AV shuttles.

The Test & Learn facility is located in the Sports and Entertainment District, one of the system expansion areas under consideration.



TEST & LEARN WILL EXAMINE:

- **Reliability** of vehicles
- **Maintenance** needs
- Range of **battery life** and battery charge
- Performance of the vehicle in different **weather**
- Performance of vehicle in different **scenarios**
- Performance of vehicle to operate on converted **elevated structure**
- Vehicle **control** requirements
- **Supervisory system** for multiple programmed routes
- **Accessibility** by disadvantaged customers
- Acceptance by the **public**

Test & Learn facility - Dec 2017

Comment Card

ULTIMATE URBAN CIRCULATOR

The Jacksonville Transportation Authority's(JTA) mission is to provide universal access to dynamic transportation solutions. We exist to serve our customers and community. Please complete the comment card and give it to a JTA team member.

PLEASE CHECK ONE:

Did you feel safe while riding the vehicle?

☐ Yes ☐ No

Was the vehicle clean and comfortable?

☐ Yes ☐ No

Would you use a JTA operated autonomous vehicle for travel in the future?

☐ Yes ☐ No

Was signage easy to read and understand?

☐ Yes ☐ No

PLEASE TELL US ABOUT YOUR RIDING EXPERIENCE:

_____

_____

_____

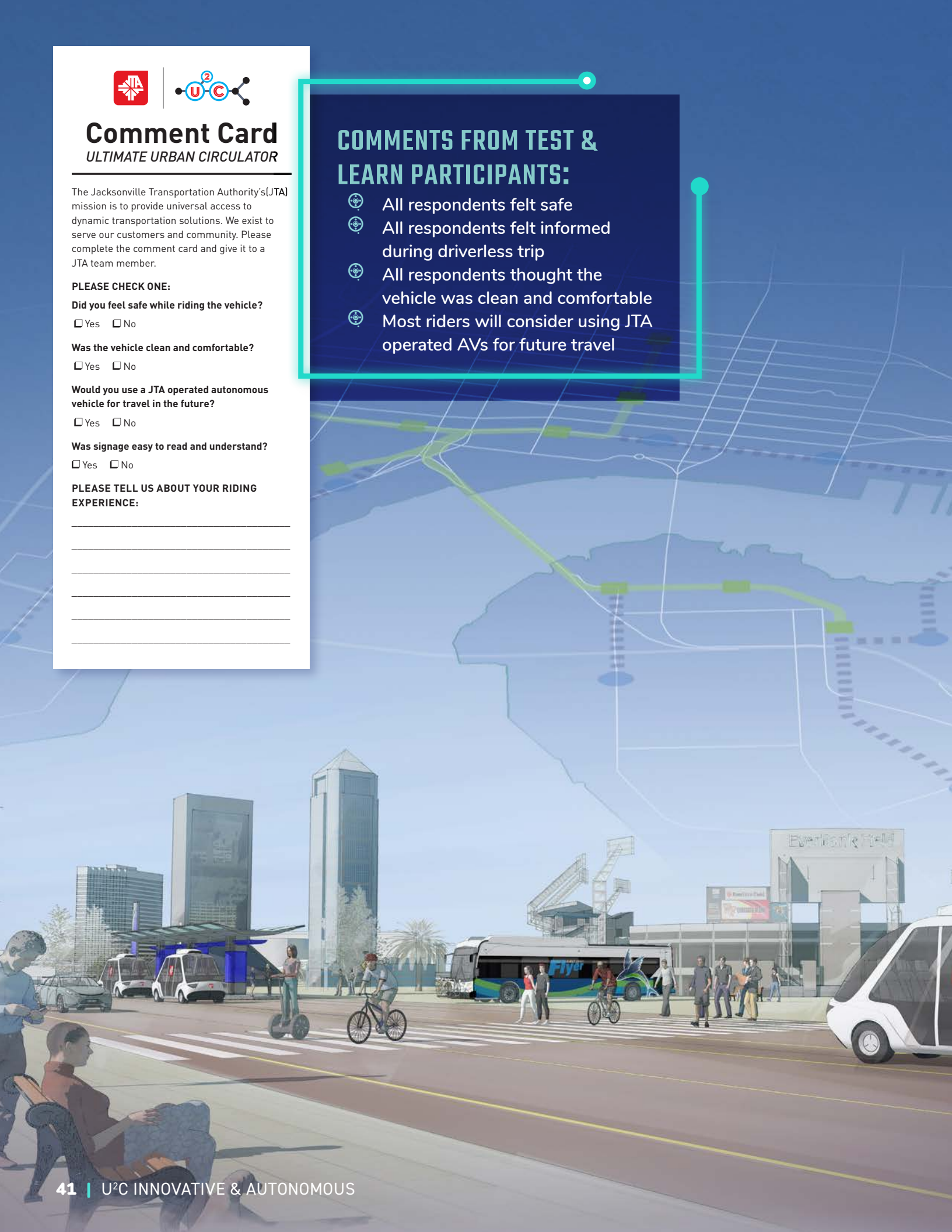
_____

_____

_____

COMMENTS FROM TEST & LEARN PARTICIPANTS:

- All respondents felt safe
- All respondents felt informed during driverless trip
- All respondents thought the vehicle was clean and comfortable
- Most riders will consider using JTA operated AVs for future travel



Autonomous Vehicle Demonstration - March 2017

The Test & Learn will remain in place for up to two years while various vehicle manufacturers and operators demonstrate the functionality of the vehicles. Expansion and modifications to the Test & Learn facility, to replicate existing guideway curvature and conditions, are also part of the Test & Learn plan. Additional test and learn pilots are under consideration, as JTA is working with city leaders and key stakeholders to safely deploy AVs in more complex environments.

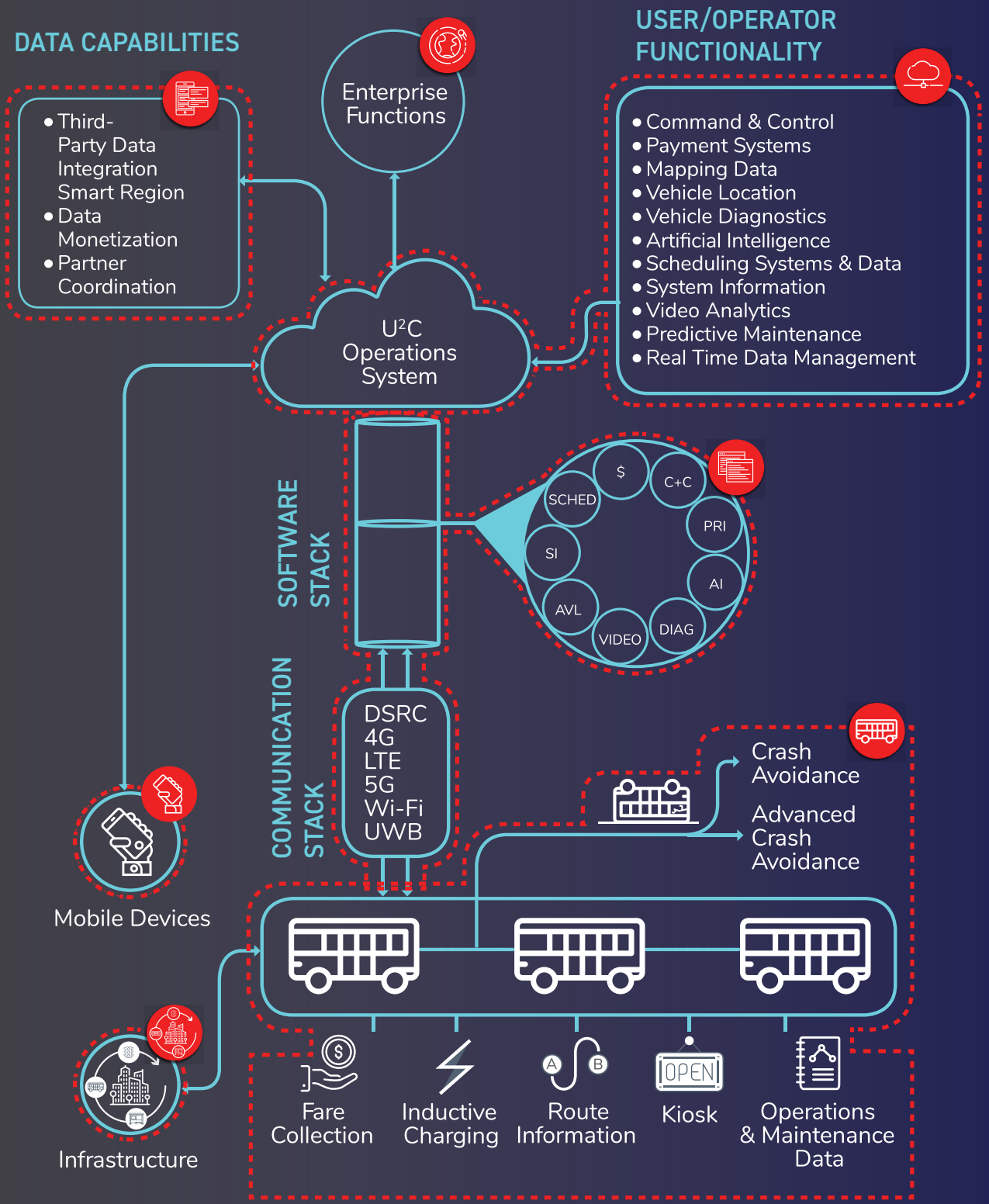
During the Test & Learn events and tours, JTA is collecting feedback from the community. This data is essential to have an ongoing evaluation of public perception of autonomous technologies and how opinions may change throughout the testing and program development process. The community input will also define what other outreach strategies may be necessary in order to gain support and provide an overall positive experience for the passengers.

To support ongoing research and to advance student learning opportunities, JTA has established a partnership with Florida Polytechnic University (Florida Poly). Florida Poly has developed a curriculum where students are conducting research and development of autonomous technologies.

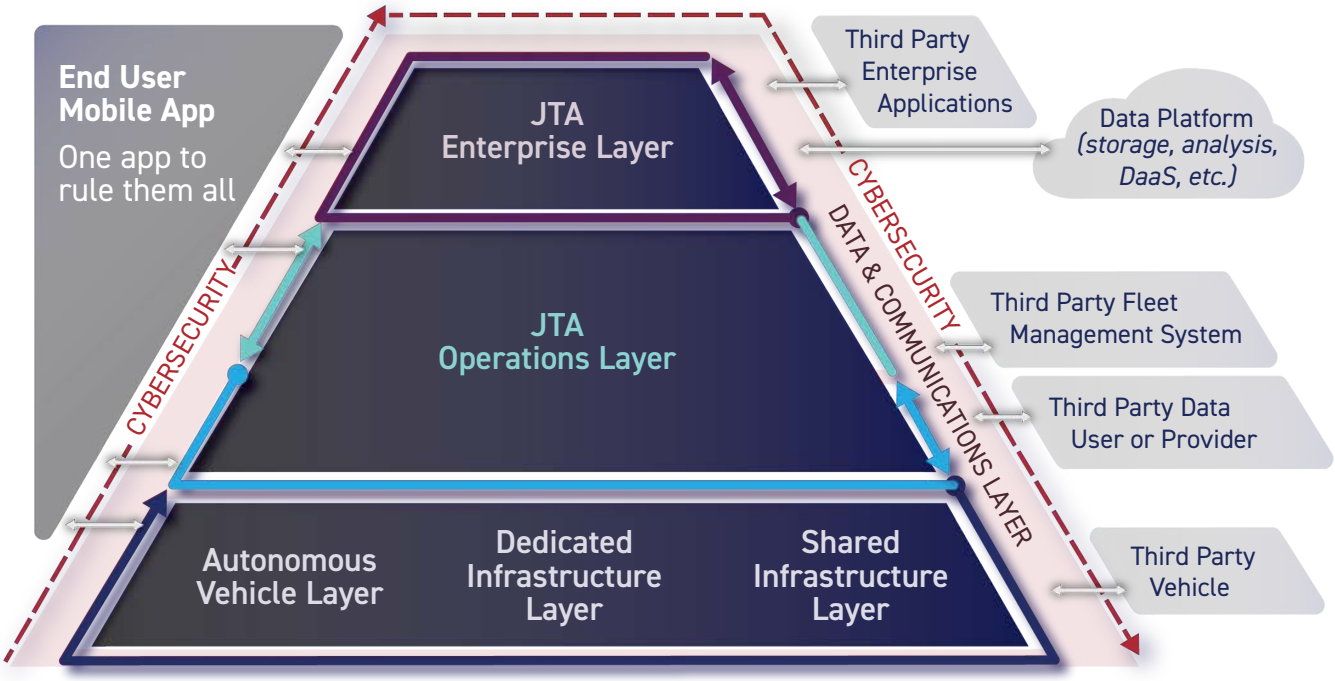

LATEST
ACCESSIBILITY
FEATURES

TECHNOLOGY ROADMAP

TECHNOLOGY ROADMAP



SYSTEM ARCHITECTURE



AUTONOMOUS TECHNOLOGY SOFTWARE STACK

SUPERVISORY SYSTEMS

ERP & ESB Applications	ORACLE · ORACLE SERVICE BUS
Safety & Security	Symantec · ARGUS CYBER SECURITY · Olympus Sky · CYMOTIVE TECHNOLOGIES
Communications, Traffic, Fleet, & Operations Management Systems	verizon · Trapeze · waze · BESTMILE

VEHICLE SYSTEMS

Autonomous Vehicle Operating Systems	drive.ai · ZOOX · DEEPMAP
Command Control & Diagnostics	niolabs · GE · PREDIX
Vehicle Platforms	2getthere · navya · EASY MILE · CarPostal · local motors

A NEW MODEL

The task of modernizing and expanding an elevated people mover system in an urban environment is an exciting opportunity, yet it is a mission full of complex analyses, extensive research and all-encompassing coordination and decision-making. The Skyway modernization assessment required appropriate levels of planning, research, alternatives evaluation, technical analysis and stakeholder engagement to get to this strategic opportunity today.

DIGITAL TRANSFORMATION

JTA believes that in order to demonstrate excellence in autonomous vehicles we must become a digital company. We are building a framework of software and digital systems architecture that will support our autonomous vehicle infrastructure. We believe that the competencies and skills we add in the digital side of the business will translate to improved efficiencies in our conventional operations, such as, fixed route bus, bus rapid transit, ferry, paratransit and roadway design and construction.

Key features of our digital strategy include seamless data transfer between all layers and cybersecurity as a standard build-in to every element. The proposed framework is fluid, based on the development of technology and the advancement of the industry, however it is rigid in adherence to core principles; excellent data management and robust cybersecurity.

Our view of the digital environment is holistic, including functionality for operators, maintenance, revenue, fleet management, safety and security and artificial intelligence. As we assemble a custom digital framework we are conscious that our primary user, the customer, must have access to our data and transparency into our system. As with big tech, the user experience and peer-to-peer advocacy of our system is paramount to our success.

The proposed U²C system architecture will ensure secure and efficient transfer of information between the infrastructure, JTA's autonomous vehicles and the operational systems that will monitor and manage them. Data obtained from the environment will be

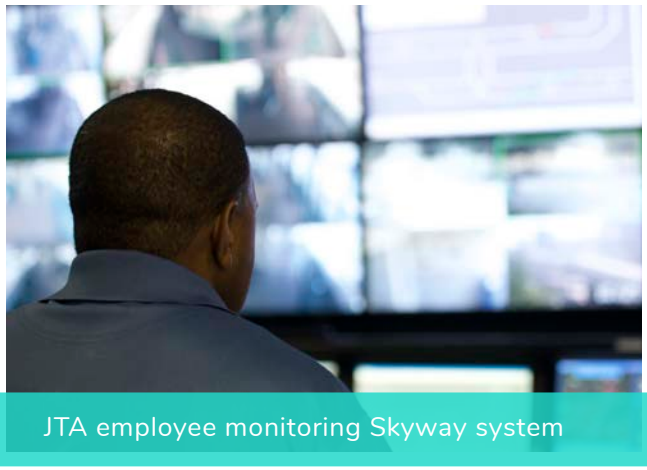
warehoused and analyzed for opportunities in several areas including, operational efficiencies, safety and security and maintenance planning.

The U²C program will produce vast amounts of data from a variety of sources such as JTA's Enterprise Resource Planning Systems, customers, operations and maintenance staff, the autonomous vehicles systems and sensors, and numerous IoT (Internet of Things) devices integrated into the Infrastructure. In order to efficiently manage data at what is currently an unknown scale, it will be necessary to develop sophisticated software systems utilizing cloud computing and storage capabilities in a completely isolated data environment.

The influx of new data will provide data analytics opportunities to help JTA understand ridership patterns and improve service. This will require the addition of business intelligence staff members to create and maintain Data Lakes, Data Warehouses and the accompanying desired analytic solutions.

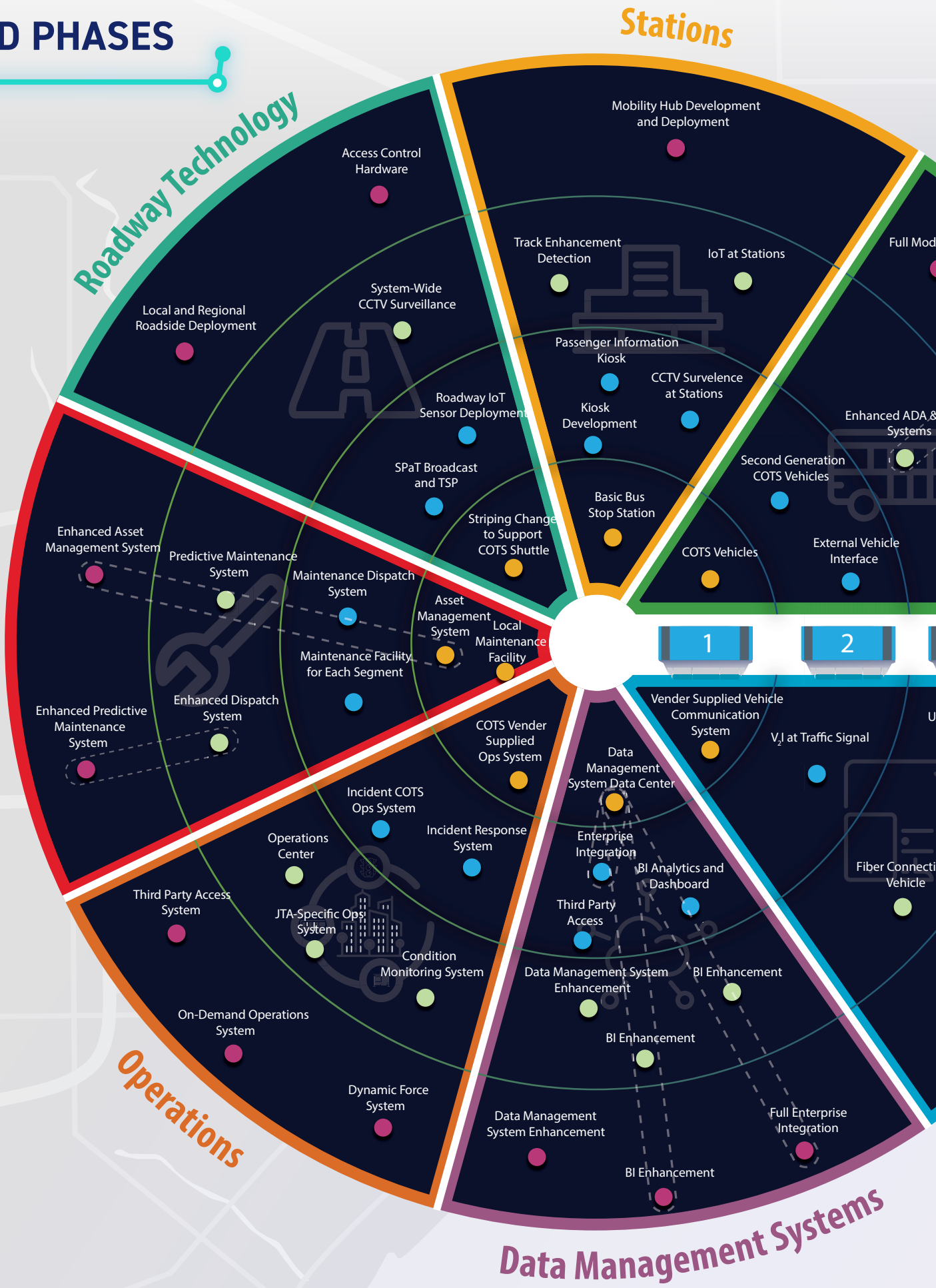
CYBERSECURITY

With the introduction of an entirely new computing environment, measures must be taken to ensure the secure storage and transmission of sensitive data. Moreover, technology will be implemented to ensure the safety of our customers and employees. These will require appropriately trained information security officers to monitor and assess the security posture of the environment as well as implement new capabilities and address any security deficiencies in software applications or the network environment.



JTA employee monitoring Skyway system

BUILD PHASES



Complete Timeline

The technology roadmap is divided into four builds that correspond with the four key phases of deployment of a major technology project. The four phases or builds for JTA are:

- **Build 1.** Pilot deployments on closed corridors or segments.
- **Build 2.** Preliminary deployments in live traffic and revenue-type service. This is considered a fully operational segment.
- **Build 3.** Operations on the modernized skyway requiring full replacement of all existing skyway components.
- **Build 4.** A fully integrated AV system including multiple mixed traffic segments and the skyway.

Vehicles

Stations

Roadway Technology

Maintenance

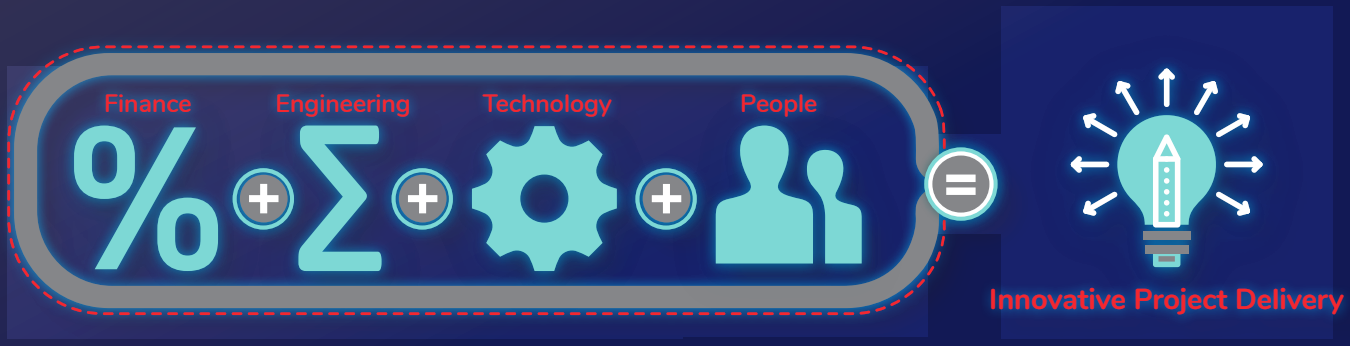
Operations

Data Management System

Communications


COMFORTABLE
SEATING

DELIVERING INNOVATION



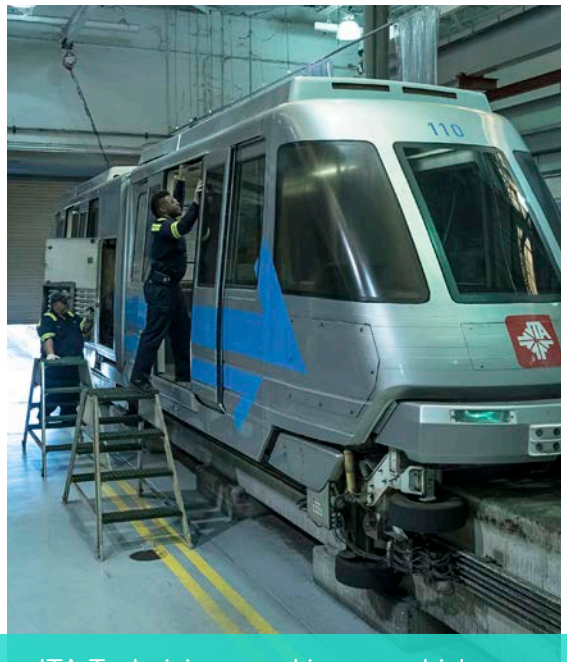
Rapidly developing technology is challenging how public sector agencies deliver innovative, technology-based projects. Public agencies need to rethink their organizational focus, structure and capacity to deliver technology and innovation. Traditional planning and project development processes must be faster and anticipate technology changes or risk facing obsolescence. New strategies to finance, deliver, operate and maintain projects over the longer term will force partnerships with the private sector to foster innovation and manage growing technology risks. It is essential that funding programs become nimble enough to fund new innovations and approaches.

ORGANIZATIONAL CAPACITY

WORKFORCE OF TOMORROW

The modification of infrastructure, and integration of emerging technologies as part of a new project delivery model, necessitates an ongoing assessment of staff resources and skillsets to meet the demands of operating and maintaining the autonomous transportation services, and the multifaceted transportation system. This dialogue is both exciting and opportunistic for current and future employees.

For example, as the software and system integration processes mature, JTA will need to appropriately staff with a chief technology officer, cloud solution architects, database architects and software developers to produce data integration solutions that will allow for the safe and efficient exchange of data between the U²C environment and the JTA corporate network.



JTA Technicians working on vehicles

JTA UNIVERSITY

Transportation will change more in the next 10 years than it has in the last 100. JTA intends to strengthen its leading role in this evolution through **JTA University**. The design of JTA University encapsulates the assessment of the organizational adaptability and addresses how we can adjust the structure and business processes to successfully achieve agency goals in response to the transformation of the transportation industry and the pace of technology. The program supports the future needs of the organization through identification of core training needs for our divisions, future career paths and succession planning.

This is accomplished through three key areas of concentration:

- Identification of high potential employees across the organization to engage in a six-month intensive development program focused on enhancing their knowledge of key areas and components of the transportation organization and their interdependencies for purposes of developing our future leaders.
- Certification tracks and skills assessments tailored to supporting the career paths of our employee population.
- Assembly and delivery of an intensified customer-focused training program for transportation operations.

This model strengthens JTA's ability to develop the workforce of tomorrow as it shifts towards autonomous and emerging technologies.

JTA's model can be used as a best practice for agencies to learn how to engage the process of preparing for the future of transportation and creating a culture to embrace exciting opportunities to strengthen and expand skill sets of its workforce.

JTA U²C PROGRAM ORGANIZATION

The development of the U²C program has evolved from a system and operational planning project into an agency-wide program initiative. As a result of its widespread implications on overall agency operations, the management team developed a program organizational structure according to key functional areas. To better address the needs of the U²C program, JTA staff and consultant resources are aligned within three key working groups: Communications/Outreach, Technology/Operations and Program/ WorkForce Development.


EXIT

JTA CNG Facility

PROJECT DELIVERY PLAN

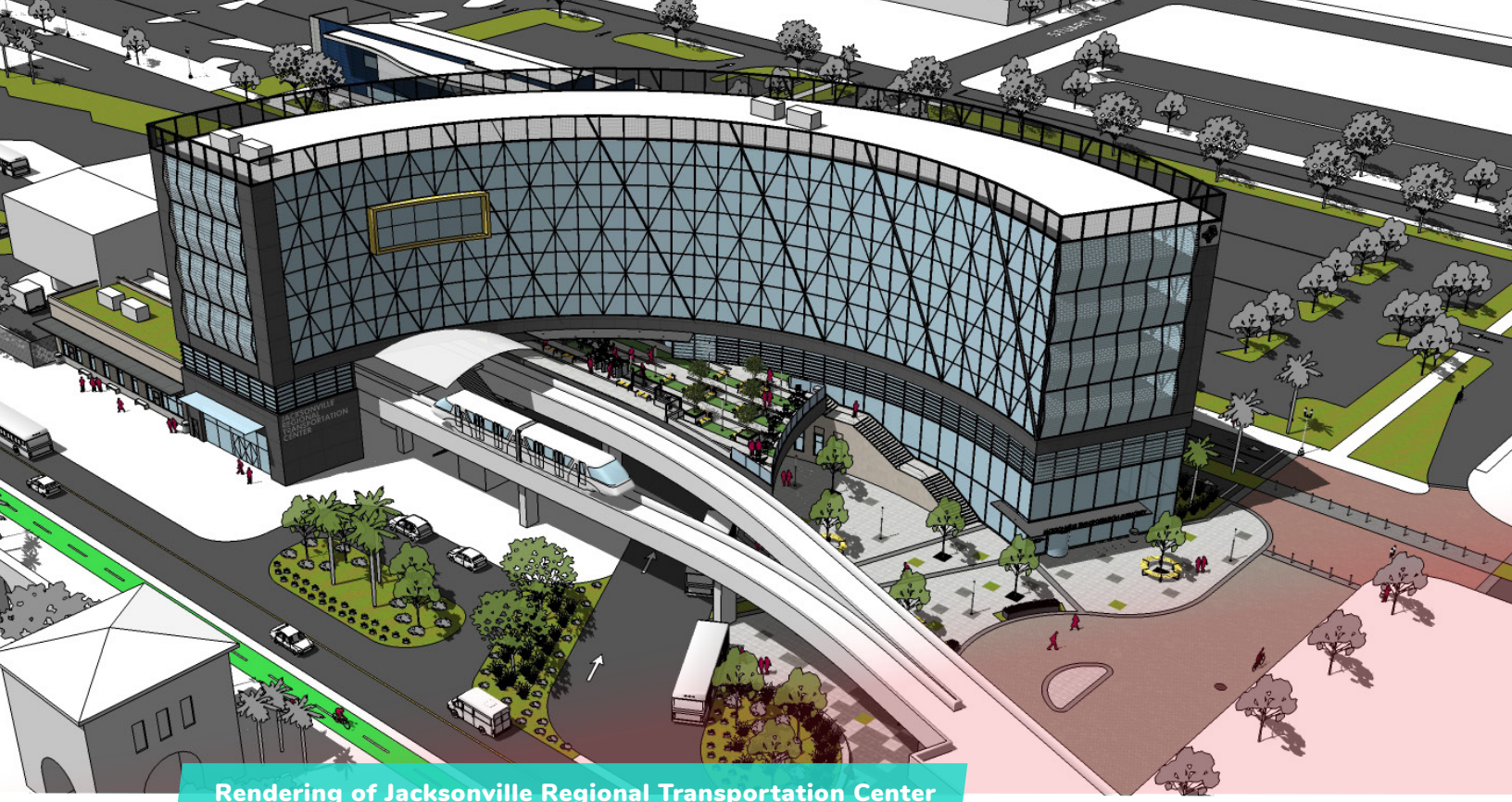
Traditional project delivery is time consuming, relies heavily on public grant funding, does not foster innovation and places too much risk on risk-averse public agencies. The clockspeed of technology development will challenge the transportation planning and project development model. It will also present incredible opportunities to change the relationship between local, state and federal partners to develop a sustainable model for planning, developing, constructing and operating transportation services.

Public-Private Partnerships (P3s) can accomplish more than providing project financing. Private sector partners can help assume certain technology risks, enhance accountability, bring incentives for innovations with new technology and expedite project delivery.

Often public agencies lack the capacity to handle complex alternative project delivery models. Through a Compressed Natural Gas (CNG) public-private partnership, JTA has developed the technical expertise in such arrangements. JTA understands the complexities of procuring, contracting and delivering a P3 and is well-suited to create a model innovative project delivery framework

JTA POSITIONED FOR DELIVERING INNOVATION

- Organizational Capacity
- P3 Experience
- Innovative Funding and Finance Strategies



Rendering of Jacksonville Regional Transportation Center

for an AV Transit system. Additionally, the State of Florida is a leader in supporting statutory authorization for P3s.

Managing risk will be an integral part of delivering innovative projects. As part of the U²C program, JTA has taken initial steps to conduct a risk assessment analysis of our system and program, and held an industry wide forum with national and international experts in attendance. The preliminary risk assessment will serve to advise JTA leadership of potential risks, as well as opportunities, as new guidance and legislation pertaining to autonomous vehicles is in development. The summary of potential risks primarily focused on funding availability, other agency financial constraints and organizational capacity.

To better understand and advance the dialogue of potential funding and project delivery options, JTA gathered industry expertise for an in-house Alternative Project Delivery Workshop to share information and broaden the knowledge of agency staff on project delivery options, focusing on public-private partnerships. This effort will help inform the U²C program delivery strategy.

FAVORABLE STATE ENVIRONMENT

- Allows public-private partnerships
- Laws enable testing and deployment of autonomous vehicles
- Suntrax providing ground for advanced transportation technology

FUNDING AND FINANCING STRATEGIES

USDOT funding has focused on supporting major capital investments, such as light and heavy rail projects. These projects often have an extensive lead time in planning, environmental, design, construction and operations. It is common for projects to take well over a decade from concept to operations. The trend towards investments in more flexible, more cost effective capital projects, like bus rapid transit has already started. But, the trend will accelerate with new technology.

The U²C partnership will provide a roadmap for the future of transportation funding and project development. Major capital projects need to consider new strategies to fund and finance projects. This includes initial capital investments and long-term operations and maintenance. The U²C program will explore alternative funding scenarios that will include leveraging JTA real estate assets and station areas for joint use development and value capture.

The shift will be towards investment in technologies, like autonomous transportation, to make services more frequent, flexible and demand responsive. The services will be cost effective and efficient allowing transportation agencies to deploy more service at a lower cost and generate new revenues to enhance fare recovery.

Programs like U²C will generate significant data. The production of mass amounts of data responsible cybersecurity and responsible data management is critical. At the same time, data management can generate revenue opportunities to support long term operations.

A financial plan will be a critical element to successful project delivery. Existing financing tools, such as TIFIA, Private Activity Bonds and the State Infrastructure Bank, will be evaluated as part of a comprehensive project funding and financing plan.

The President's Initiative for *Rebuilding Infrastructure in America* (February 2018) recognizes the challenge in funding new innovative projects. JTA looks to work with the USDOT to demonstrate the potential when funding is flexible enough to quickly deliver innovative, leading-edge, technology-based projects.

FINANCIAL CATEGORIES

SEGREGATION STUDIES	An infrastructure or transportation project that can have multiple funding sources, depreciation timelines and tax exemption, asset and expense categories. By properly segregating infrastructure, rolling stock, engineering and equipment assets at the front end of a project, optimization of the financial performance occurs without extra cost.
SAVINGS ACCELERATION	Projects with multiple savings and revenue sources can be optimized to allow for early realization of savings or revenue based on critical path scheduling and long lead scheduling. This technique requires a creative look at what portions of the project can be accelerated without affecting the project duration and the finance "triggers" of the project. Projects optimized for savings acceleration can experience significant gains to IRR with little to no increase to overall project budget.
DELAYED CASH FLOW	Projects that have capital spending spanning over several financial years can benefit from delaying cash flow of expenditures. This strategy results in a marginal capital cost increase to the project since the cost of short-term financing is added to the project. However, the project benefits from the difference between interest rates: **Short Term Finance Rates – WACC = change to IRR**
ASSET LEASE	Asset cost can be removed from a project by utilizing a capital lease or operating lease on the asset. This technique lowers the capital burden required to achieve new facility or equipment investment while helping to preserve cash-flow for the agency. A secondary benefit from an asset-only lease is that the best interest rates can be achieved, while minimizing balance sheet liability and leveraging the government's guarantee.
TOTAL PROJECT LEASE	Allows a business unit to pay the total cost of a project as an operational expense once the project achieves revenue or savings. Soft costs include: install, utilities, engineering, commissioning, software, communications and company direct labor.
PUBLIC-PRIVATE PARTNERSHIP (P3)	In some cases the new staffing or technology requirements for a new operation place an undue burden on the agency. At other times, projects lack scale to make in-housing of an operation feasible. When we study the value stream of a project we calculate the total landed cost of goods to ensure that we have highlighted any options for 3rd party operations or 3rd party production of a portion of a project. We set targets for the company when conditions would be right to "in-house" the operation.


VEHICLE LOCATION
SENSORS

A STRATEGIC PARTNERSHIP

BENEFITS OF U²C TO ADVANCE AUTONOMOUS TRANSPORTATION NETWORKS

JTA'S U²C PROGRAM PROVIDES A UNIQUE SETTING AND CIRCUMSTANCES FOR AV TECHNOLOGY DEPLOYMENT

- The existing Skyway structure is ideal for safe deployment of autonomous transportation shuttles in the near term and expand service to more complex situations as technology allows
- The project utilizes an existing federal investment that needs modernization
- JTA and FTA can introduce AV service in an urban setting with meaningful public transportation benefits
- The project will demonstrate the potential for first and last mile application of AV technology by supporting the last mile connections of the FTA funded First Coast Flyer Bus Rapid Transportation system
- JTA has conducted significant planning and program development and is the best positioned public transportation agency to conduct an ATN transformational deployment project

OPPORTUNITY TO INFORM UPDATE OF FEDERAL PROGRAMS AND REGULATIONS

- Current funding programs and project development requirements are time consuming and will be challenged to keep pace with the clockspeed of rapidly developing technology
- Research efforts will help identify policy and regulatory issues to be addressed in federal transportation legislation

PROVIDE GUIDANCE TO TRANSPORTATION INDUSTRY AND PRIVATE SECTOR DEVELOPERS

- Regulatory guidelines and safety standards must be developed for the deployment of AV transportation networks and this partnership would enable the development of new standards and guidelines for the industry
- The public transportation industry needs to work with the industry in the development of the digital architecture and associated standards to support the real-time deployment, management and supervision of an autonomous transportation network

ENSURING A COMMITMENT TO ADDRESS WORKFORCE IMPACTS

- The FTA-JTA partnership would allow the development of transition strategies to mitigate the workforce impacts and implement workforce development plans that create new, value added jobs and optimize available public resources to enhance transportation service

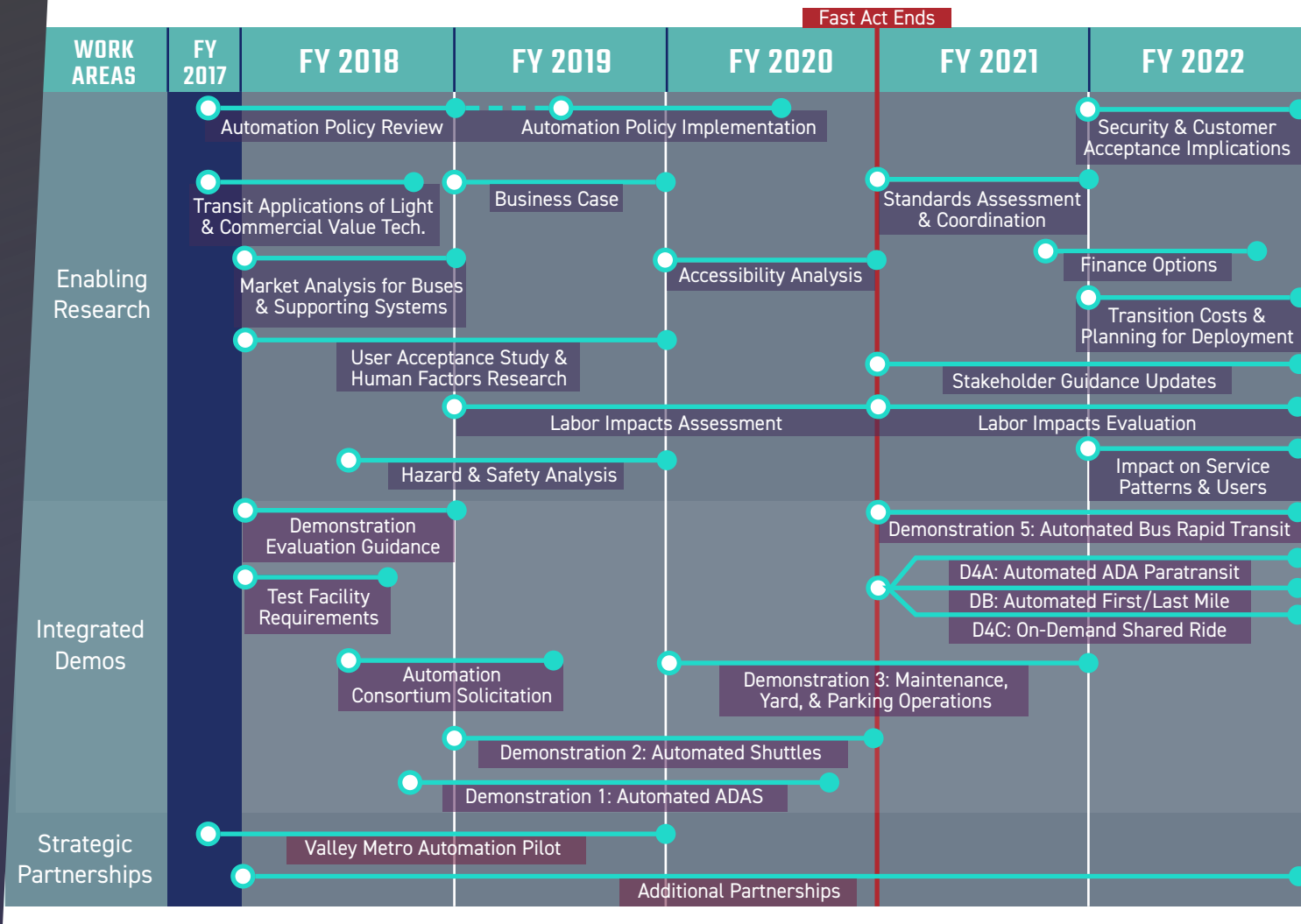
ULTIMATE URBAN CIRCULATOR

While rapidly developing technology has inherent risks, JTA believes a partnership to demonstrate the potential application of an automated transportation network using the existing Skyway infrastructure would have tremendous benefits to FTA and JTA. A deployment demonstration would provide important insights for application of the new and emerging technology in the rest of the transportation industry and help inform federal policies.

The USDOT recognizes the transformative nature of autonomous vehicle technology. As a result, the Strategic Transportation Automation Research Program (STAR) had been developed to advance the technology through its safe, deliberate, development and introduction into public transportation. The USDOT recognizes federal involvement is needed to responsibly accelerate adoption of new technology.

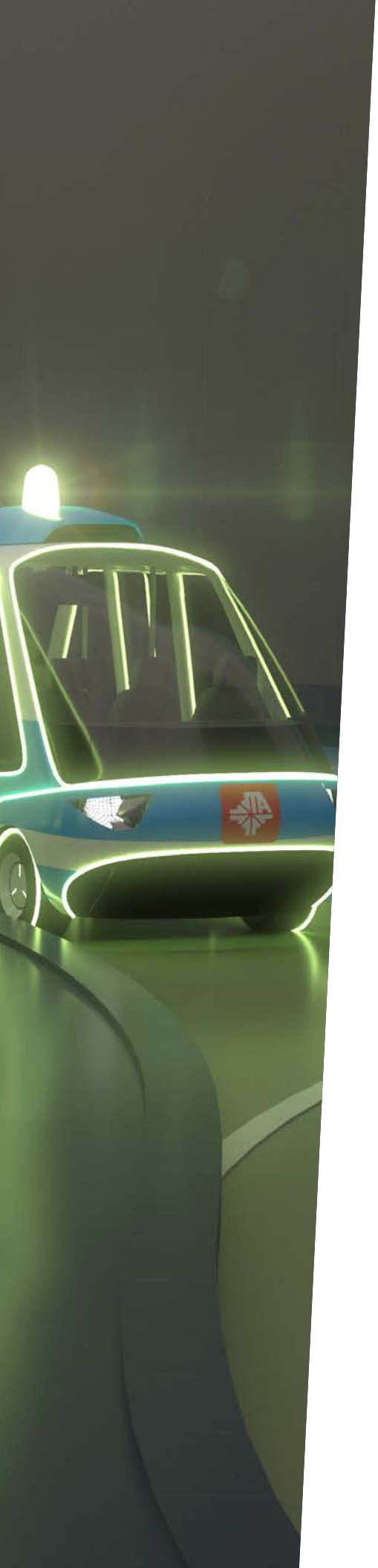
STRATEGIC TRANSIT AUTOMATION RESEARCH ROADMAP

Source: Federal Transit Administration (December 2017)



TRANSFORMATIVE PROJECTS

The Administration proposes to invest $20 billion in game-changing approaches to delivering transportation projects and services through the establishment of a Transformative Projects Program, which will provide competitive grants and technical assistance for bold, innovative, and transformative infrastructure projects that could dramatically improve infrastructure.



The FTA has identified numerous barriers to the adoption of autonomous public transportation. It is clear that the best way to break those barriers down is through a partnership with a local public entity on the leading edge of innovation.

JTA is uniquely positioned to partner with the USDOT in developing a roadmap to the effective and safe use of autonomous vehicle technology. We must move beyond individual vehicle demonstrations to a fully integrated autonomous transportation network with vehicles that are connected to each other and the surrounding infrastructure and managed collectively as a coordinated fleet.

WHY JTA?

JTA is ideally situated to partner with the USDOT for a number of reasons:

- JTA has already made a significant commitment and investment in the move to an ATN
- The modernization of the Automated Skyway Express is a unique opportunity and platform to launch the technology in an urban setting
- We have created the technology roadmap to the ATN
- Our Test & Learn facility demonstrates the commitment to safe deployment and building public confidence in AV technology
- We have experience in the delivery of major projects and understand the complexities of public-private partnerships
- Florida has a favorable legal framework for AVs and public-private partnerships
- We understand and have developed strategies to position our organization and workforce for the disruptive change AV technology is going to bring

Our U^{2}C is not just a cool program, it is a comprehensive program that is geared towards harnessing the remarkable potential of new technology to transform the way we plan, develop and deliver transportation projects and services. We are ready to move beyond vehicle demonstrations and develop the autonomous transportation network. We invite USDOT to partner with JTA for ATN deployment that is successful, safe and timely.

GLOSSARY

This glossary is provided for quick reference for the following terms and acronyms used throughout the document.

Advanced Driver Assistance Systems (ADAS) — vehicle systems designed to improve driver safety but still require a driver.

Artificial Intelligence (AI) — ability of a machine or computer to make decisions for itself.

Automated Vehicle (AV) — unmanned vehicle that operates in a coordinated manner with other vehicles and infrastructure environment; sensing and communicating with its environment and navigating without human input (Automated is connected; autonomous is not).

Automotive Data Center — designed to handle workloads associated with development of AVs, like deep learning training and cloud services.

Charging Modes — plug-in wiring types that define connection types and power requirements.

Commercial-Off-The-Shelf System (COTS) — software or hardware that are ready-made and available for sale to the public.

Communication Protocols

V2I — Vehicle to infrastructure communications. Protocol vehicles can communicate with infrastructure, like traffic signals and stations, to negotiate arrival. Mass transportation AVs would be able to notify signals they are approaching. The signal begins clearing pedestrians and stops other vehicular flow, allowing the AV vehicle to proceed directly through the intersection. Occurs using WiFi, DSRC or cellular technologies.

V2X — Vehicle to everything communications. Connected vehicles communicate to Smart City infrastructure. Equipped vehicles can pay for tolls, parking, or recall a parking spot. Occurs using WiFi, DSRC or cellular technologies.

V2V — Vehicle to vehicle communications for platooning, emergency maneuvers, collision avoidance or navigating intersections. Occurs using DSRC or specifically designed cellular channels. The majority of research and development activities are focused on DSRC.

Connected Vehicles (CV) — vehicles connected via wireless communications.

Connection Protection (CP) System — will hold a bus for someone with a reserved trip.

Cybersecurity — state of being protected against the criminal or unauthorized use of electronic data, or the measures taken to achieve this.

Data Management System (DMS) — secure, SaaS web-based application that allows management of a parking meter network.

Data Retention — continued storage of data for compliance or business.

Data Security — tools, policies, practices and procedures used to protect data from being accessed, manipulated, destroyed or leveraged by those with malicious intent or without authorization, as well as, the corrective actions taken when breaches are suspected or identified.

Data Sharing Policies — approach for making data available to others.

Dedicated Short Range Communications (DSRC) — two-way short- to medium-range wireless communication that permits high data transmission critical in communication-based active safety applications.

Deep Learning — ability of a system to gather intelligence and make decisions with minimal or no human involvement; a subset of machine learning that involves processing, large amounts of data and vast compute capacity; a foundation for AI.

Edge Conditions/Boundary Conditions — decided upon by humans instead of the AI system to enhance performance of a vehicle.

Emergency Electronic Break Light Warning (EEBL) — application that enables a vehicle to broadcast a self-generated emergency break to surrounding vehicles.

Emergency Vehicle Alert (EVA) — application that alerts vehicle operators about location and movement of public safety vehicles responding to an incident so there is no interference with emergency response.

Enabling Technologies — innovation that alone or paired with an existing solution produces a better end user solution rapidly.

5G — The fifth-generation of cellular technology currently under development and testing.

Form Factor Neutral — Design of roadways and infrastructure so that vehicle type on the roadway does not matter. Maximum constraints and vehicle requirements will apply: max weight, max width, max height, turning radius and braking capability.

Forward Collision Warning (FCW) — application that warns vehicle operators in the case of an impending rear-end collision with another vehicle in traffic, in the same direction of travel.

GPS/GNSS — (Global Positioning System/ Global Navigation Satellite System) deployed by Department of Defense to provide location information in open sky environments.

Host Vehicle — issues a notification to vehicle operator in a safety-critical situation.

Inductive Charging — (wireless charging or cordless charging) uses an electromagnetic field to transfer energy between two objects through electromagnetic induction, usually done with a charging station.

Integrated Data Exchange (IDE) — proposed data warehouse in Northeast Florida to support Smart City and Smart Region development activities.

Intersection Movement Assist (IMA) (V2V Safety) — application that warns vehicle operators when it is not safe to enter an intersection due to high collision probability with other vehicles.

In-Vehicle Compute — computing systems inside the vehicle that powers autonomous driving, ADAS or in-vehicle experiences.

In-Vehicle Experiences (IVE) — experiences inside vehicle that provide driver assistance, information and entertainment, while enhancing safety.

Lane Change/Blind Spot Warning (V2V Safety) — application intended to warn vehicle operator of a vehicle lane change attempt to a blind spot zone occupied by another vehicle traveling in the same direction.

LiDAR — (Light Detection and Ranging) the most powerful vision system on an AV. Capable of seeing 360-degrees and shoots laser point clouds off of the environment. When laser signal is returned to the system, a 3-D map of the environment can be imaged. Laser scans happen dozens of times per second, giving the vehicle a real-time view of surroundings. Accuracy is about 200-yards in all directions. Like human vision, it is limited to visual fields. Effective range will decrease in heavy weather.

Machine Learning — subset of AI that gives machines the ability to learn on their own, resulting in algorithms that make data-driven decisions.

On-Board Equipment — located in vehicles, includes: GPS receiver, vehicle sensors, vehicle data bus, communications equipment, including a DSRC radio, processing unit and a display.

Open-Data — information available for anyone to use and republish.

Open-Source Concepts — collaboration and voluntary contribution for software development by writing and exchanging programming code.

Operational Data Exchange (ODE) — dynamic governed platform that integrates data and data services for real-time operational use.

Operational Design Domain (ODD) — area where an AV is expected to function and make decisions, includes: roadway, shoulders, sidewalks and areas where pedestrians interact with traffic.

Original Equipment Manufacturer (OEM) — original producer of a vehicle's components, where parts are identical to parts used in production.

Performance Metric — project performance measurement.

Platoon — several vehicles using on-board and infrastructure technology to maintain spacing to improve safety, fuel mileage and efficiency.

Push Notifications — alerts pertaining to selected route, mode of transportation, congestion, barriers to travel or pricing change.

RADAR — (Radio Detection and Ranging) commonly used vision system for weather detection, aviation and the back-up alarms in cars.

Red Light Violation Warning (RLVW) — application that enables a CV approaching an instrumented signalized intersection to receive information from the infrastructure about the signal timing and geometry of the intersection.

Reduced Speed School Zone (RSSZ) — application that provides CVs that are approaching a school zone with information on the speed limit.

Roadside Equipment — includes: traffic signal controllers, pedestrian detection equipment, GPS receiver, communication equipment including UWB/DSRC radio, a processing unit and an audio pedestrian interface.

RTK — (Real Time Kinematic) satellite navigation technique that enhances the precision of position data derived from satellite-based positioning systems (GNSS) such as GPS, GLONASS, Galileo and BeiDou.

Smart Parking Meter — equipped with technology to collect data and make interactions easier for the end user.

Smart Sensors — takes input from the physical environment and uses built-in technology to perform functions upon detection of specific input and processes data before passing it on.

System Analytics/Data Analytics — procedures or business practices to locate information that can be used to create solutions.

System Integration User — firm specializing in compiling component subsystems into a whole and ensuring they function together.

Traffic Signal Priority/Preemption (V2I Mobility) — application that provides improved mobility for emergency, heavy-duty and transportation vehicle operators.

Transit Pedestrian Indication (V2I Safety) — application that provides vehicle to device communications that informs pedestrians of the presence of a vehicle at a station or stop.

Transit Vehicle at Station/Stop Warning (V2V Safety) — application that informs nearby vehicle operators of the presence of a transit vehicle at a station or stop.

Transportation Network Companies (TNCs) — private businesses, non-profits and quasi-governmental agencies that offer one or more types of transportation for use in exchange for payment.

Ultracapacitors/Supercapacitors — (SC, also called supercap, ultracapacitor or Goldcap) high-capacity capacitor with values higher than other capacitors (but lower voltage limits) that bridge the gap between electrolytic capacitors and rechargeable batteries.

Unified Parking Availability and Reservation System — would allow parking availability information and reservations for parking lots and garages without concern of lot or garage ownership.

Ultra-Wide-Band (UWB) Communications — short pulse technology that allows high accuracy location using time delay of arrival cooperative location algorithms.

Vehicle Agnostic — design of operating, fleet management and charging systems that can handle many types of vehicles, if they meet minimum requirements. Ride hailing platforms, like Uber and Lyft, are vehicle agnostic.

Vehicle Data for Traffic Operations (VDTO) — application uses probe data obtained from vehicles in network to support traffic operations, including incident detection and implementation of localized operational strategies.

Vehicle Turning Right in Front of a Transit Vehicle (VTRFTV) (V2V Safety) — application that determines movement of vehicles near a transit vehicle stopped at a stop. Provides an indication to the transit vehicle that a nearby vehicle is pulling in front of the transit vehicle to make a right turn.

5 LEVELS OF AUTONOMOUS DRIVING

SAE International | J3016: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems

5 FULLY AUTONOMOUS

Vehicle is Completely Driverless

Per SAE, full-time automated driving in all conditions without a human driver. These vehicles will not feature driving equipment and will no longer look like the vehicles of the past.

4 HIGH AUTOMATION

Capable of Performing all Safety-Critical Driving Functions while Monitoring Environments/ Conditions in Defined Use Cases

Per SAE, self-driving is fully possible in most road conditions and environments without need of human interventions. A functional driver cockpit is still in place (steering wheel, brake/acceleration pedal, etc.)

3 CONDITIONAL AUTOMATION/ LIMITED SELF-DRIVING

The Car Becomes Co-Pilot

The vehicle manages most safety-critical driving functions is known (mapped) environmental conditions. A human driver is still present and expected to manage vehicle operation.

2 PARTIAL AUTOMATION/COMBINED AUTONOMOUS FUNCTIONS

Key Automated Capabilities Become Standard but Driver Still in Control

At least two simultaneous autonomous tasks become managed by the vehicle in specific scenarios.

1 DRIVER ASSISTED/FUNCTION-SPECIFIC

Intelligent Features Add Layer of Safety and Comfort

A human driver is required for all critical functions. The car can alert the driver to conditions, environment and obstructions. It can also offer assisted/smart performance and driving capabilities.

ZERO AUTOMATION

Driving as Usual

A human driver is required to operate the vehicle safety at all times.

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