SmartTampa

Beyond Traffic: The Smart Tampa Vision

Notice of Funding Opportunity Number DTFH6116RA00002
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U.S. Department of Transportation

City of Tampa Florida

A Message from the Mayor

Welcome to Tampa!

Tampa is the 3rd largest city in the state of Florida and the metropolitan heartbeat of Tampa Bay, a region of more than 3 million people. Tampa is a city of resilience—a city built by the determination of immigrants from Cuba, Italy, Spain, South and Central Americas, Scotland, and others. Thousands came to Tampa in search of prosperity, safety, and equal opportunity, but what the early architects of this great city brought to Tampa was just as valuable as what they sought. They brought a vision and a motivation that laid the groundwork for a better tomorrow, a vision we are still building on today.

Our journey from a small port town to the 53rd largest city in the United States has been one of perseverance and vision. It's that vision that led us out of the Great Recession. While there was no blueprint for our recovery, we emerged stronger. Today, we stand united as a vibrant city rich in diversity and culture. Diversity is a pre-requisite for creativity and innovation, and by extension, our economic competitiveness. We have never been more competitive for business, for intellectual capital, or for trade as we are today. We are home to championship winning sports teams, a collection of museums and cultural assets, and world-class educational institutions.

We are building communities that provide a true live, work, and play environment; communities that foster public safety, healthy living, and the highest quality of life. In downtown Tampa, we completed the Riverwalk, a project championed by 6 mayors and pushed through 40 years until its completion in 2015. This waterside walkway features Tampa's most valuable natural asset, the Hillsborough River, and connects our downtown in a new innovative way.

In the Channel District, our port is exporting more goods than ever before and connecting us with international markets. In West Tampa, we are reimagining neighborhoods that are safer, provide choices, and afford residents more opportunity to raise a family. And soon Tampa will be home to the world's first WELL Certified district, a community with a modern focus on health and wellness, walkability, clean air, and sustainable development.

We are pleased to respond to the Smart City Challenge and present our vision for the future. We are a city on fire, a city with swagger, a city reimagined. Now, it's time to grow smarter.

Thank you for your consideration.

Bob Buckhorn

Mayor Bob Buckhorn

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1. SMART CITY VISION

Tampa and its partners are pleased to respond to the U.S. Department of Transportation (USDOT) Smart City Challenge. Our **Smart Tampa** vision is to spearhead the deployment of bold and innovative concepts involving advanced technologies, data, and applications to help improve safety, increase mobility, enhance security, boost productivity, and protect the environment.

Why Tampa for the Smart City Challenge?

- ✓ Tampa is a hub of cultural diversity—veterans, seniors, millennials, low-income and middle-class—which makes it possible to develop and demonstrate solutions that impact a wide range of the population groups. Tampa is part of the emerging mega-region along the I-4 corridor (as sited in *Beyond Traffic 2045*).
- ✓ Tampa provides a wide range of transportation modes (surface, air, rail, and water) that allow for effective demonstration of multi-modal smart city concepts, which can be transferred to other cities across the nation.
- ✓ Florida offers one of the friendliest regulatory environments in the U.S. for automated vehicles (AVs). Meridian, a pioneer in vehicle automation, has been operating its autonomous shuttles at Tampa's MOSI (Museum of Science and Industries) for several months, and this operation has already transported more than 40,000 passengers, making it the world's most extensive trial of autonomous vehicles involving the general public. In addition, Audi conducted several trials of its highly automated vehicles on Tampa's highways. We will use this vast experience to successfully deploy the urban automation vision element in Tampa.
- ✓ The USDOT/Tampa Hillsborough County Expressway Authority (THEA) Connected Vehicle (CV) Pilot Deployment in Tampa is establishing a real-world environment that will allow vehicles, roadside infrastructure, and mobile devices to communicate with each other, offering Tampa unprecedented opportunities to provide improved safety and mobility solutions enabled by connectivity. We will build off of the strong foundation that the CV Pilot Deployment will provide.
- ✓ Approximately 50 buses in Tampa have already been installed with Mobileye technology. We will leverage the experiences and data from the existing installations to more effectively deploy Mobileye technology that will be made available through the Smart City Challenge.
- ✓ We have assembled an impressive group of public, private, and academic partners who are all committed to accomplishing the Smart Tampa vision. Our team includes the following partners:
  - *Public* – City of Tampa (lead), THEA, Florida Department of Transportation (FDOT), Hillsborough Area Regional Transit Authority (HART), Hillsborough Metropolitan Planning Organization, Tampa Downtown Partnership (TDP), Tampa Bay Area Regional Transportation Authority (TBARTA), Tampa International Airport (TIA), Port Tampa Bay, AARP.
  - *Private* – Booz Allen Hamilton, Tampa Electric (TECO), Google/Waze, Zipcar, Siemens, Meridian, Coast Bike Share, vRide, Audi, Bosch, SPP.
  - *Academic* – University of South Florida (USF)/Center for Urban Transportation Research (CUTR), Embry-Riddle Aeronautical University, University of California Berkeley.
- ✓ We have developed a comprehensive list of concepts for all 12 USDOT vision elements. Our holistic and integrated approach to implementing these concepts ensures that they synergistically combine to address various challenges in Tampa, and result in multiple benefits.
- ✓ The city has made significant investments (over $240 million) to improve the livability of downtown Tampa, support the transformation of the surrounding neighborhoods connected to the business district, and spur economic development. Our private sector partners have also invested millions of dollars and human resources in developing the solutions that we plan to implement as part of our Smart Tampa vision.

1.1 Challenges and Solutions for Smart Tampa

The Smart Tampa initiative plans to leverage the USDOT's Smart City Challenge funding to address such challenges faced by our region in the context of growth, urbanization, climate change,

security, and the sharing economy. Table 1 summarizes our proposed high-level concepts (under each of the 12 vision elements) that we plan to implement using the Smart City Challenge funds, along with corresponding challenges that these concepts are expected to address.

Table 1: Smart Tampa High-Level Concepts and Challenges Addressed

Technology Elements and Proposed Concepts		Challenges Addressed
 Urban Automation	• Automated vehicles on Reversible Express Lanes • Low-speed fully automated electric shuttles in downtown and at TIA • Automated marine and ground security vehicles at Port and TIA • Bus-on-Shoulder-System with Mobileye and active safety systems	• Demand for point-to-point downtown shuttle • Port carries significant hazmat and fuels close to downtown • Increased security concerns from fast-boat attacks • MacDill Airforce base security risk
 Connected Vehicles	• Additional applications leveraging THEA CV Pilot Deployment • Safety: Red light violation warning • Environment: Eco-approach and departure • RESCUME: Emergency Communications and Evacuation	• Sustainable environmental and safety solutions to address existing car culture (as we transition to Transit Oriented Development or TOD) • Unfavorable weather patterns, and impeding sea level rise will have an impact on 27,757 households in working class neighborhoods within flood zones.
 Intelligent Sensor-based Infrastructure	• Road-side: weather, air quality, noise, traffic cameras, etc. • In-vehicle: position, velocity, weather, etc. • In-building: Indoor navigation beacons at Convention Center • Leveraging of USDOT's road weather products (Vehicle Data Translator, Motorist Advisory and Warnings, and Enhanced Maintenance Decision Support Systems)	• Limited parking availability and location info causing congestion during peaks and special events • No means of communication to users regarding parking availability in garages or on street • Poor record on pedestrian safety • Limited open-data availability • Limited accessibility options for visually disabled in urban spaces
Innovative Approaches to Urban Transportation Elements and Proposed Concepts		**Challenges Addressed**
 Urban Analytics	• Platform for data ingestion, processing, and decision making support • Predictive analytics tools based on historical and current data • Goal driven capability build out • User-friendly and unified interface	• Record flooding event in 2015 with an ineffective communication means to disseminate safety information • Emergency management especially during critical weather events such as hurricanes and flooding. • Congestion ranked 12th worse in U.S. • Legacy traffic control infrastructure
 User focused Mobility Services and Choices	• Integrated Mobility Platform for Tampa (IM-T) application • Solutions such as kiosks for vulnerable communities who cannot afford smart phones • Tampa senior center on-demand dynamic shuttle • Indoor navigation for improving accessibility to visually impaired	• Lack of multi-modal information • Limited mobility options for vulnerable populations (seniors, low-income, disabled) • Limited accessibility options for visually disabled in urban spaces • Increase of the retirement community, Tampa has 12% of the population aged 65 and older

Technology Elements and Proposed Concepts		Challenges Addressed
 Urban Delivery and Logistics	• Data-driven, connected urban freight movement • App for Port to reduce check-in wait times • Freight-specific dynamic travel planning application • Sensor-enabled dynamic routing for trash collection	• Lack of advanced traveler information systems for goods transport
 Strategic Business Models and Partnering Opportunities	• Leveraging of capabilities and distributing risk, costs, and revenue • Public-private partnerships (PPP) to enhance Zipcar, Coast Bike Share, and HART • PPP between Tampa Electric and Tampa for smart grid • Leveraging of private partner's technology investments for deployments	• Limited avenues to leverage entrepreneurs • Limited adaptation to newer business models • Need to leverage sharing economy
 Smart Grid, Roadway Electrification, and Electric Vehicles (EVs)	• Vehicle-to-grid and vehicle-to-home smart charging pilot • Infrastructure for EVs (static and dynamic charging) • Smart grid enabling intelligent infrastructure communication • Leverage of smart grid communication to automate traffic signals	• Limited EV infrastructure • Partial smart grid • Inefficient energy grid
 Connected, Involved Citizens	• Citizen-to-Citizen (C2C) crowdsourcing platform • Crowdsourced social events senior center shuttle • Collaboration with AARP on training for those that are not up to speed on newer technologies	• Lack of multi-modal information • Limited mobility options for vulnerable populations (seniors, low-income, disabled) • Limited public access to existing data sources • Demand for more community input on local issues • Need to educate on the value of transit and new transportation technologies • Need to leverage sharing economy
Smart City Elements and Proposed Concepts		**Challenges Addressed**
 Architecture and Standards	• Leveraging of Connected Vehicle Reference Implementation Architecture (CVRIA) and Systems Engineering Tool for Intelligent Transportation (SET-IT) • Identification and communication of gaps in existing interfaces/standards • Support of standards for urban automation, CVs, sensor-based infrastructure, smart grid, user-focused mobility	• Lack of comprehensive standards for Smart City elements
 Low cost, efficient, secure, and resilient ICT	• Use of cloud to eliminate capital expenditures and enable scalable computing • Data governance to address privacy concerns • Securing of architecture for edge devices and back-end systems	• Lack of existing infrastructure for open data-sharing • Limited public access to existing data sources • Demand for more community input on local issues • Need to leverage sharing economy

Technology Elements and Proposed Concepts		Challenges Addressed
Smart Land Use	• Shared parking app • Meet-Up Bike and Walk to School or Work App • Enhanced community participation tools	• Limited adaptation to newer business models • Need for TOD

1.2 Implementation and Operations Approach

Tampa's approach to implementing and operating the Smart Tampa vision described in this proposal will follow a four-step continuous improvement process that leverages the Plan-Do-Check-Act Model:

- **Plan** – Develop a comprehensive implementation plan for the Smart Tampa demonstration. Establish objectives and processes needed to deliver results. Develop structure, methods, and processes to measure effectiveness.
- **Do** – Launch Smart Tampa according to the details documented in the comprehensive implementation plan. In some scenarios, it may become evident early in the implementation that changes are immediately required to ensure that Smart Tampa can successfully run to completion. Implement changes using change management processes, ensuring that such changes are well documented and understood by the project team and the USDOT. Communicate the changes to all Smart Tampa participants. The Smart Tampa participants must know what their responsibilities are throughout the implementation.
- **Check** – Monitor the usage of various demonstration concepts. Understand how each concept/application is being used by the participants throughout the demonstration. Document the behaviors and findings of the demonstration participants. Report the results of each concept/application monitoring to affected team members of Smart Tampa. Monitor the physical and technical environment and track technical issues throughout the demonstration. Use the demonstration participants as a base for extrapolating the Smart Tampa system performance measures. Employ standardized evaluation reports and surveys to gain understanding of the advantages and disadvantages of each demonstration concept/application.
- **Act** – System enhancements or documentation updates are common requirements resulting from the demonstration operations monitoring. Understand how the demonstration participants interact with the concepts/applications and perform their transportation functions such as driving, riding, biking, and walking. Work with the USDOT to share data and lessons learned. Openly collaborate and commonly agree on changes needed to improve the functionality and/or performance of each concept/application.

1.3 Program Management Approach

The Smart Tampa initiative will be led by the Mayor's Office and managed through the Department of Transportation and Stormwater Services. To successfully manage this initiative, we will create a Smart Tampa Board, which will include the heads of participating city departments, as well as representatives appointed by the Mayor. The board will meet bi-weekly in the initial stages (and less frequently in later stages) to review progress, risks, and partnerships. In addition, we will stand up a Program Management Office (PMO) to run the day-to-day efforts of the initiative, and will apply the Project Management Body of Knowledge (PMBOK) principles as we move through the various phases of program implementation and operation. Additionally, we will establish clear lines of communication between Tampa and the USDOT for important decisions and participate in efforts to share lessons learned from this initiative with other cities.

Tampa is fully committed to spearhead the demonstration of forward-looking Smart City concepts involving advanced technologies, data, and applications to help improve safety, increase mobility, enhance security, boost productivity, and protect our environment.

2. POPULATION CHARACTERISTICS OF TAMPA

Tampa is a mid-sized city with a population of 335,709 according to the 2010 Census. It has a dense urban population of 2,960 people per square mile (113.4 sq-mi). Tampa represents a significant portion of the population of its local urbanized area with a ratio of 13.7 percent. Tampa's daytime population is more than double its night-time population. In 2015, the population within Tampa's corporate limits was approximately 356,000 people; this number is projected to grow to over 480,000 by 2040, as shown in Table 2. Because vacant land within the corporate limits is scarce and there is little potential to annex undeveloped property, the vast majority of this growth must occur through downtown residential development, transit-oriented development along major commercial corridors, and infill of the city's existing residential neighborhoods.

Table 2: Tampa Population Projections

POPULATION	2015	2020	2025	2030	2035	2040
Temple Terrace	36,245	38,304	40,062	40,579	41,887	43,134
Plant City	40,530	44,146	49,740	64,555	69,113	71,523
Tampa	355,850	384,153	410,669	433,103	457,322	481,128
Unincorporated County	857,723	940,112	1,014,852	1,075,680	1,136,625	1,194,597
COUNTYWIDE TOTAL	1,290,348	1,406,715	1,515,323	1,613,917	1,704,947	1,790,382

Source: Metropolitan Planning Organization Imagine 2040 Long Range Transportation Plan

Today, over 355,000 people from 3 counties in the region work within the city limits, and this number continues to grow. This growth will be concentrated predominantly in three major business centers:

- ***Downtown*** – A mix of corporate offices and civic-related employment as well as cruise ship terminals, future USF medical school, and Tampa General Hospital
- ***Westshore Business District and TIA*** – Corporate offices, regional retail, hospitals, and airport-related industries
- ***USF Area*** – USF campus (48,000 student Research 1 university), three major hospitals, Busch Gardens amusement park, and industrial park areas.

3. TAMPA CITY CHARACTERISTICS

Tampa is the third-largest city in Florida. The region's largest airport, port, university, two professional sports arenas, and central business district are all located within the city limits, which makes it the economic hub of the Gulf Coast. Tampa provides a wide range of transportation modes (surface, air, rail, and water) that allow for effective demonstration of our proposed Smart City concepts, which can be transferred to other mid-sized cities across the nation.

Tampa has a well-connected network of freeways (38 miles), highways (21 miles), arterials (316 miles), and three major bridges across the Tampa Bay. THEA has various ongoing projects including Bus Toll Lanes, Automated Vehicle demonstration, and the USDOT Connected Vehicle (CV) Pilot Deployment. Also, Tampa has all-electronic Reversible Expressway Lanes (RELs), allowing for express travel between the City of Brandon and downtown Tampa.

HART operates the public transportation in Tampa, which includes public bus, paratransit, and a streetcar line. HART covers an area of approximately 1000 sq. miles with a fleet of nearly 200

buses. The streetcar system runs between the Ybor City historic district and downtown Tampa. HART offers its customers innovative tools such as OneBusAway, which relays real-time bus information to smart phones. The ongoing relationship between HART and USF/CUTR (a USDOT University Transportation Center) has proven effective for deploying innovative transportation technologies in Tampa. Water taxis are available on a charter basis for tours along the downtown waterfront and the Hillsborough River. TBARTA provides bus, light rail, and other transportation options for the seven-county Tampa Bay area.

TIA is Tampa's main airport and the primary location for commercial passenger airline service into the Tampa Bay area. Tampa's intercity passenger rail service is based at Tampa Union Station, a historic facility, adjacent to downtown between the Channel District and Ybor City. Uceta Rail Yard on Tampa's east side services CSX as a storage and intermodal freight transport facility. Port Tampa Bay handles about one-third of all cargo moving in and out of the state of Florida, and the cruise port handles about 900,000 passenger moves a year.

Tampa led or co-led several large federally funded initiatives, including 2012 HUD Choice Grant, 2013 TIGER Grant, and 2012 Republican National Convention. With commitment from Tampa's Mayor Buckhorn; heads of nine City of Tampa departments; and multiple public, private, and academic partners, Tampa has the leadership and capacity to successfully carry out the Smart City Challenge demonstration.

Tampa has the latest ridehailing/rideshare systems in the nation—services like Uber and Lyft and carpooling apps are available. In addition, a bike sharing program called Coast Bike Share allows users to find and reserve bikes via a mobile app in Tampa. Coast Bike Share offers nearly 300 rental bikes distributed at 30 hubs in or near downtown, which commuters and HART riders can use for the first and last miles of their daily trips. In addition, Zipcar currently has three locations in Tampa, and supports services for members with disabilities including vehicles with hand controls and service animals.

TECO is currently investing millions of dollars and human resources in new energy technologies that support Tampa's smart grid evolution. Limited transportation by privately operated neighborhood electric vehicles (NEVs) is available, primarily in downtown Tampa and Ybor City. Also, ChargePoint, the world's largest and most open electric vehicle (EV) charging network with over 25,200 locations, has several charging stations in Tampa.

Tampa is a leader in promoting open, machine-readable data. The city hosts an open data site, and Mayor Buckhorn has hosted hackathons with the tech startup community. Tampa's website and citizen-facing services have been upgraded to the latest open source platforms and are fully enabled for mobile access. Tampa worked with key business providers to install free WiFi at major parks, attractions, and business locations throughout the city. HART and USF/CUTR provide standards-compliant open data on transit schedules and transit arrivals. Coast Bike Share publishes anonymized trip data, which is used to understand usage and improve service.

4. ANNOTATED PRELIMINARY SITE MAP

The proposed Smart City Challenge implementation area comprises Tampa's vibrant downtown, the Port Tampa Bay, historic Ybor City, and the TIA. Figure 1 indicates the locations of key issues and proposed Smart City concepts that align with the USDOT vision elements.

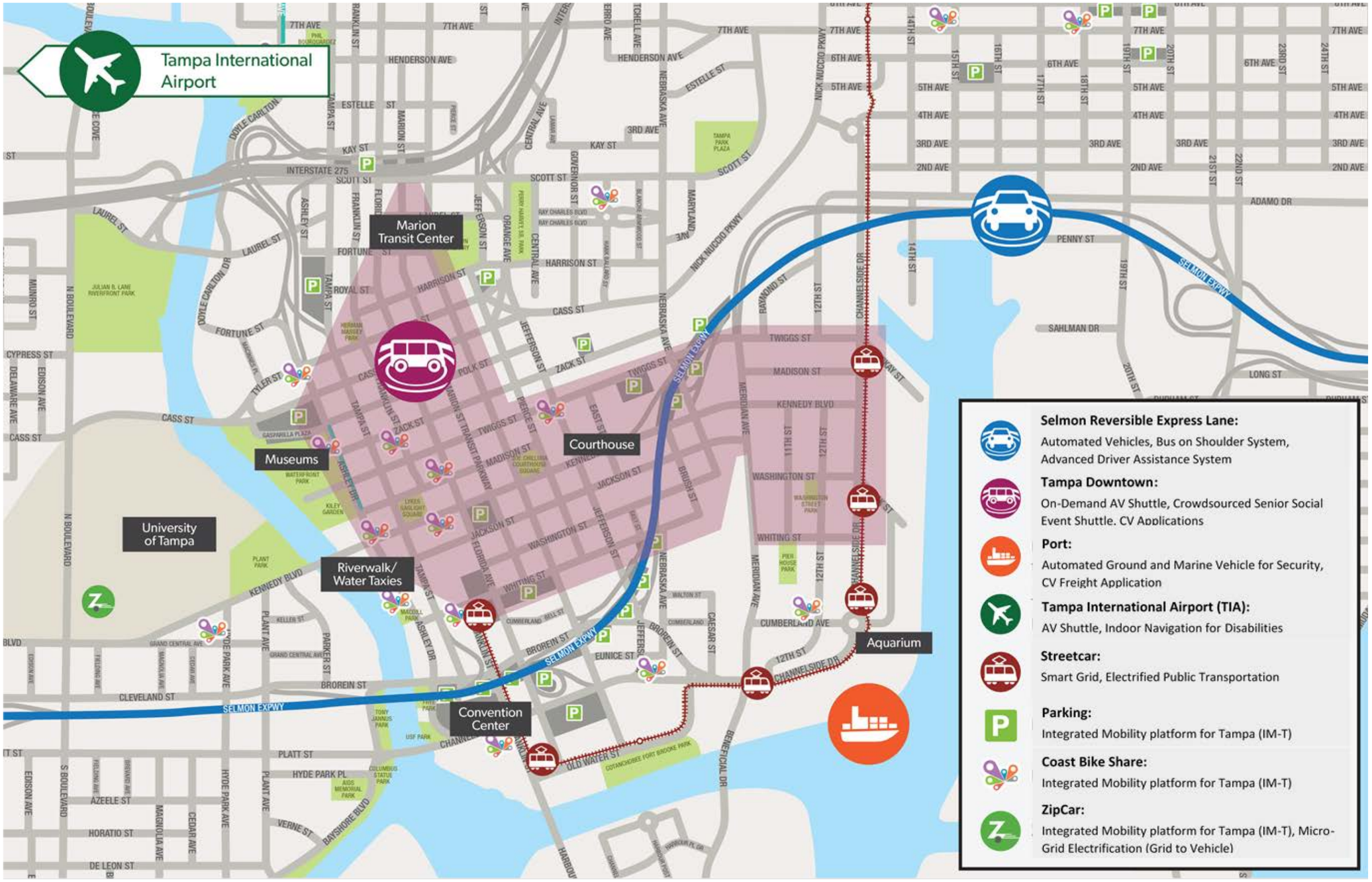

Figure 1: Annotated Preliminary Site Map

5. SMART CITY VISION ELEMENTS

The Smart Tampa vision offers bold and innovative ideas to demonstrate and evaluate the benefits of various Smart City concepts that align with the USDOT's 12 vision elements. An impressive set of carefully chosen partners representing Tampa's agencies, infrastructure network operators, and service providers will work together (see Figure 2) to address the USDOT's Smart City goals and Tampa's challenges, focusing specifically on empowering vulnerable populations, making more efficient use of existing infrastructure through innovation, fostering a sharing economy, and improving resilience to climate events.

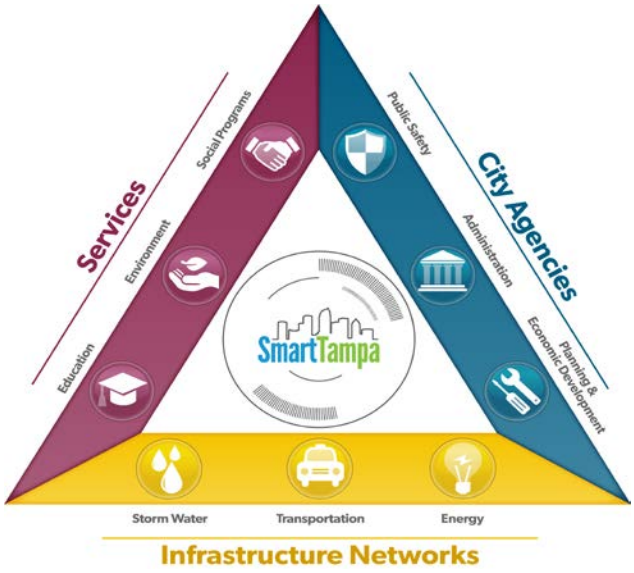

Figure 2: Smart Tampa Partners

The following subsections describe the high-level concepts (under each of the 12 vision elements) that we plan to implement using the Smart City Challenge funds.

5.1 Vision Element #1: Urban Automation

- Automated vehicles on Reversible Express Lanes
- Low-speed fully automated electric shuttles in downtown and at TIA
- Automated marine and ground security vehicles at Port and TIA
- Bus-on-Shoulder-System with Mobileye and active safety systems

Lead Partners: Audi, meridian, HART, Embry-Riddle Aeronautical University, Bosch

Our proposed concepts under this vision element will demonstrate adoption, use, and impacts of urban automation on public roads. Working with our public and private partners, Tampa will demonstrate the capabilities of various automated vehicle technologies and engage with other cities to accelerate nationwide adoption.

Figure 3: Automated Vehicles on REL

5.1.1 Automated Vehicles on REL

With support from THEA, Tampa will deploy several vehicles with highway pilot (SAE Level 3) on the REL (see Figure 3). Audi, a pioneer in vehicle automation, will work with Tampa to deploy and test these vehicles, using the city employees as operators. These vehicles will operate in real traffic on a daily basis. THEA will also make available 5 to 7 mile segments of the REL for AV testing at times when portions of the REL are closed for the daily lane reversal process.

In addition, HART will deploy Bus on Shoulder Systems (BoSS) on the REL (see figure) to increase the capacity of existing infrastructure. The BoSS vehicles will incorporate the Mobileye systems to be provided to the final selected city. Additionally, lateral control of buses provided by Bosch will improve BoSS operations, especially during Tampa's challenging climate events like the record flooding in 2015.

5.1.2 Autonomous Shuttles in Downtown Tampa and at TIA

Our partner Meridian will deploy SAE Level 5 fully automated low-speed multi-passenger shuttles in downtown and at the TIA. Tampa Downtown Partnership (TDP) will lead the deployment of an on-demand downtown shuttle that connects existing transportation options (Amtrak, Greyhound, Coast Bike Share, water taxis, and street cars) and important destinations in Tampa (scenic riverfront, museums, and signature parks). The complementary shuttle will provide increased mobility and accessibility opportunities to vulnerable populations. Tampa's Downtown Guides will serve as operators of the shuttles, providing city information and helping passengers with disabilities. This service will meet the needs of downtown's workforce (58,000), residents (8,100), and visitors (3.6 million). Certain stretches of the shuttle routes will also provide wireless charging capabilities.

Figure 4: Meridian Shuttle at TIA

TIA is building an automated people mover (APM) to connect its terminal to the economy parking garage and the Consolidated Rental Car Facility (ConRAC). The APM will drop off travelers a considerable distance from their parked cars in the garage. A Meridian shuttle will transport 8 to 10 passengers and their luggage between the APM drop-off point and their vehicles, making their trip from terminal to car completely automated. This shuttle service will be continuous during the peak periods and on-demand during off-peak periods.

Smartphone apps and kiosks will be provided for ride hailing. Meridian's Supervision platform will record all real-time parameters (sensor data, actuation orders, etc.), and this data will be shared with the USDOT and insurance companies. Meridian will also work with the USDOT, Florida Department of Transportation (FDOT), and Tampa on understanding the vehicle certification process.

5.1.3 Port and Airport Security

Figure 5: ASVs in Port Tampa Bay

Our partner Embry Riddle Aeronautical University (ERAU) will work with Port Tampa Bay to deploy their Marine automated surface vehicles (ASVs), which are already equipped with autonomous navigation and advanced sensors. Port security applications will include cruise ship security zone monitoring, hazardous material leak monitoring, and detection of fast boat approaches. ERAU will also deploy its autonomous ground vehicles to patrol the cruise port terminals for security issues. These vehicles will be equipped with facial recognition technology to identify authorized personnel. In addition, the ASVs will also monitor for threats in the waterways along TIA's runway approach paths.

Upon identification of potential issues, the ASVs will respond accordingly (e.g., alert port security, warn unauthorized vehicles, and allow the security office to investigate threats).

5.2 Vision Element #2: Connected Vehicles

- Additional applications leveraging THEA CV Pilot Deployment
- Safety: Red light violation warning
- Environment: Eco-approach and departure
- RESCUME: Emergency Communications and Evacuation

Lead Partners

Audi

Tampa-Hillsborough Expressway Authority

Booz Allen

For the Smart City Challenge, we will build on the strong foundation (connected vehicles, roadside units, and mobile devices) that the USDOT/THEA CV Pilot Deployment (http://www.its.dot.gov/pilots/pdf/03_CVPilots_Tampa.pdf) will provide for CV implementation in Tampa. Specifically, we will deploy additional CV applications (leveraging software available through the USDOT's Open Source Application Development Portal or OSADP) that will address additional challenges beyond those that are originally targeted and planned in the THEA CV Pilot.

The CV concepts will be implemented with support from our partners Audi and Booz Allen. Audi has the necessary vehicle systems and applications expertise, and Booz Allen has been supporting the USDOT for the past 10 years in CV research and development and is also a key partner in the THEA CV Pilot Deployment. The following are our proposed CV applications.

1. **Red Light Violation Warning (RLVW)** – The RLVW application will leverage the Intersection Movement Assist concept used in the THEA Pilot to enable connected vehicles approaching instrumented signalized intersections in Tampa to receive information from the infrastructure regarding the signal phase and timing (SPaT) and the geometry of the intersection. The RLVW application will use its speed, heading, and acceleration profile, along with the SPaT and geometry information to determine whether the vehicle will likely enter the intersection in violation of a traffic signal. If the violation seems likely to occur, the driver will receive a warning.
2. **Eco-Approach and Departure** – Similar to the RLVW application, the Eco-Approach and Departure application in equipped vehicles will receive intersection geometry and SPaT information from instrumented signalized intersections. Based on this information, the application will provide speed advice to drivers, allowing them to adapt the vehicles' speed to pass the next traffic signal on green or to decelerate to a stop in the most eco-friendly manner. If possible, with support from Audi, we will also explore the concept of automated longitudinal control for the Eco-Approach and Departure.
3. **Emergency Communications and Evacuation (EVAC)** – To address transportation challenges in Tampa due to adverse weather events such as hurricanes and flooding, we will deploy this CV application to provide travelers/evacuees with information such as passable routes and current traffic and road conditions. We will provide this service in coordination with many agencies including Tampa police, fire and rescue departments, emergency management, and public and private transportation providers.

Pertinent data (without any Personally Identifiable Information or PII) collected will be made available via the USDOT's Research Data Exchange (RDE).

5.3 Vision Element #3: Intelligent, Sensor-Based Infrastructure

- Road-side: weather, air quality, noise, traffic cameras, etc.
- In-vehicle: position, velocity, weather, etc.
- In-building: Indoor navigation beacons at Convention Center
- Leverage USDOT's road weather products (VDT, MAW, and EMDSS)

Lead Partners: SIEMENS, Booz Allen

Our concept integrates existing sensor data (e.g., from Bluetooth readers and bike detection sensors) with new data sets from additional sensors to be installed, allowing Tampa to improve the operations and maintenance of the transportation network.

Siemens will help deploy the additional **roadside** and **in-buildings sensors**, and will combine the data from these sensors with **in-vehicle** data (from THEA CV Pilot vehicles) to provide the foundation (see Figure 6) for road weather applications. Specifically, we plan to install weather sensors on vulnerable infrastructure (low-lying roadways, coastal property, etc.) to help predict where the heaviest rainfalls and flooding will likely occur, with the help of our Stormwater Services Division. The collected road weather data sets will be fed through the USDOT's Vehicle Data Translator (VDT); outputs from the VDT will be used in USDOT-developed road weather applications. Specifically, we plan to use the Motorist Advisory and Warnings application to provide flood alerts to city residents and motorists, and will use outputs from the Enhanced Maintenance Decision Support Systems to provide roadway maintenance alerts for efficient city operations during adverse weather events.

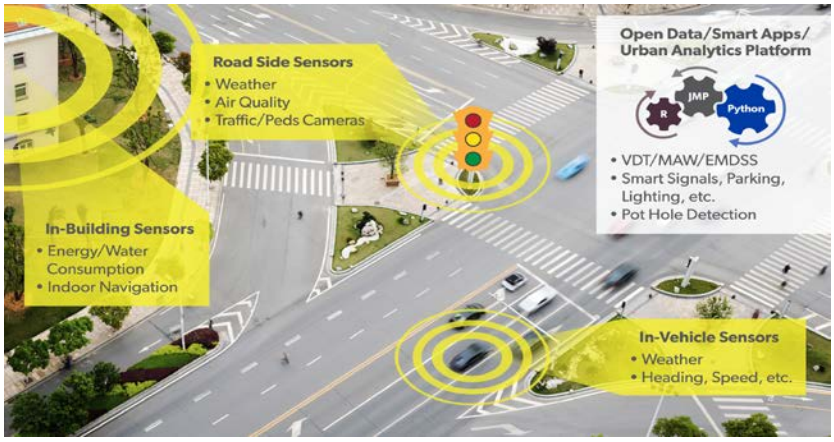

Figure 6: Roadside, In-Vehicle, and In-Building Sensor Network

5.4 Vision Element #4: Urban Analytics

- Platform for data ingestion, processing, and decision making support
- Predictive analytics tools based on historical and current data
- Goal driven capability build out
- User friendly and unified interface

Lead Partners: Booz Allen, CUTR Center for Urban Transportation Research

With the data-rich environment envisioned for Tampa, analytics will play a key role in evaluating and improving urban performance with enhanced awareness and decision support tools. Booz Allen is a leader in developing data analytics solutions that ingest data to create and extract insights that support decision-making processes. Urban analytics is the extension of data analytics that brings together Smart City components and vision elements, and is the engine required to operationalize Tampa's Smart City concept. Figure 7 illustrates how urban analytics functions as the core to support the full realization of the benefits of Smart Tampa's concepts. The data from various vision elements and components of Smart

Tampa will be fed into the analytic engine. The urban analytics platform supports decision makers, facility managers, and facility users in Tampa to realize their Smart City goals, such as improving efficiency and resilience. The information and insights will be delivered via an intuitive, unified visualization dashboard developed with user objectives in mind.

Urban analytics will support the monitoring and management of traffic, incidents (both transportation and non-transportation), energy consumption and production, air-quality, and road surface condition and quality (including pothole monitoring and the presence of water or other substance that adversely affect roadways), as well as the allocation and dispatch of resources during emergencies. Tampa's instrumented roadways will provide real-time data for assessing and monitoring facilities and improving the use of existing infrastructure. We will develop predictive analytic tools that use a combination of historical and real-time data to perform predictive mappings and develop proactive control strategies. For example, predictive systems could be used to alert Tampa's Traffic Management Center (TMC) staff if the arterial system is approaching saturation, who can thereby proactively introduce strategies such as signal timing optimization. Beyond traffic management, this tool can help prepare Tampa for climate events (e.g., allowing the fire department to proactively place their rescue vehicles to avoid troubled roadways and still perform operations). Additionally, the platform can be used to learn more about the accessibility challenges of vulnerable populations.

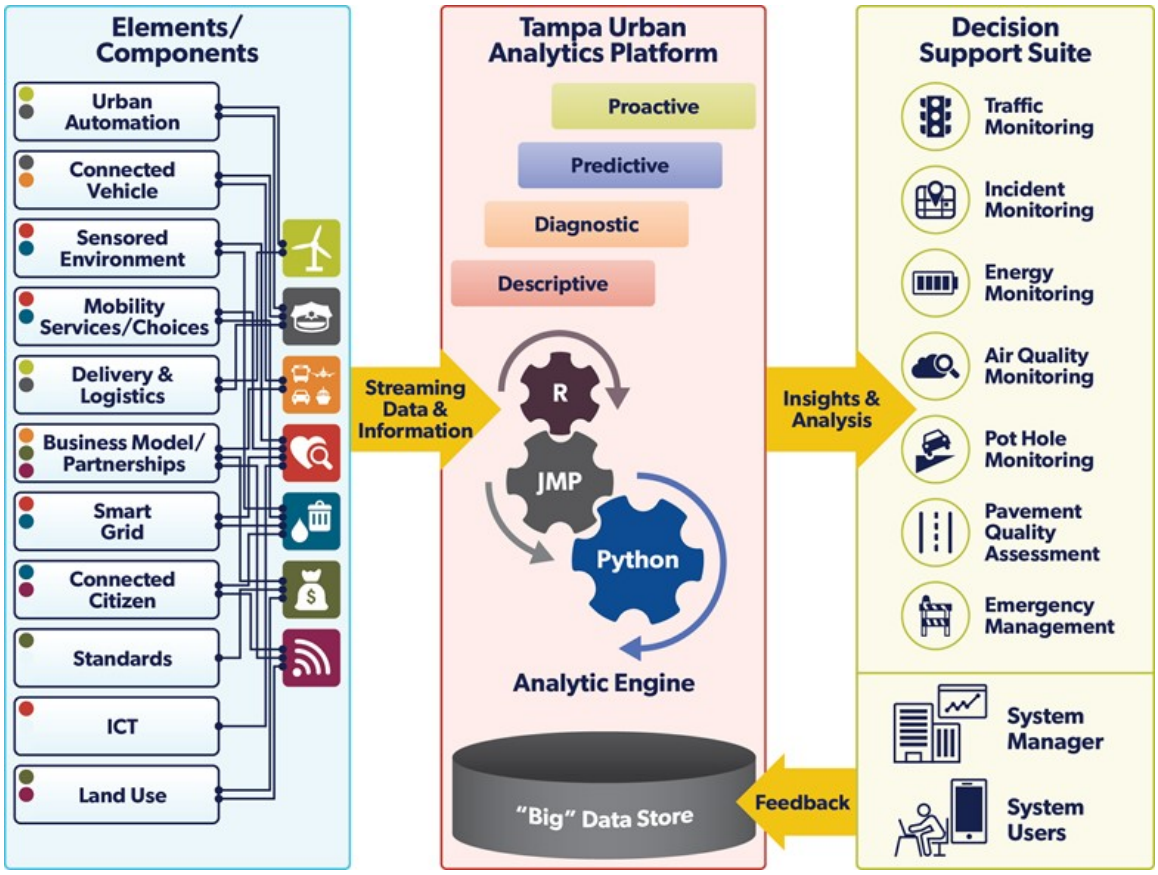

Figure 7: Urban Analytics: Central to the Operationalization of Smart Tampa Concepts

5.5 Vision Element #5: User-Focused Mobility Services and Choices

- Integrated Mobility Platform for Tampa (IM-T) application
- Tampa senior center on-demand dynamic shuttle
- Indoor navigation for improving accessibility to visually impaired

Lead Partners: waze, zipcar

5.5.1 Integrated Mobility Platform for Tampa (IM-T)

Under this vision element, we propose to develop a first-of-its-kind **IM-T** that integrates all travel modes and transportation choices within a single interface.

Unlike existing platforms and applications, this platform will consider multiple travelers simultaneously, clustered by their most chosen routes, and enable the creation of ride-share suggestions. The proposed design is accessible to all travelers, including the elderly and disabled, through a smartphone app, dial-in number, or kiosks in designated locations. Users enter a destination and receive customized trip options with the factors needed to make an informed decision. To develop and deploy this bold and innovative concept (see Figure 8 for illustrations of the IM-T app), Tampa has partnered with Waze, Coast Bike Share, HART, Meridian, Zipcar, and vRide, and will leverage existing payment platforms, non-fixed route transit (Flex routes), and the OneBusAway transit arrival information system.

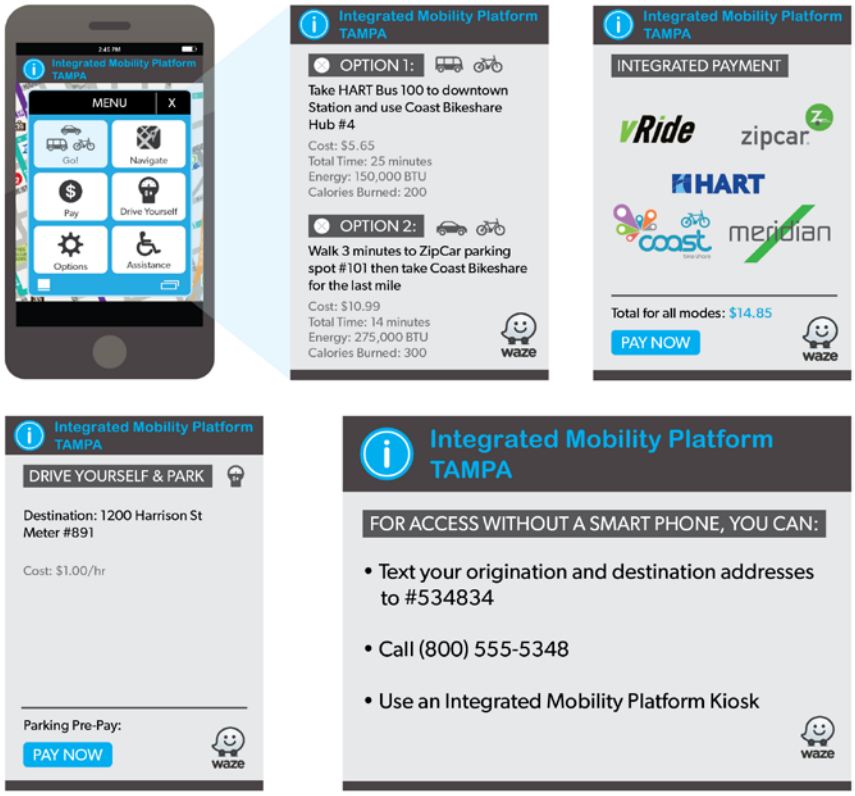

Figure 8: Illustrations of the IM-T App

5.5.2 Tampa Senior Center On-Demand Dynamic Shuttle

The urban core of Tampa has a number of senior citizen facilities. Some centers have designated shuttles, others do not and rely mainly on public transit and paratransit services for their residents. Using existing shuttle vehicles from the HARTFlex program's ADA accessible shuttle services and adding new shuttles as needed, we will establish an on-demand dynamic shuttle to aggregate trips requested in real time from different senior centers. In addition, we will integrate this solution with the existing OneBusAway service in Tampa. Users will be able to schedule the on-demand dynamic shuttle via a website, mobile application, phone call, or mobility station located outside each participating center. These mobility stations will include electronic equipment capable of

hailing a shuttle via a touch-tag sensor that works with the senior center's identification card or mobile ticket. Senior center front desk staff will also be trained to call the shuttle via website or mobile application for a requesting senior resident. The service will begin by operating between selected areas, such as participating senior centers and the downtown core as well as identified popular travel areas for senior citizen residents. As the service grows and travel demand increases, we will examine the possibility of expanding the service area by teaming with more senior centers in Tampa.

5.5.3 Indoor Navigation for Improved Accessibility

Personal navigation applications are important for disabled and elderly populations, and these applications often depend on GPS, which is unreliable in many locations (e.g., inside buildings and parking garages). Beacon positioning systems (BPS) offer an alternative to obtain localization and contextual information. We will install these sensors inside the Tampa Convention Center. Figure 9 illustrates the proposed indoor navigation deployment.

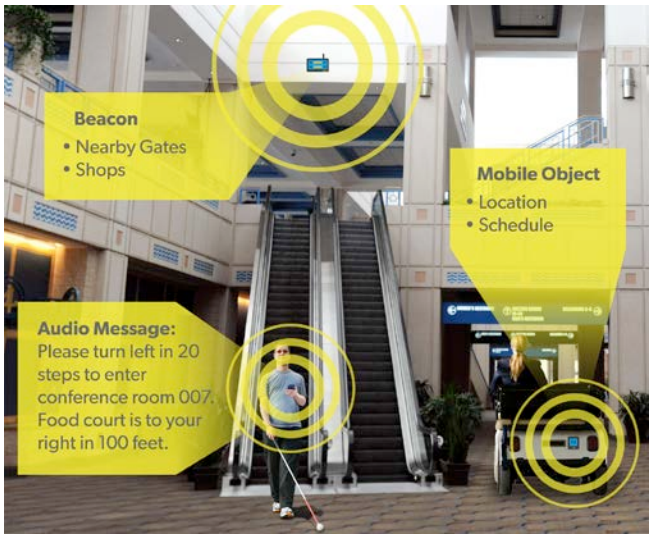

Figure 9: Proposed Indoor Navigation Deployment

5.6 Vision Element #6: Urban Delivery and Logistics

- Data-driven, connected urban freight movement
- App for Port to reduce check-in wait times
- Freight-specific dynamic travel planning application
- Sensor-enabled dynamic routing for trash collection

Lead Partners

PORT TAMPA BAY

SIEMENS

The I-4/Selmon Expressway Connector witnesses a flow of around 12,000 trucks per day that use a dedicated truck lane as they move into (and from) the Port Tampa Bay. A freight-specific dynamic travel planning application will leverage existing data on roadway conditions (accidents, incidents, etc.) and information on Port Tampa Bay entry/exit delays, and provide dynamic truck routing information to local fleet operators interested in participating in this deployment. Port Tampa Bay will also improve its operational efficiency by increasing access to information and streamlining check-in procedures. The application will provide freight movers with up-to-date check-in wait times and allow drivers and companies to coordinate their arrivals and departures to reduce wait times. Furthermore, the application will also include a digital pre-check-in feature to reduce processing time at the gate.

In addition, waste management trucks in Tampa will become more efficient through sensor-enabled dynamic routing and eco-approach and departure. Trash collection points will be instrumented to monitor trash volume and inform our Department of Solid Waste and Environmental Program Management when trash emptying is necessary. A centralized dynamic routing algorithm hosted on the Urban Analytics platform (See Section 5.4) will then optimize

truck routing. Trash trucks will also be equipped with the Eco-Approach and Departure application to improve fuel efficiency.

5.7 Vision Element #7: Strategic Business Models and Partnering Opportunities

- Leveraging capabilities and distributing risk, costs, and revenue
- PPP to enhance Zipcar, Coast Bike Share, and HART
- PPP between Tampa Electric and Tampa for smart grid
- Leveraging private partner's technology investments for deployments

Lead Partner

TAMPA DOWNTOWN PARTNERSHIP

Recognizing the limited public resources available to successfully execute the proposed Smart Tampa concepts, as well as the private sector's appetite for deploying innovation, Tampa has identified the business models necessary to develop *and sustain* its Smart City vision. TDP has been instrumental in creating strategic public private partnerships (PPPs) that provide attractive options for distributing risk, operating costs, and revenue streams. Three PPPs that TDP developed in conjunction with this proposal leverage public investments in infrastructure and regulatory risk reduction to incentivize private investment in operation, including deployment of shared cars (Zipcar), bike share (Coast Bike Share), and electric shuttles (Meridian). Additionally, multimodal travel will be enhanced through a partnership between public transit (HART) and Coast Bike Share, including price promotions and plans to unify payment cards.

Strategic private sector partners will bring resources to help fulfill the vision elements. Audi and Meridian are providing their expertise to ensure safe and accelerated deployment of AVs. Bosch and Siemens have offered their expertise for implementing off-the-shelf and customized solutions to meet Tampa's challenges. Waze will provide access to a robust information management system and will partner on developing new features for Tampa. Multimodal shared economy partners Zipcar, vRide, and Coast Bike Share have agreed to work with the team to create an integrated transportation interface for users. Coast Bike Share and HART are partnered through promotions to increase cross-utilization.

Tampa's very own UTC, USF/CUTR, has a long-standing research relationship with HART and Tampa. CUTR is providing its expertise to ensure cutting-edge technologies are transitioned into practice, especially related to enhancing mobility for elderly users and developing data standards. Partner ERAU is a core member of the Federal Aviation Administration's Unmanned Aerial System Center of Excellence. The Transportation Research Sustainability Center (TSRC) of U.C. Berkeley is providing unique expertise in the Mobility On-Demand and integrated/shared mobility services. All three academic partners will continue to train the future workforce through Smart Tampa's applied research.

Tampa and TECO have outlined a PPP to expand investments in EV infrastructure and leveraging the smart grid communications platform to enhance Smart City capabilities across the traffic management system environment and the electric grid. AARP brings the perspective of the elderly population to this project, and the nine participating City of Tampa departments will ensure broad interest group representation.

5.8 Vision Element #8: Smart Grid, Roadway Electrification, and Electric Vehicles

- Vehicle-to-grid and vehicle-to-home smart charging pilot
- Infrastructure for electric vehicles (static and dynamic charging)
- Smart grid enabling intelligent infrastructure communication
- Leverage smart grid communication to automate traffic signals

Lead Partner

There is increased consumer interest in choosing EV options, with close to 900 EVs and over 80 charging stations in Tampa. With the funding that Vulcan will provide to the final selected city, our partner TECO will deploy the following concepts:

- Implementation of a vehicle-to-grid and vehicle-to-home smart charging pilot in the downtown core, with data available to the public for research and development
- Implementation and evaluation of static and dynamic inductive charging, with data available to the public for research and development.
- Opportunities in the downtown core include:
  - Designated areas for shared EVs (e.g., Zip Car, Uber, Lyft)
  - Parking spaces dedicated to EVs
  - Piloting of a dynamic inductive charging corridor through downtown
  - Residential parking spaces dedicated to EVs in high-rise condominiums
  - Installation of solar charging stations for the public and downtown workplace charging
  - Installation of traditional charging stations at downtown workplaces.

TECO is currently building an advanced communication network as a platform for communicating with sensors and automation technology across the city and supporting smart grid deployment in Tampa. The Vulcan funding can also support Tampa by providing this communication infrastructure for automating all 560 traffic signals to create a new advanced traffic management system, which will help Tampa in alleviating traffic congestion and lowering vehicular incidents, as well as reducing drive time, fuel usage, and carbon emissions.

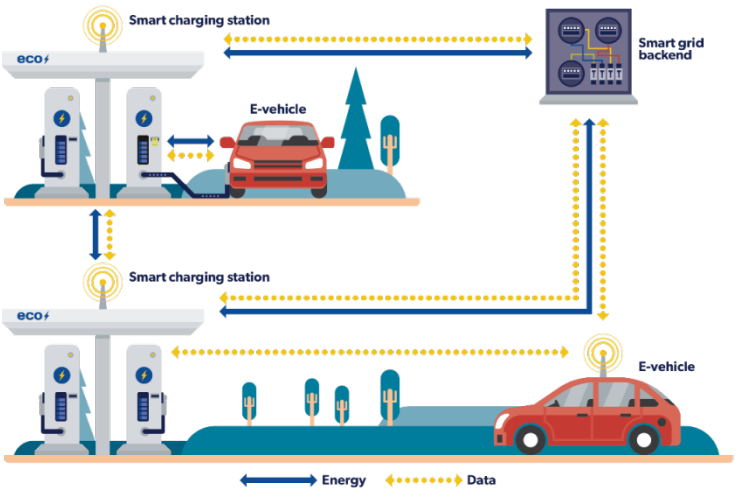

Figure 10: Electric Charging Stations Network

5.9 Vision Element #9: Connected, Involved Citizens

- Citizen-to-citizen (C2C) crowdsourcing platform
- Crowdsourced social events senior center shuttle

Lead Partners: waze, Booz Allen

5.9.1 Citizen-to-Citizen (C2C) Crowdsourcing Program

In partnership with Waze, Smart Tampa will create a new C2C Crowdsourcing program.

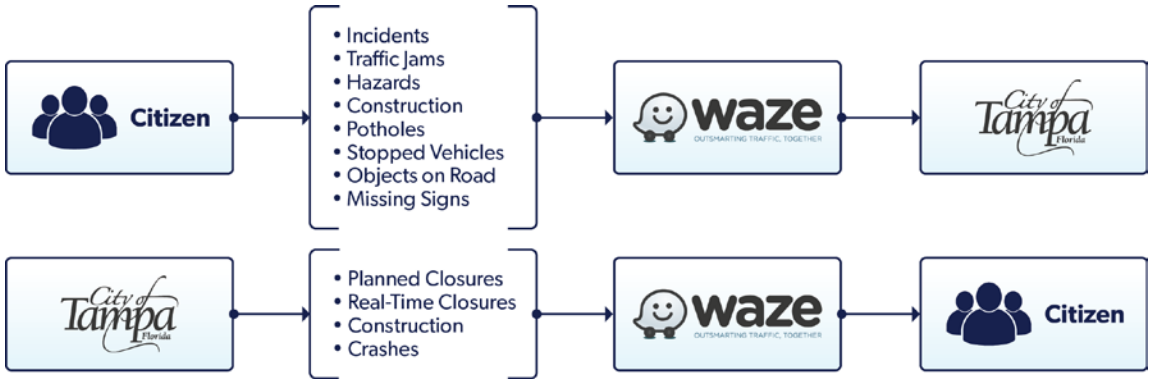

Figure 11: Citizen to Citizen Crowdsourcing of Information

In this program, Tampa will receive crowdsourced information generated by Waze users in Tampa. For example, every time a Waze user reports a pothole in the roadway, Tampa will be notified in real time. By storing this data, Tampa will be able to run sophisticated analytics (using the Urban Analytics platform) to determine the areas that show the most regularity in pothole reporting. With this added insight, Tampa could then make informed maintenance policy decisions. There are many possibilities because the crowdsourced data coming from Waze includes accidents, vehicles stopped on the road, hazards, flooding, and traffic jams, among others. Under its partnership with Tampa, Waze can share with drivers any city-owned open-data made available through its existing channels. Waze can also be leveraged as a form of direct communication with Tampa drivers by displaying events and incidents reported by Tampa.

5.9.2 Crowdsourced Social Events Senior Center Shuttle

In conjunction with the Urban Tampa Senior Center Dynamic Shuttle, Smart Tampa will add a crowdsourced social events concept. Using display screens in the common areas of each participating senior center, weekly events requiring shuttle travel will be displayed up to weeks in advance. This will enable senior center members to sign up for the events in advance. The dynamic shuttle will be routed by existing algorithms in the most efficient manner to drive all interested residents to and from events. Events will be scheduled in advance by senior center management, as well as proposed “on the fly” by senior center members themselves. These more impromptu events will be proposed by center residents and then displayed in real time at all participating centers. After a 2-hour sign-up window for the proposed event(s), if there was adequate demand for a shuttle, the event will be locked in and a shuttle will be deployed. If the event does not attract enough demand to warrant use of the dynamic shuttle, members will still have the option to use a

smaller paratransit vehicle. This approach introduces an aspect of social gamification among senior centers and aims to promote active lifestyles and social activity among senior center members.

5.10 Vision Element #10: Architecture and Standards

- Leverage CVRIA and SET-IT
- Identify and communicate gaps in existing interfaces/standards
- Support standards for urban automation, connected vehicles, sensor-based infrastructure, smart grid, user-focused mobility

Lead Partner

Booz Allen

Tampa endorses and embraces the challenges and rewards of using a standards-based reference architecture as the foundation for the Smart City solutions providing interoperability with other deployments and a consistent, reliable transportation experience for all users. As part of deploying the Smart Tampa concepts, Tampa and its partner Booz Allen are committed to developing interfaces using the CVRIA as the foundation, and new interfaces will be developed to the extent feasible, using existing networking, data, or other standards. All interfaces, current or new, will be specified through the SET-IT tool, and relevant feedback will be provided to the USDOT for incorporation into the CVRIA. Where gaps in functionality or necessary changes to existing standards are identified, or where the need for new standards are identified, these requirements will be specified and provided to the USDOT for possible coordination and remediation with relevant standards developing organizations (SDOs).

While the initial application of CVRIA and SET-IT have focused on connected vehicle and automated vehicle applications, Booz Allen will leverage its knowledge and experience with these USDOT assets, and extend the "platform" to integrate new and innovative Smart City solutions for Tampa, both within the ITS domain and for new use cases leveraging existing or emerging transportation domains such as smart grid integration and urban automation, logistics, and delivery. Booz Allen is fully committed to supporting the USDOT National Architecture Team as they integrate the CVRIA into the National Architecture and expand it to incorporate these and similar Smart City solutions.

Several of the vision elements (Urban Automation, Connected Vehicles, Sensor based Infrastructure, and Communications Technology) inherently have a strong baseline in terms of architecture and standards. Other vision elements, such as the *Smart Grid, Roadway Electrification, and Electric Vehicles* and the *User-focused Mobility Services and Choices,* have relevant or emerging standards that facilitate their adoption for Smart City solutions and eventual integration into the National ITS Architecture. For example, the USDOT and the U.S. Department of Energy (DOE) supported initiatives to develop relevant standards enabling the Smart Grid, Roadway Electrification, and Electric Vehicles vision element. The USDOT contributed to this joint effort through support for development and evolution of National Transportation Communications for ITS Protocol (NTCIP) standards, particularly in the area of Electrical and Lighting Management Systems, while the DOE supported electrical distribution standards through the National Institute of Standards and Technology's Smart Grid Interoperability Program, specifically with IEEE 1901-2010 and IEEE 2030-2011. To illustrate this in more depth, Tampa can examine the *User-focused Mobility Services and Choices* vision element where several data formats for open multimodal transportation data are now available in Tampa. For some modes

(e.g., fixed-route transit), these formats are well established, while standardized formats for other modes (bike share, flex route, crowd-sourcing) are still emerging. We will track such developments and adopt them as appropriate.

5.11 Vision Element #11: Low-Cost, Efficient, Secure and Resilient Information and Communications Technology (ICT)

- Cloud to eliminate capital expenditures and enable scalable computing
- Data governance to address privacy concerns
- Secure architecture for edge devices and back-end systems

Lead Partner

Booz Allen

Tampa's ICT infrastructure will be the enabling technology that captures sensor and other types of open data in real time, provides a processing environment to support multiple Smart City vision elements, and then disseminates the resulting information to targeted groups in the user community. Within the context of a Smart City, providing unrestricted and continuous public access to ever growing amounts of open data requires an ICT architecture that is capable of providing a resilient, scalable, secure, and affordable infrastructure. Therefore, in many respects, Tampa considers the ICT as a fourth utility alongside water, sewage, and electricity. The following describes key elements of Smart Tampa's ICT deployment strategy.

Tampa will leverage a public Cloud service provider to deploy core components of the ICT architecture since this option provides numerous advantages. Financially, the biggest advantage is the elimination of capital expenditures that would be destined to stand up a traditional in-house data center. From a technology perspective, the cloud option provides Tampa with a scalable computing capability that can be provisioned in a matter of a few hours and would be cost prohibitive if deployed in a Tampa-owned data center. The cloud environment also provides a greater amount of fault tolerance and failover than would be typically affordable in a Tampa-owned infrastructure (e.g., by providing load balancers and alternative data centers). From a software perspective, the ICT will leverage open standards to ensure interoperability with new sources of data as these become available in the future. Use of open standards is also important for Tampa, as it facilitates the use of Free and Open Source Software (FOSS) platforms when developing our Smart Tampa applications. Much of the Big Data software technology that will be central to the Urban Analytics capability, for example, can be deployed in clusters running FOSS software such as Hadoop and Spark.

In addition, Tampa will define data governance policies to address how data privacy issues will be handled within the Smart Tampa ICT, especially as these relate to PII. This is the case regardless of whether the data in question is streamed in real time within the ICT and/or stored to disk for subsequent analysis. Our team member Booz Allen has extensive experience in helping to define appropriate public sector data governance strategies and translate these policies into a framework capable of being implemented within the data center. For the USDOT's CV program, Booz Allen has designed and implemented a data cleansing capability in the Southeast Michigan Operational Data Environment (ODE) to ensure that real-time streaming data from CVs has been filtered pursuant to privacy policies.

Lastly, in the area of security, our ICT architecture will ensure that edge devices, such as sensors, can only connect to the ICT if they are trusted devices and known to be free of viruses/malware when connecting. Booz Allen's experience in developing the Security Credential Management System for the USDOT's CV program provides a strong background in securing one particular class of edge device (i.e., the CV). Within the ICT network itself, the team plans to deploy a continuous monitoring capability via an Intrusion Detection System to add an additional layer of security to the network.

5.12 Vision Element #12: Smart Land Use

- Shared parking app
- Meet-Up Bike and Walk to School or Work App
- Enhanced community participation tools

Lead Partner

TAMPA DOWNTOWN PARTNERSHIP

Tampa will demonstrate the power of connected technologies to shift people from cars and sprawl to vibrant, mixed-use nodes of development, by leveraging the existing transit and bike/pedestrian infrastructure. Our proposed concepts include:

- **Shared Parking App** – A parking option will be added to the IM-T application proposed in Vision Element #5, which identifies available parking within a certain distance of a user's destination. This includes both public parking and unused parking that is made available for public use by participating private businesses, thus contributing to more optimized use of available land and shared economy.
- **Meet-Up Bike and Walk to School or Work App** – Commuters can choose to meet up with a local group minutes before their departure. The mobile app identifies a nearby location for bicyclists or pedestrians to meet up and commute together, thus promoting walkable bicycle-friendly land use and public health.
- **Enhanced Community Participation** – A connected community participation tool to increase the public's awareness of, accessibility to, and input into Tampa's planning process, so that the community itself can help optimize the use of available transportation choices for improved access to employment, housing, education, and health services.

The above tools will be accessible to all community groups, including low-income, elderly, and veterans, through the use of smart phones and alternative methods (e.g., kiosks).

5.13 Integrated Approach for All Vision Elements

Figure 12 depicts Smart Tampa's holistic, integrated approach to implement the Smart City concepts described above. It illustrates how our demonstration concepts align with multiple vision elements, how they synergistically combine to address various challenges in Tampa, and how the various vision elements result in multiple benefits. Our approach will optimize the use of available Smart City Challenge funds to deploy and demonstrate solutions that can be transferred to other mid-sized cities across the country, and produce measurable impacts.

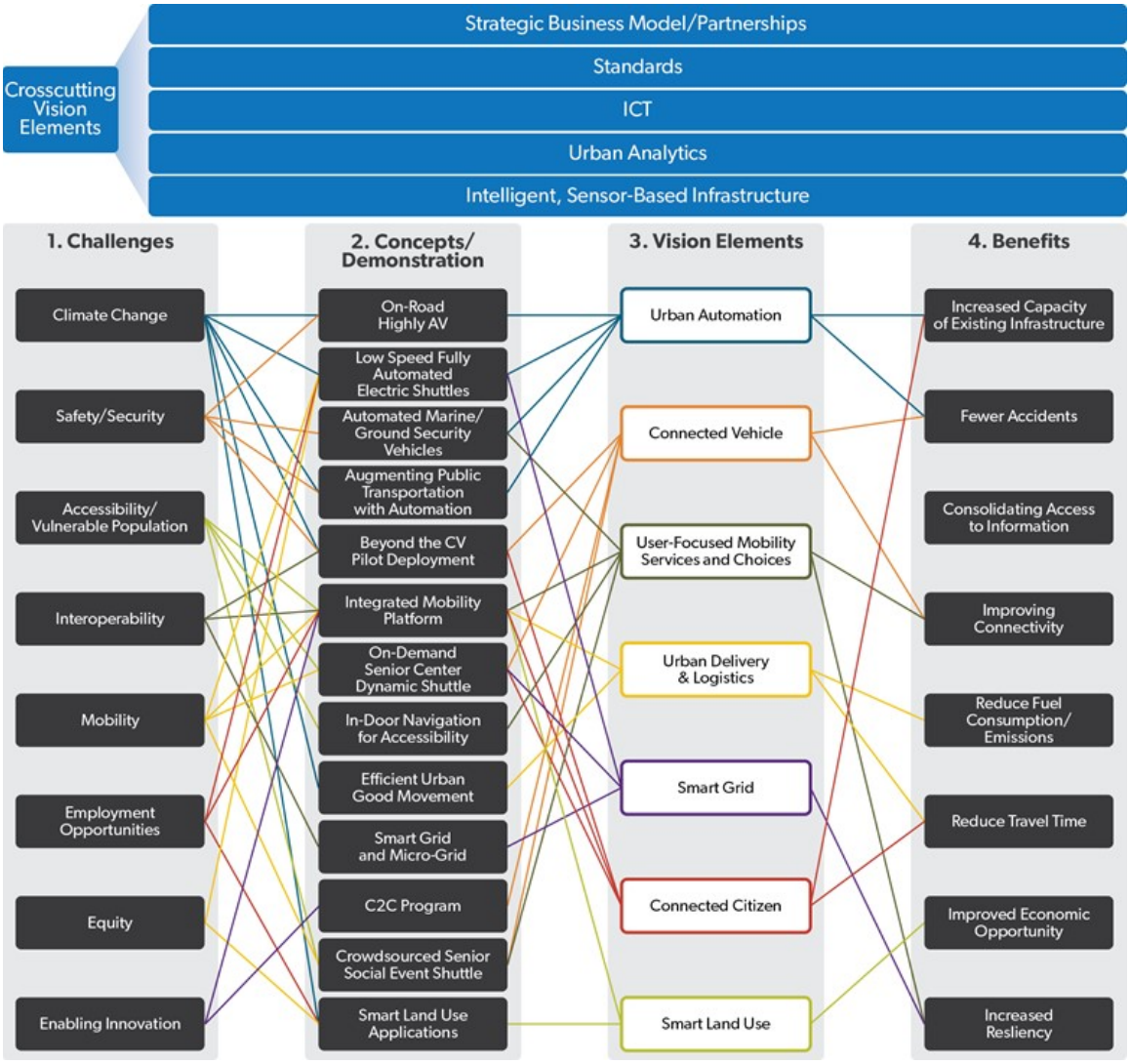

Figure 12: Holistic Integrated Approach Connecting Challenges, Concepts, and Benefits

6. RISKS ASSOCIATED WITH THE DEPLOYMENT VISION

Table 3 summarizes potential key risks associated with the deployment of our Smart Tampa concepts, along with their rating (High, Medium, and Low) and our proposed mitigation approaches.

Table 3: Potential Key Risks for Smart Tampa Concepts

Vision Element	Potential Risk	Mitigation Approach
	Technical	
Low cost, Efficient, Secure, and Resilient Information and Communications Technology	The security of automated and connected communications systems will continue to be a challenge for the foreseeable future (High).	Our team member Booz Allen will continue to engage with efforts to develop and implement robust cybersecurity solutions

Vision Element	Potential Risk	Mitigation Approach
Intelligent, Sensor-Based Infrastructure **Urban Analytics**	Erroneous sensor data poses a risk to quality of information and inappropriate decision support (Low).	The team will apply robust data validation techniques for eliminating erroneous data and producing and disseminating reliable information.
Smart Grid	EVs will place new loads on the electric system, which could exacerbate peak load issues (Low).	TECO will use a smart grid that communicates with charging infrastructure and vehicles to smooth peak loads.
Urban Analytics	Processing real-time data in time for it to be useful for various applications, and predictive and proactive strategies (Medium).	Leverage team members' experience in data analytics and processing, apply advanced analytics tools and techniques such as Bayesian Networks.
Policy / Institutional		
Smart Land Use	Emergence of new technologies change how local agencies operate and maintain transportation systems and require policy updates (High).	Promote strong intergovernmental coordination to fully embrace and integrate the technologies across the region.
Urban Automation	The regulatory uncertainty surrounding automated vehicle certification (Medium).	Leverage Florida's friendly regulatory environment and actively engage the USDOT and other agencies to develop robust certification procedures.
Urban Automation **Urban Delivery and Logistics**	Vehicle automation and ADAS systems are known to make transit and delivery workers uncomfortable. Employees are concerned with being monitored by technology deployments and potentially losing jobs from automation (High).	HART and TBARTA have developed methods for implementing driver assistance systems in ways that minimize operator non-compliance. Furthermore, all proposed solutions augment existing services instead of replacing services.
User-Focused Mobility Services and Choices **Connected, Involved Citizens**	Potential equity issues by excluding certain disadvantaged populations (Medium).	For citizens who don't own smartphones, kiosks and low-tech solutions will be provided. Accommodations will be made for differently abled individuals.
Strategic Business Models and Partnering Opportunities	Managing multiple partners can be challenging, and not all partners may participate throughout the period of performance (Medium).	Obtained commitment letters from each partner. All the partners will be actively engaged through regular communications, and managed through a committee of representatives from each lead partner. Identify alternative solution providers.

7. TEAM PARTNERS

The City of Tampa has assembled a strong team tailored to address the unique multimodal challenges of a rapidly growing coastal city. Few, if any, other teams could bundle together a port, an airport, a UTC, an FAA UAS COE core team member, an electric utility, SAE Level 3 automated traditional automobiles, SAE Level 5 automated low-speed vehicles, multimodal shared economy partners, and a deep bench of leading innovation firms. In total, **nine** City of Tampa departments have committed to executing the Smart Tampa vision. The effort will be led by the Mayor's Office through the Department of Transportation and Stormwater Services. Other departmental partners include the Contract Administration, Planning and Economic Development (includes the Tampa Convention Center), Logistics and Asset Management (Parking, Fleet, and Facilities Management), Parks and Recreation, Technology and Innovation, Revenue and Finance, Tampa Police Department, and Tampa

Fire Rescue. Table 4 lists our partners (in alphabetical order), the vision element(s) they will participate in, and a brief description of their contribution.

Table 4: Smart Tampa Partners

Partner	Vision Element	Description/ Contribution
AARP	5	Representing accessibility of aging demographic, training those that are not up to speed on newer technologies
Audi	1, 2	Connected/ automated vehicle original equipment manufacturer (OEM) providing vehicles, expertise, and testing support
Booz Allen	2, 4, 9, 10, 11, 12	Broad transportation and information systems expertise, contributor to many vision elements, program management support
Bosch	1	Leading automotive and automation technology Tier-1 supplier, providing automated vehicle solutions for BoSS
Coast Bike Share	5	Privately operated bike share partnering with TDP to expand service area and helping with integrated transportation information management system
ERAU	1	FAA UAS COE core member; transitioning transportation innovations from lab to market through research agreement; especially for marine, ground, and aerial unmanned/ automated vehicles
FDOT	1, 2	Implementing state transportation innovation, including partnership with HART and TBARTA existing Mobileye deployment on about 50 vehicles
HART	1, 5	Innovative public transportation agency; existing partnerships with FDOT to implement Mobileye systems, USF/CUTR for open data and accessibility; helping with integrated transportation information management system
Meridian	1	Low-speed connected/ automated vehicle OEM providing vehicles, expertise, open data, and certification guidance to public agencies
Siemens	3, 4, 9, 10	Leading smart city technology firm providing expertise
TDP	1, 2, 5, 7, 8, 12	Business model and partnership architect
TECO	8	Smart grid and alternative fuel vehicle deployment, PPP with Tampa on smart grid enabled ITS
TIA	1, 5	Implementing automated shuttle service and improving accessibility for vulnerable populations
Port Tampa Bay	1, 2, 6,	Deploying automated ground and marine vehicles
TBARTA	1, 5	Innovative public transportation agency; partnership with FDOT implementing Mobileye systems; developing integrated transportation information management system
THEA	1, 2	Expressway authority providing roadway access for automated vehicle deployments, and partnering on deploying CV applications
USF/CUTR	4,	USDOT UTC; transitioning transportation innovations from lab to market through research agreement, especially on open data and accessible transportation
vRide	5	Shared vehicle system helping with integrated transportation information management system

Partner	Vision Element	Description/ Contribution
Waze	5, 9, 12	Transportation information management firm helping with integrated transportation information management system
TSRC – U.C. Berkeley	4	Transitioning transportation innovations from lab to market through research agreement, especially for shared mobility and mobility on-demand
Zipcar	5, 8	Shared vehicle system helping with integrated transportation information management system

8. EXISTING TRANSPORTATION INFRASTRUCTURE

Section 3 of our proposal described Tampa's key transportation infrastructure elements, including freeways, arterials, transit services, shared-use mobility services, and Smart Grid and EV charging infrastructure. Additional information is provided below:

8.1 Information and Communication Technology (ICT)

In terms of communication technology, Tampa has completed upgrades to many of its key business systems using cloud-based, hosted infrastructure. Tampa has also deployed many other cloud-based systems for parking and public safety services. Over the next 3 years, Tampa's technology changes will include a migration to a new data center with support for Azure, Amazon, and other elastic computing resources. In addition, Tampa has put a premium on pursuing cloud-first, mobile-enabled business applications solutions when available to meet the demands of the city. Tampa also consolidated and replaced many of its planning, permitting, and neighborhood services business applications with the Accela line of products, all of which embrace full citizen access and move Tampa closer to an end-to-end digital business process.

8.2 ITS Infrastructure and Signals

Table 5 lists the number of signals and ITS infrastructure capabilities that exist in Tampa.

Table 5: Tampa's Signals and ITS Infrastructure Capabilities

■ Traffic Signals – 546	■ UPS – State Roads
■ Advanced Controllers – 69	■ LED Indications – Citywide
■ CCTV Cameras – 50	■ Legacy Copper Cable Network – 43 Sections
■ Fiber Optic Cable > 60 mi	■ Twisted Pair Copper > 250 mi
■ Communications Hubs - 3	■ Wireless Radios - 50

9. DATA NEEDS AND AVAILABILITY

In a data-rich smart-city environment, large amounts of data will be generated by CVs, citizens, infrastructure sensors, etc. Tampa aims to expand its existing open data, which currently hosts static data, to include new data sources as well as develop Application Program Interfaces (APIs) to provide access to real-time data feeds in a secure, privacy-focused environment. The new technologies and applications will be integrated to enable existing systems to also contribute to the open-data hub and encourage developers to use them for developing applications that can help

improve safety, enhance mobility, and address environmental issues. While our open data approach aims at providing source collected data in a timely format, the ICT systems will be designed to incorporate privacy and security safeguards. This will involve removing PII as well as providing enterprise-level software security to avoid system tampering.

9.1 Current and New Data Collection Efforts

Tampa currently offers an Open Data Share website that provides open access to Geographic Information Systems (GIS) shape-files on intersections, roadways, parks, etc. While this site provides a plethora of open data, they are static in nature. HART provides General Transit Feed Specifications (GTFS), GTFS-realtime, and Service Interface for Real-Time Information (SIRI)-formatted data that are used by developers to share real-time bus information. Additionally, the Hillsborough County Sheriff's Office provides an interactive real-time incident data tool that shows the incidents and their attendance status along with estimated clearance times. In addition to these, certain data at the county and state levels are openly shared under Data.gov website including water resource management, flood maps, etc. In terms of the existing data for the different mobility services, Zipcar supports a public API through which third-party sites and applications can access information about Zipcar, including: (1) Home locations of Zipcar vehicles (where the vehicles "live" when not in a trip), and (2) details about specific vehicles including make, model, color, size and type, and price. Coast Bike Share also provides an API in the standardized General Bike Share Feed Specification format for real-time bike rental availability. This type of data (and others) can be used in the development of the proposed platform IM-T (Vision Element #5), EV grid concept (Vision Element #8), and C2C program (Vision Element #9).

As part of the Smart City Challenge, we envision several new data collection efforts from various concepts to support the suite of proposed applications, as well as for the Urban Analytics platform in Vision Element #4. One of the key developments in this would be the creation of a data bus that can receive feeds from infrastructure-based sensors, CVs, probe vehicles and other sensors (weather stations, pavement sensors, etc.). The data bus will be developed in a scalable environment to ingest small and big data sources at varying resolutions to: (1) clean input data from errors and noise, (2) provide privacy protection tools, and (3) secure the system to avoid malicious input. The data bus is also envisioned to provide machine-readable, direct, real-time data APIs for use by public and private developers to improve transportation accessibility among the general public. The team is also working with crowdsourcing private partners such as Waze who could supplement the city-collected data using data provided by citizens.

Table 6 summarizes our preliminary assessment of data currently being collected and new data that needs to be collected for each vision element.

Table 6: Assessment of Vision Element Existing Data and Needs

Vision Elements	Data Existing	Data Needs
Urban Automation	• Traffic data along freeways and arterials • Priori Maps	• High-definition 3D maps • Real-time weather information • Localization
Connected Vehicles	• RDE • Weather Data Environment • Traffic signal information • Traffic data along existing roadway corridors	• Freight information • Pedestrian information

Vision Elements	Data Existing	Data Needs
Intelligent Sensor-based Infrastructure	• Bluetooth • Traffic data along existing roadway corridors	• Air / water quality information • Energy / water consumption • Pedestrian information
Urban Analytics	• RDE • Weather Data Environment • Traffic signal information • Traffic data along existing roadway corridors • Waze	• High-definition 3D maps • Real-time weather information • Localization • Air / water quality information • Energy / water consumption • Pedestrians information • Freight information • Pedestrian information
User-Focused Mobility Services and Choices	• RDE • Weather Data Environment • Traffic signal information • Traffic data along existing roadway corridors • HART schedules and route information	• Indoor localization • Information on senior citizens • Traveler choices • Payment information
Urban Delivery and Logistics	• RDE • Weather Data Environment • Traffic signal information • Traffic data along existing roadway corridors • Construction plans • Incident information • Waze • Route information	• Freight information • Localization and 3D Maps
Strategic Business Models and Partnering Opportunities	• Existing partnership agreements	• New partnership agreements • Data sharing agreements
Smart Grid, Roadway Electrification, and EVs	• Number of charging locations	• Real time energy consumption • Air quality
Connected Involved Citizens	• RDE • Weather Data Environment • Waze	• Accurate data • Number of citizens reporting data
Architecture and Standards	• Existing CVRIA	None
Low Cost, Efficient, Secure, and Resilient ICT	• RDE • Weather Data Environment • Traffic signal information • Traffic data along existing roadway corridors	• Security breaches • Performance measures
Smart Land Use	• Weather Data Environment • Traffic data along existing roadway corridors	• Real-time parking information • Air quality information

9.2 Transportation Data Integration

One of the key proposed initiatives is the data integration that aims to bring together data from multiple agencies within the same platform. Thus, data from Tampa's transportation infrastructure, county and city-run transit, taxi and other shared-use services, and bike-share, as well as other multi-modal data will be integrated into one single data hub. By doing so, Tampa intends to accelerate shared-use mobility, which can reduce congestion, improve mobility, and mitigate climate change issues without burdening travel time or cost. Additionally, data from our partners such as Waze and other TNCs can also be integrated to make these data hubs and secondary products user-friendly as a venue for the IM-T app. The data integration effort will:

1. Provide a one-stop location where all the data is accessible to users without registration and in a machine-readable format.
2. In addition to a specific format data, provide a developer portal that provides real-time query-able methods to build applications. By doing so, the team intends to expand the scope of analytic tools to support innovation from the developer community.
3. Provide assessment and evaluation logs for interested citizens to conduct independent analyses.

Data collection and software development activities will maximize participation of the third-party developer community and private industry by using permissive licenses such as Apache v2.0 and Open Data Commons.

9.3 Cross-Cutting Partnerships

By partnering with Waze, ZipCar, Coast Bike Share, vRide, and HART, the City of Tampa will be able to work more effectively in defining the most common hurdles that drivers in Tampa face daily. For example, Tampa could use Waze data to identify the corridors that are most prone to congestion. Using this information, Tampa could change the signal timing of adjacent roads to divert traffic into these adjacent roads and therefore reduce commuting time among the public.

10. ITS AND CONNECTED VEHICLE STANDARDS/ ARCHITECTURE

Section 5.10 of our proposal described our approach to using architectures, standards, and processes, as well as our plans for identifying and documenting new interfaces and cooperating with the SDOs to enhance existing standards or help develop new standards.

11. MEASURABLE GOALS AND OBJECTIVES FOR THE SMART CITY VISION

The Smart Tampa vision consists of several parallel deployments and projects that work in an intricate way to improve the mobility, safety, efficiency, air quality, and overall quality of life of residents and visitors. The team aims to set measurable goals and objectives for the entire program as well as for individual projects within it. The findings can be used to cross-check and document the benefits of these systems and as a baseline for other cities while prioritizing resources.

11.1 Performance Measures

The team will initiate five different types of performance measures to cover the key areas of transformation that will reflect the new Smart City investment. For individual projects, the team will estimate realistic goals for each of these areas; and thus, a fair comparison can be made after deployment. Tampa has a resourceful database to estimate several of these performance measures for pre-deployment evaluation. Not all deployments are intended to have measurable goals in all of the following categories. The data-rich environment will provide enough data to calculate the benefits of these deployments in the near term, as well as to estimate the benefits in the long term.

11.1.1 Safety Performance Measures

Many of the proposed tools and strategies involve enhancing the safety of travelers, both on the roadway and on the move. The team will use measures, such as crash rates, fatality rates, average time to clear incidents, and probability of secondary crashes, to estimate the improvement in safety due to the deployed applications and strategies. The team will also explore estimating surrogate safety measures to include indirect safety benefits such as number of insurance claims and red-light runs.

11.1.2 Mobility Performance Measures

Mobility measures such as vehicle miles traveled, vehicle hours traveled, number of trips, and vehicle occupancy will be used to evaluate how these systems enhance mobility in Tampa. Certain applications produce surrogate measures of mobility without actually impacting the direct measures. For example, a shared-use multi-modal trip planning application can improve the traveler's quality of traveling and perception of transit services by providing better information on arrivals, but may not improve the actual travel time.

11.1.3 Air Quality Performance Measures

Environmental quality is also quantified since several deployments are selected and designed to mitigate climate change issues. In addition to using environmental sensors, the team will use indirect methods to estimate these measures. For example, freeway speed differential logs between adjacent loop detectors can be used to estimate acceleration characteristics and estimate approximate emissions. The team will also use financial measures such as fuel sold and gas tax earned to estimate energy consumption.

11.1.4 Other Performance Measures

While the above three measures aim to quantitatively define or evaluate the deployments, the team will conduct alternate methods to measure improvement in quality of life, quality of travel, perceived infrastructure reliability, and other factors through voluntary citizen inputs sought through interviews and polls.

11.1.5 Benefit-Cost Assessment

The team will also supplement these assessments using benefit-cost analysis to quantify the breaking point of these investments by converting the performance measures to quantifiable dollars. The team has past experience in developing extensive benefit-cost analysis tools for different programs under the USDOT such as the Applications for the Environment: Real-Time Information Synthesis (AERIS) program and the Dynamic Mobility Applications (DMA)

program. Benefit-cost analysis documentation will be developed as a valuable tool for other cities in comparing the cost effectiveness of applications or deployments.

11.2 Post-Deployment Assessment

Contrary to typical post-deployment assessment, the Smart City assessment consists of multiple parallel deployments that could impact the performance measures in intrinsic ways. Several factors contribute to the biases when using the before-and-after data in conducting the analysis. For example, when RLVW and Eco-Approach and Departure applications are introduced (in Vision Element # 2) together on an arterial, it is difficult to estimate the contribution of each in reducing the congestion. For the proposed program, these biases can play an important role in classifying the assessment between different tools, applications, or strategies. Understanding this, the team will use empirical field data to perform the post-deployment assessment. From the experimental design, the team will work systematically to collect pre-deployment and post-deployment data as well as reduce the probabilities of parallel deployments impacting each other's assessment. The team will also use approaches such as correction factors and Bayes methods to reduce or eliminate exogenous factors from these assessments. Ultimately, the team will document the post-deployment assessment results so that other cities can use them to prioritize their deployments.

12. PAST PERFORMANCE (CAPABILITY EVIDENCE)

Tampa has a substantial history with implementing evidence-based approaches to achieve intended outcomes, such as "place-based strategies," to revitalize the urban core. By combining economic development, public improvements, and pedestrian and bicycle improvements, together with incentives to spur private sector investment, Tampa has been the steward of more than $1 billion over the past 10 years to foster an environment where jobs, housing, and walkable neighborhoods thrive.

Recently, under Mayor Bob Buckhorn's administration, the City of Tampa led or co-led several large federally funded initiatives, including *2012 HUD Choice Grant (Co-Applicant, $30 million in funding), 2013 TIGER Grant (Lead, $10.9 million in funding),* and *2012 Republican National Convention (Lead, $49 million in funding).* Also, Tampa was deemed a *2015 Promise Zone Second Round Finalist,* and will apply for the 2016 Promise Zone Round and a second HUD Choice Grant.

City officials are ***fully committed*** to executing the Smart Tampa vision and managing multiple public, non-profit, and private partners. The City of Tampa Revenue and Finance (R&F) Department *(RNC Grant Administrator)* will be tasked with oversight for all components of grant administration. The department consists of the Budget Office, Accounting Division, and a dedicated Grants section equipped with staff that are well versed on federal grant requirements and use best practices in grants administration. R&F staff will work closely with the Smart Tampa program team and management board to implement programmatic components of the plan and daily activities. Additional staff will be hired if necessary to ensure complete oversight for all project activities. All financial transactions, purchasing, and property inventory tracking will be maintained in Tampa's Oracle ERP System. However, data and performance management is administered by using several legacy systems citywide and manual processes. City officials will explore the creation of a data management system with the USF, review the purchase of comprehensive systems to manage a project such as eCivis (grants management/performance), or develop another solution.

13. OPPORTUNITES TO LEVERAGE FEDERAL RESOURCES

Tampa has made significant investments (over $240 million) to improve the livability of downtown, support the transformation of the surrounding neighborhoods connected to the business district, and spur economic development. The Smart City Challenge grant award to Tampa will foster closer relationships with federal, state, and local partners—creating more opportunities to align federal programs directly with local needs. Examples of existing partnerships and programs that will help in leveraging the USDOT's Smart City Challenge investment include the following:

Project Title	Total Funds	Funding Agency	Vison Element(s)
Airport ConRac/ APM project	**$500,000,000**	**USDOT, FDOT, Florida State appropriations**	**Urban Automation (#1)**
Description: The Consolidated Rental Car Center (ConRAC) and Automated People Mover (APM) projects include a 2.3 million square foot rental car center and 1.3-mile APM system connecting travelers from baggage claim areas to the ConRAC and the Economy Parking Garages. These areas are scheduled for completion in the fall of 2017. This system will be connected to the TIA **Meridian** automated shuttle service in Vision Element #1.			
Connected Vehicle Pilot	**$17,000,000**	**USDOT**	**Connected Vehicles (#2)**
Description: Tampa City has vast experience in CV projects through supporting multiple USDOT agencies. We currently lead one of three pilots awarded by the USDOT. The Smart City proposal will expand CV applications to include red light violation, eco-approach/departure, and FRATIS..			
Tampa STP Grant	**$196,908**	**USDOT**	**User Focused Mobility (#5) Strategic Partners (#7)**
Description: This USDOT Surface Transportation Program grant is being used by our partner **Tampa Downtown Partnership** to expand and improve Tampa transit (with partner **HART**), Bike Share (with partner **Coast Bike Share**), Car Share (with partner **ZipCar**), Wayfinding, and Outreach. These projects intersect with many of the projects in this proposal, including the low-speed electric shuttle program with **Meridian**.			
Advanced Traffic Management	**$10,732,736**	**FDOT, City of Tampa**	**Urban Analytics (#4) Smart Grid (#8)**
Description: The City of Tampa partnered with FDOT to improve the capability of traffic managers to monitor traffic flow by installing new traffic surveillance equipment to signalized intersections. This funding will create a public-private partnership, allowing Tampa and partner **Tampa Electric** to expand investments in leveraging the smart grid communications platform to enhance traffic management system environment and the electric grid.			
Enhancing Airport Wayfinding	**$460,000**	**ACRP**	**User Focused Mobility (#5)**
Description: This Airport Cooperative Research Program project funds **USF/CUTR** to address accessibility challenges for the elderly and persons with disabilities through indoor positioning systems used in Vision Element #5.			
Development of Waterfront	**$2,000,000,000**	**Strategic Property Partners, City of Tampa**	**Land Use (#12)**
Description: This overhaul of the Waterfront district will include sustainable, walkable, bike-friendly infrastructure, and sensors in parking garages. The Smart City Challenge funding will leverage this development.			