PART 1: Vision Narrative

submitted by SARTA
2/4/2016

0.0 Project Summary

In 1805, land surveyor Bezaleel Wells founded the City of Canton, OH (the City), naming it after China's fourth-largest city as a memorial to a long-time trader whom he deeply admired. As the founding place of the National Football League, home of 25th US President William McKinley, headquarters of what was once the world's largest watch-works, and the location of the largest brick/paver company in the region, Canton and its partners are today leveraging the region's unique and vibrant history into a new era of revitalization and growth. To this end, the Stark Area Regional Transit Authority (SARTA) – the Applicant – in partnership with the City and over a dozen design and implementation partners, is deeply committed to developing and deploying a data-driven, user-oriented, green, and integrated approach to managing transportation and public services.

Figure 1: The City of Canton maintains a rich and many-faceted history, and is the birthplace of the National Football League and the Professional Football Hall of Fame, which will soon undergo renovation into an amusement park-style Hall of Fame Village. The Project promises to deliver $14.7 billion in cumulative net total economic output, with over 8,200 visitors/day.

With planning and implementation support under DOT's Smart City grant, the project team will build on its existing regional leadership in renewable-powered, smart transit systems and services, to create a safer, more accessible, and optimized metropolitan area. In this way, selection and deployment of the Canton Smart City Program (Program or Project) will provide a flagship example for the redevelopment, reinvigoration, and greening of the Rust Belt, a region deeply in need of creative thinking, new ideas, and technological development.

SARTA and the City's vision for the Project seeks to deploy the proposed Smart City system by carefully and thoughtfully interfacing with SARTA's and the City's available assets and infrastructure. When complete, the Program will implement a Smart City system that is at once tailored to local needs, while deploying advanced technologies and systems that provide several categories of key benefits in line with DOT goals. With a strong focus on enhanced user experience, improved safety, and increased transit and energy efficiency, major facets of the Program will include:

- **Enhanced Connectivity.** The Program will take major steps to integrate and coordinate existing modes of public and personal transit, extending current systems by deploying infrastructure-based sensors, data tracking and management, and centralized information collection and management systems that will significantly enhance the quality of transportation service delivery, while also facilitating expansion into advanced coordination of delivery of goods and services. The Program will include a strong focus on enhancing transportation opportunities among existing and proposed infrastructure, including the Akron-Canton Airport, the Canton City core area, and the Professional Football Hall of Fame and proposed Hall of Fame Village.

- **Smart System Enabled Adaptability.** The Program will deploy advanced data management algorithms to allow transit systems to adapt to changes in demand, changes in traffic conditions, and other conditions such as environmental changes, ride-sharing, new forms of land-use, and multi-modal trip management to support adaptive system management, enabling strong improvements to efficient transportation.
- **Monitoring.** Under the Program, SARTA's and the City's transportation networks will be re-envisioned to operate as a single entity, capable of being monitored, to provide real-time status regarding the performance and operation of all modes of transportation at any given time.
- **Energy and Environmental Enhancement.** The Program will enhance, support, and fit into SARTA's existing and anticipated deployments of advanced low-emission and zero-emission vehicles, including the Midwest region's first deployment of hydrogen fuel cell buses, helping to further advance the agency as the regional leader in clean transit. The Program will also support the City's broader plans to provide and develop an integrated, environmentally sustainable, pleasant, and renewable-energy-based living environment with upgraded smart infrastructure.
- **Key Infrastructure and Facilities.** The Project will also include deployment of new key infrastructure and facilities targeted at enhancing transit and environmental/greening opportunities, including deployment of clean vehicle fleets, renewable energy systems, and updates to transit infrastructure.

In total, the Program will strongly support DOT's goals of enhancing mobility, improving safety, and addressing environmental concerns by reducing environmental footprints and greenhouse gas (GHG) emissions. The team will meet these goals by deploying a Smart City system that focuses on a balanced portfolio of technology vision elements (Advanced and Connected Vehicles, Smart Energy, Intelligent Sensor-Based Infrastructure, and Back-Office Infrastructure), smart city vision elements (Smart City Data Collection and Management, Smart Land-Use Management, and Smart Parking), and innovative approaches to urban transportation (Advanced Urban Analytics, Connected and Involved Citizens, Advanced Logistics Management, and User Experience Management).

Why Choose Canton?
NFL Hall of Fame Campus Proposed Expansion (est. 13,000 workers, 3,000 visitors/day)
William McKinley Presidential Library/National Monument
National First Ladies Library and Research Center
World-class hospital system
Five area universities
Early adopter/regional leader for alternative energy transit vehicles: 7 hydrogen fuel cell buses to be in operation by 2017
City size makes significant Smart City progress achievable
Manageable number of transportation service delivery agencies with existing and established working relationships
Existing/foundational smart systems and data collection/management
Strong environmental commitment and holistic planning approach
Existing well-planned bike lanes/paths provide alternative access throughout City
Management strongly supports Smart City development
City is currently revising its Comprehensive Plan for the first time in 50 years, providing opportunity for Smart City elements and features to be written into City plans for years to come

Table 1: Canton boasts a unique combination of infrastructure and historical resources that can be optimized with Smart City applications to support a vibrant tourist economy a user-friendly cityscape.

As shown in Table 1, the Canton Urbanized Area makes an ideal location for the proposed Smart Cities initiative. The Project would make a significant improvement to local transportation optimization, renewable energy, and city livability, while also providing strong support to the area's existing tourist industry. The project lends strong support to a significant planned expansion of the NFL Hall of Fame to encompass a theme-park like experience, which is expected to generate $14.7 billion in cumulative net economic benefit, bringing in 8,200 people per day to the Canton area. By interfacing with and supporting the Hall of Fame Village Project with smart city and smart transit systems, the Project will strongly support local economic development and tourism, while enabling showcasing of the proposed smart city systems and technologies to hundreds of thousands of visitors to the City each year in an unexpected yet pivotal location: a historic Rust Belt city fighting to revitalize and serve as a regional example of successful economic development, advanced service, and environmental sustainability.

NoFo Vision Element	Project Vision Element
1. Urban Automation	Data Management Centers; Advanced Connected/Green Vehicles; Autonomous Vehicles
2. Connected Vehicles	Data Management Centers; Advanced Connected and Green Vehicles; Advanced Connected and Green Vehicles; Advanced Traffic Management; Traffic Management
3. Intelligent, Sensor-Based Infrastructure	Data Management Centers; Advanced Connected and Green Vehicles; Intelligent Sensor-Based Infrastructure; Advanced Traffic Management; Traffic Management Initiative
4. Urban Analytics	Data Management Centers; Smart City Data; Advanced Urban Analytics; Advanced Logistics Management; Smart Apps and Crowdsourcing; User Experience Management
5. User-Focused Mobility Services & Choices	Data Management Centers; Smart Parking; Connected Involved Citizens; Advanced Logistics Management; Smart Apps and Crowdsourcing; User Experience Management
6. Urban Delivery and Logistics	Data Management Centers; Advanced Connected and Green Vehicles; Smart City Data; Traffic Management Initiative; Advanced Logistics Management
7. Strategic Business Models & Partnering	Information Services and Management; Connected Involved Citizens; Advanced Logistics Management; Smart Apps and Crowdsourcing
8. Smart Grid	Data Management Centers; Zero/Low-Emission Vehicles; Smart Energy/Smart Grid
9. Connected & Involved Citizens	Data Management Centers; Information Services and Management; Connected Involved Citizens; Smart Apps and Crowdsourcing; User Experience Management
10. Architecture/Standards	Section 10.1 Deployment per Existing Standards/Architectures; Section 9.0 Data
11. Secure Resilient Information Technology	Section 10.1 Deployment per Existing Standards, Architectures and Certification; Section 9.0 Data
12. Smart Land Use	Smart Land-Use Management; Smart Parking

Table 2: The proposed Project Vision Elements would overlay onto and address all NoFo Vision Elements

1.0 Canton Area Smart City Vision

1.1 Key Challenges Facing the Canton Area

Despite its rich history and status as the county seat of Stark County, Canton faces several critical challenges, many of which are typical of Rust Belt cities. Sluggish economic development has been perhaps the most central, long-term challenge for the City. While Canton is making meaningful progress toward recovery from a decades-long urban decline (1960s through the 1990s), the City and surrounding areas have still struggled to hold up what is left of their once-vital manufacturing base. For example, leading vacuum maker Hoover recently announced closure of its last remaining facility in North Canton, representing the final step in the company's withdrawal from its birthplace, where the upright vacuum cleaner was first manufactured. Other key challenges largely relate to the long-term loss of industry and resulting

changes in population dynamics and city infrastructure. Population in the City proper peaked in the 1950s at approximately 117,000, but has declined by 2% to 15% each decade since. This has resulted in several unique challenges, including excess but declining infrastructure, low road capacities, and urban center decay, including loss of retail enterprises. The City has also faced planning challenges while trying to support economic development, including growth of urban sprawl, and the razing of many historic structures and closing of services.

1.2 Proposed Smart City Elements Will Address Key Challenges

The Project will provide support to mitigating several of the Project team's key challenges. The Project will directly and strongly address what is likely the most critical challenge faced by the Project team – limited and/or sluggish economic development. The Project will carefully integrate with planned facilities and operations of the (separately proposed) Hall of Fame Village expansion project, which is expected to draw over 8,200 visitors per day, on average, to the City. The Project will provide transportation support and smart infrastructure designed to minimize travel burdens for Hall of Fame Village visitors, while also helping to link the proposed Village with retail centers and other attractions located in the City (National First Ladies Library, McKinley Presidential Museum and Monument, downtown shops and hotels, etc.). The Project will also support other efforts by the City to revitalize its downtown core, making transit throughout the City easier, more accessible, and safer for all parties involved. Outside of Canton, the Project will further support the availability of services to underserved populations, support connectivity among Project Area communities, thereby supporting economic development and revitalization across the Project Area, and also ease of transportation, making the Project a model within the region for smart city deployment and implementation.

1.3 Approach to Implementing and Operating the Demonstration Project

SARTA (the Applicant) and the City will work closely with CalStart together as team leaders to design and implement the Program. While SARTA working with CalStart will ultimately be responsible for overall grant administration (see Section 1.4), SARTA and the City will lead and coordinate partner agencies/technology providers during Program development and deployment, with strong project management support provided by CalStart. CalStart will also provide the key function of measuring the success of the Project. During an initial planning phase, SARTA and the City will work with other team partners to design the overall Project. Other team partners will carry responsibility for technical and integration aspects of the Project, according to their areas of specialty and/or needs. During Project operation, SARTA, CalStart, and the City will oversee and be responsible for all smart city functionality, equipment, and infrastructure within

their purview. Other team members – for example the Akron Canton Airport – may retain responsibility for limited functions within the smart city Program (i.e., on site data collection), within the Project's overarching collaborative framework.

1.4 Program Management Approach

The project will deploy a collaborative Program management approach, led by the Applicant, SARTA, working in close collaboration with the City of Canton, CalStart, and other Project partners. As an experienced manager of federal grant funding, SARTA boasts a strong background in grant program administration and implementation, with experienced staff and administration. SARTA also maintains a large geographic reach, which includes the entire urban area considered under the Program. Thus, SARTA will draw on its experience and geographic location as the ultimate administrator of the Program during the Program during both the planning and implementation phases. During the initial planning/Program development phase of the Project, SARTA's management team will work closely with City leadership and other team members to plan the proposed Program, finalize proposed design, and identify an implementation strategy for the Canton Smart City Program. During the deployment phase, SARTA and the City will collectively manage and oversee transportation and urban area infrastructure/management aspects of the Program, respectively. This structure will allow the team members to focus on their strengths: SARTA on deployment of transit oriented Program components, and the City on urban planning, traffic, and other urban-specific project aspects.

2.0 Canton Area Population Characteristics

The Canton Urbanized Area (Program Area) meets all conditions required by DOT in support of this application. Based on Census-designated place population figures from the 2010 census, the total population of the Program Area was 279,245, of which the City of Canton accounted for 73,007, or 26% of the total population in the Program Area. The Program Area includes 100% of the local urbanized area population, as defined by DOT. Additionally, the project area contains a dense urban core in the City of Canton, as typical for a mid-sized urban area in the US Midwest. SARTA maintains an existing public transportation system, which serves the entire Program Area (see Section 3.1 for additional detail).

3.0 Canton Infrastructure and Planning Elements

3.1 SARTA's Existing Public Transit System

Figure 3: SARTA Hydrogen Fuel Cell Bus Prototype.

SARTA maintains an extensive transit network that provides over 2.8 million rides each year in Stark County, Ohio. SARTA currently operates 34 fixed routes in Alliance, Akron, Canton, Cleveland, Hartville, Jackson Township, Louisville, Massillon, North Canton and Uniontown, with 79% of Stark County's population living within one-half mile of one of SARTA's fixed routes. In order to provide reliable service to as many as possible in Stark County, these fixed routes operate over 20 hours and more than 7,500 miles each day, Monday through Saturday. SARTA also deploys the special Proline program, targeted at individuals with

disabilities, who are unable to utilize SARTA's normal fixed-route system. This countywide service picks residents up at their residence (or required origin) and delivers them to their desired destinations. It is a crucial service for thousands of disabled individuals across Stark County. The organization also operates MedLine - non-medical transportation for eligible Medicaid Waiver holders, available through the Board of Development Disabilities, supporting employment, adult day support, and vocational training only.

As the Midwest's budding leader in the demonstration and deployment of efficient, clean vehicles and renewable energy technology, SARTA is actively seeking out and engaging advanced and environmentally friendly transit vehicle technologies. As recently as 2012, SARTA did not own a single low- or zero-emission transit vehicle. Today, SARTA's fleet of 100 vehicles includes 40 converted low-emission compressed natural gas (CNG)-powered transit buses and four low-emission diesel-electric hybrid transit buses. SARTA has also committed funding (totaling nearly $20 million) for 7 new hydrogen fuel cell buses, which will be deployed into fee service during 2016 and 2017. This growth in the fleet's low-emission vehicles represents SARTA's commitment to moving its entire fleet to low- and zero-emission vehicles through conversion and new vehicle acquisitions as existing diesel vehicles reach the end of their lifespans. In the near term, SARTA anticipates retaining only 25 diesel-powered transit buses, with the ultimate goal of a mostly zero-emissions fleet.

3.2 Amenability of the Area to Smart City Demonstration

SARTA and the City are highly amenable to Smart City demonstration and deployment. In addition to its commitment to environmental stewardship, SARTA as an agency actively supports deployment of smart systems and technologies within its service area. The agency has made a strong and growing commitment to deploying advanced data management and user interface systems within its existing transit infrastructure and transit operations. Since 2010, SARTA has implemented a suite of advanced data collection and management tools designed to optimize transit efficiency and enhance rider experience. These include: (1) PinPoint, a GPS system that enables riders to precisely estimate when fixed route buses will arrive at a given location; (2) GoLine, an online trip booking system used to book and optimize booking and routes for Proline trips; (3) Google Transit Interface, an online trip planning system for SARTA's fixed route services that helps users to optimize their route and tell passengers when buses will pick them up with 10 minutes; (4) System Map, which shows all of SARTA's fixed routes and their interconnection points; and (5) Travel Training, which trains riders how to most effectively use SARTA, how to read schedules, and how to use PinPoint. With the Project, SARTA is looking to expand on its existing experience with deploying smart technology to optimize transit systems and support enhanced user services. SARTA's efforts under the Project will build on existing infrastructure and data management systems, enabling an easy transition to the further deployment of smart city systems and technologies.

Figure 4. SARTA's existing PinPoint GPS system allows riders to get a precise estimate of bus arrival within its service area.

The City of Canton is also well-positioned to deploy new smart city technology to enhance transit, livability, and safety within the proposed Smart City Component areas. The City is, for the first time in 50 years, in the process of updating its Comprehensive Plan. This anticipated update will provide a new framework for the advancement of smart technologies and smart city systems as proposed under the Project. Additionally, Canton's planning staff and officials acknowledge the major potential economic, livability, safety, and environmental benefits of the Project, and strongly support deployment of the proposed Smart City system within the City.

3.3 Leadership Commitment and Capacity

As discussed in Section 3.2, SARTA and City leadership have shown a strong and continued commitment, including at the leadership level, to deployment of smart city systems and technologies; the Project will act as a natural extension and expansion of these existing activities, which SARTA and the City strongly embrace and commit to as a means to support economic growth, livability, safety, and service within the Program Area.

With respect to capacity, SARTA and CalStart maintain administrative staff with strong experience in grant administration and successful grant management. If awarded, SARTA and CalStart will allocate experienced staff time to the administration, management, and deployment of the proposed Canton Smart City Program, and commit to supplementing existing staff with training and/or new hires as needed to design and deploy the Program. The City of Canton also maintains extensive experience in grant program management and implementation, and has deployed a number of grants through the US Department of Housing and Urban Development, as well as other housing-oriented block grants. If awarded, the City will allocate staff with existing experience in grant program management and implementation. Similar to SARTA, the City commits to training staff and/or making new hires needed to design and implement the Program.

3.4 Sharing Economy Integration

The Project team acknowledges significant potential benefits associated with the burgeoning sharing economy in the United States. From streamlined and reduced cost transportation to peer-to-peer based sharing of goods and access to services, sharing economies can produce significant benefits for participants by reducing the costs and economic burden associated with the purchase of goods and services. Sharing economy integration in support of the Project will focus on transit-oriented services, namely data management and services to enable and facilitate ridesharing within the Program Area. Specific facets and implementation schemes for sharing economy integration will be investigated during the Project planning phase. Efforts will focus on improving and optimizing ridesharing opportunities, with a secondary focus on the transport and delivery of goods within the Concentrated Smart Vehicle Data and Communication Area.

3.5 Data Accessibility

Led by SARTA and the City, the Project team is deeply committed to supporting data accessibility and availability for appropriate use, while also maintaining user and personal and corporate privacy and safety as applicable. The Project team will share data internally as needed to deploy all proposed elements of the Program. Where appropriate, the Project team will also consider making data available, upon request, to outside public and private entities, where doing so would not expose proprietary information (for example as maintained by the United Parcel

SMART CITY CHALLENGE
CANTON PROJECT AREA

February 2016

1 in = 2 miles

0 1 2 4 Miles

Legend

- Canton Urbanized Area
- Proposed Smart City Component Areas
- Municipal Boundary
- SARTA Routes
  Proposed Smart Vehicle Data and Communication Corridors
- Existing Facilities to be Upgraded to Serve as Data Hubs for Smart Vehicle and Personal Devices
- State and National Bike Routes
- Lincoln Highway
  1st Transcontinential Highway
- Ohio & Erie Canalway
  America's Byway

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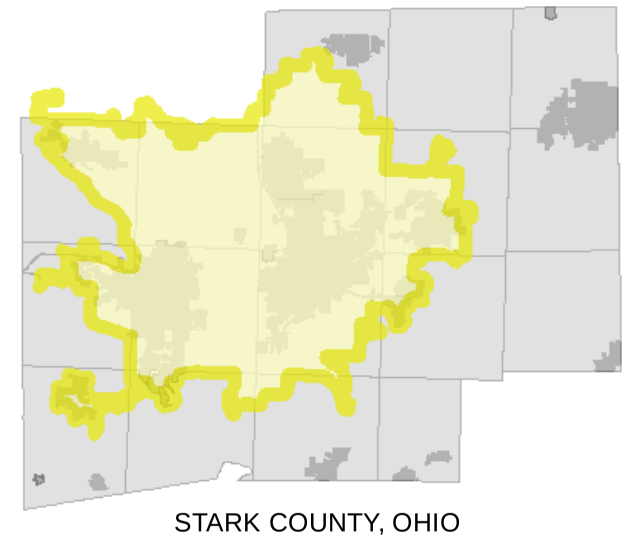
STATE OF OHIO, UNITED STATES



STARK COUNTY, OHIO

Akron-Canton Regional Airport

HOF Express Airport Loop

SARTA - Belden Village Transit Center

Canal Fulton City

North Canton City

Professional Football Hall of Fame Village

Concentrated Smart Vehicle Data and Communication Area (Canton City Limits)

Canton Engineering Headquarters

Intellengent Traffic System Control Center

Louisville City

HOF Express Autonomous Shuttle Loop

Canton City

HOF Express Downtown Loop

SARTA - Massillon Transit Center

The National First Ladies Library

William McKinley Presidential Museum & Monument

Massillon City

Canton Lincoln Highway Station

SARTA - Canton Transit Center

Smart City Intermodal Hub

SARTA Headquarters and CNG Fueling Facility

Hydrogen Fueling Facility

Stark Development Board Inc. Intermodal Facility

Wheeling & Lake Erie Railway

Canton City Water Reclamation Facility

Biodigester and Energy Production Facility

77 62 30

Service or other corporate participants) or jeopardize safety or security. If selected for funding, the Applicant will work with the remainder of the Project team and US DOT to develop a series of guidelines to govern the sharing of information collected during the course of Project deployment, also supporting open source ridesharing programs.

4.0 Preliminary Site Map

The project team has completed a Preliminary Site Map, which summarizes existing transit facilities operated by SARTA; points of interest that would be included in the proposed Smart City deployment; a Concentrated Smart Vehicle Data and Communication Area, where many facets of the Project would be deployed; and key proposed Program elements that would be deployed by the Project team.

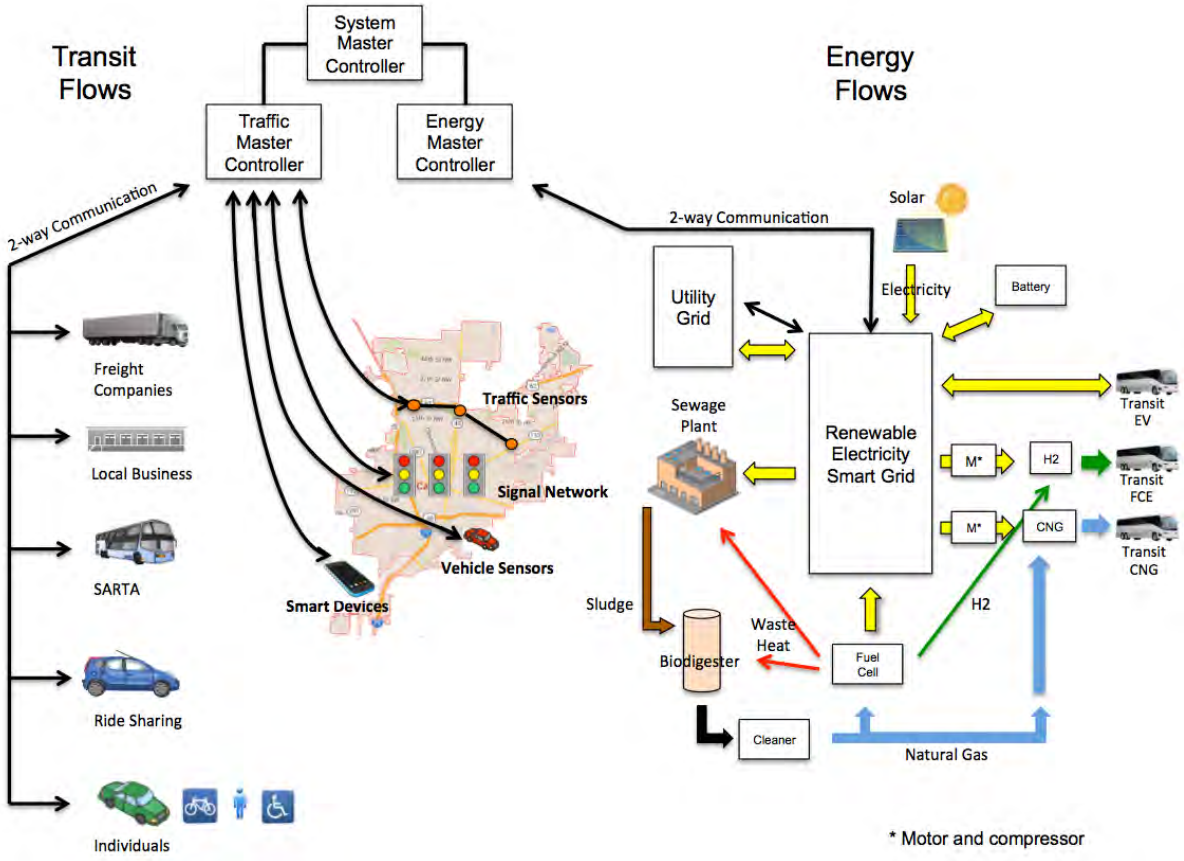


Figure 6: Vision Overview

5.2 Technology Vision Elements

Data Management Centers

Data management systems will provide the operational heart of the proposed smart city function and operation. As shown in Figure 6, the proposed data management centers will include a System Master Controller (SMC), a Traffic Master Controller (TMC), and an Energy Master Controller (EMC).

The SMC is a supervisory controller that will coordinate the work of the TMC and the EMC to manage both the transit and energy flows in the system in the best possible way. Data will be analyzed from the system to predict how to best configure both the movement of people and goods, and the movement of energy, so that the renewable energy that is produced is utilized to its best advantage, and people and goods are moved in ways that are the safest, most sustainable, least costly, and most convenient.

The TMC will draw on data and feedback provided by the proposed sensor/data collection system, via the SMC. It will implement advanced and flexible algorithms designed to optimize the movement of vehicles within the proposed smart city system. It will interface with SARTA's existing transit operations system, and will also provide feedback to other covered entities and operations, including interface with freight delivery and management corporations, local businesses, ride sharing infrastructures, and individual drivers and other individuals while they are utilizing the proposed smart city system.

The EMC will closely track and manage energy flows associated with the proposed microgrid system. The EMC will seek to configure the energy production (from the biodigester and solar array as applicable), energy storage (in the batteries on board charging vehicles, and in the proposed battery storage system), and energy utilization in such a way that the production and utilization of renewable energy is maximized. The EMC will also help to ensure that renewable energy in the form of hydrogen (H_2), natural gas (NG), and electricity is produced in sufficient quantities to meet the needs of the SARTA's transit vehicles, and that the maximum economic benefit is achieved from this system.

Back Office Infrastructure

A big data and transportation data analytics system will be developed and deployed in terms of hardware and software. This system will have the capability to ingest data from the multiple sources, including existing sensors, new sensors, nontraditional data sources, and external systems. It will have massively parallel processing capability to be able to handle the large data set involved and be able to bring data together into a single data hub using an advanced data platform. A discovery tool will also be deployed that would enable trends and patterns and insights to be developed from an integrated data set. These will all be linked through a unified data architecture to a data warehouse that will provide a long-term data storage facility. This will also be linked to and be coordinated with the EMC that will be controlling the production of renewable NG, H_2 and electricity, as well as energy storage and the interconnection of the smart grid with the utility grid.

Advanced, Connected, and Green Vehicles

Over the course of the Project, the team will deploy a smart transit system that will include a pilot fleet of advanced and connected vehicles, while also providing support for privately owned smart vehicles within SARTA's service area. The proposed vehicles and data collection systems will support SARTA's existing transit system, while enabling enhanced functionality including transit management, ridesharing, and enhanced safety for commuters, cyclists, and pedestrians. These vehicles will use dedicated short-range communication technologies, and will rely on existing and proposed sensory infrastructure to deliver information to drivers and extract probe data from enabled vehicles. The proposed vehicles will all employ vehicle-to-vehicle (V2V),

vehicle-to-infrastructure (V2I), accident avoidance, and green driving aid technologies. Green driving aids will assess traffic conditions and the status of traffic signals, and interface with the TMC to implement algorithms and vehicle management strategies that will minimize fuel

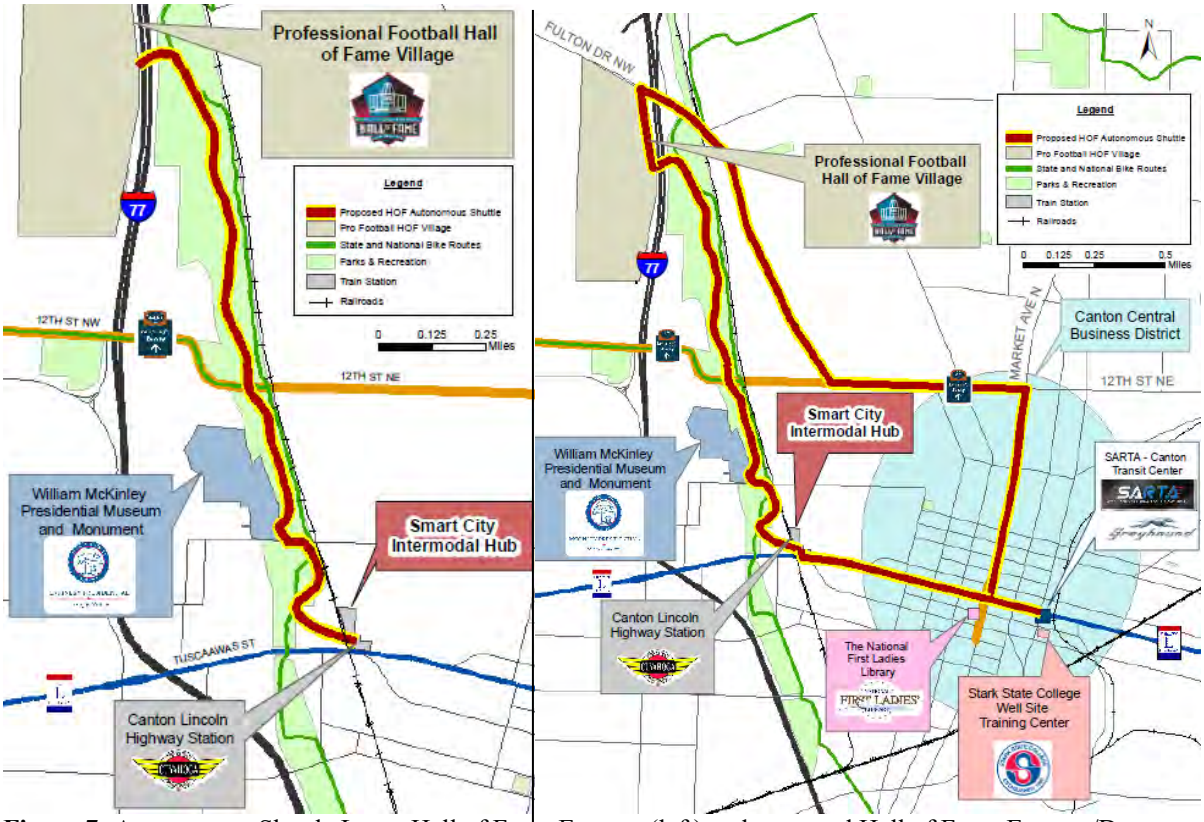


Figure 7: Autonomous Shuttle Loop: Hall of Fame Express (left) and proposed Hall of Fame Express/Downtown Loop (right)

consumption. Green driving advice will be displayed for drivers in a simple format, such as a green light to speed up, or a red light to coast, along with alternate route suggestions designed to minimize bottlenecks.

The Project will also seek to deploy additional advanced, clean vehicles and transit systems to support City operations. The City is looking to develop its own fleet of clean, low GHG emission, CNG vehicles, and would use the project as starting point for development of that fleet. Other potential infrastructure to be considered will include smart-design oriented facilities and equipment that would directly support the Project's goals as discussed in Section 11. For example, the Project will also add new SARTA service lines between the Airport, downtown Canton, and the proposed Hall of Fame Village, to provide enhanced user support/transit opportunities and to support development of the Hall of Fame Village Project. Additional proposed SARTA bus lines are also shown on the Project map (Figure 5)

Autonomous Vehicles

In addition to the proposed smart transit system, the Project will deploy an autonomous vehicle loop (Figure 7) that will include several of the Program Area's main attractions, including the Akron-Canton Airport, the Belden Village Commercial Area, the Professional Football Hall of Fame Village, Kent State University, and Stark State College, while also providing access to

Canton's downtown core area. These autonomous vehicles will be 12-passenger, battery electric vehicles that SARTA will operate along fixed routes on Park Drive, along an existing greenway. When not in use, these autonomous vehicles will be connected to the proposed smart-grid to support charging as well as grid energy storage functionality. Charging versus storage functionality will be determined adaptively by the proposed TMC and EMC systems, wherein the latter will manage renewable energy production and the smart grid system. All proposed autonomous vehicles would be battery electric, with charging stations open to the public.

Zero-Emission and Low-Emission Vehicles

The proposed smart transit system will make optimal use of zero- and low-emission vehicles by building on SARTA's fleet of 7 advanced hydrogen fuel cell buses (currently ordered with delivery to be completed by the end of 2017), plus 13 additional hydrogen fuel cell buses that will collectively represent one third of SARTA's bus fleet. Additional vans used in ridesharing in support of the Project will be deployed as CNG or battery electric vehicles, depending on the required duty cycle. Preliminary estimates completed by SARTA indicate that approximately one third of the ride sharing vans needed for the Project will be battery electric, and one third will be CNG-fueled. All proposed autonomous vehicles would be battery electric.

Smart Energy (Renewable Energy, GHG Reduction)

SARTA and the City collectively maintain several key infrastructure elements that, under the Project, will be deployed to support renewable energy production and smart energy generation and management. The City's existing, screen/membrane based sewage treatment facility currently collects and disposes of solid wastes from incoming flows. The City proposes to deploy a bio-digester system to utilize biosolids and other available organic feedstocks, via anaerobic digestion, to produce renewable natural gas (RNG). Once produced, RNG will be cleaned and used for at least one of the following purposes: (1) to be further cleaned and compressed for use as CNG in SARTA's existing fleet of CNG-fueled transit vehicles; or (2) to be routed to a high temperature molten carbonate fuel cell,[1] thereby generating generate electricity used to power the proposed smart grid and associated loads (see below regarding smart grid deployment), hydrogen for use as fuel for SARTA's growing fleet of hydrogen fuel cell buses, and waste heat to support wastewater treatment and/or other processes. In this way, the project will sharply reduce existing GHG emissions associated with the consumption of fossil fuel that SARTA currently uses to fuel its CNG and remaining diesel-fueled buses, by offsetting heat energy consumed during the wastewater treatment process and by reducing grid demand for loads to be attached to the proposed smart grid. The proposed digester will be located at or adjacent to the existing Canton sewage treatment facility.

Intelligent Sensor-Based Infrastructure

Building on the Canton Urbanized Area's base of extensive infrastructure-based sensors, this element will plan, design and deploy new intelligent sensors that will work in combination with existing sensors, while also interfacing with innovative crowdsourcing and motion analytics data collection techniques. The proposed intelligent sensor systems will be deployed in clusters

[1] As demonstrated by the University of California Irvine's Trigen Project.

around modal interchanges, and also dispersed in areas where existing gaps in sensor networks currently limit data collection efforts.

Advanced Traffic Management

The City's current/existing advanced traffic management initiative will be extended to include additional major corridors of demand that extend from the Akron-Canton airport to downtown Canton and associated hotels and commercial areas. This will include the deployment of adaptive, coordinated traffic signal control technology along with advanced sensors. Data will be used to manage the timing of smart signals, and will also be linked into the Project's Data Management Centers to support performance management of the entire trip chain.

5.2 Smart City Vision Elements

Smart City Data: Sources

The Project will rely on several key data sources to support the proposed systems. These will include: (1) Reliance on SARTA's and the City's existing data acquisition systems and infrastructure, as described in Section 9.0, as well as new data sources including (1) crowdsourcing (i.e., via smartphones); (2) infrastructure sensors; (3) probe vehicles; and (4) motion analytics. The Project will use these data, via the proposed data management centers and other applicable infrastructure, to meet the intended goals and objectives of the Project. If warranted, during the design phase of the Project, the team may elect to substitute or deploy additional data sources.

Private Car	Uber/Equivalent Ridesharing
Parking	Transit
Pedestrian	SuperShuttle
Cycle	Airport Shuttles
Air	Conventional Urban Transit
Rental Car	Autonomous Vehicle Loop
Taxi	

Table 3: Proposed Mode-Specific Data Collection

Smart City Data Collection and Management: Mode Specific and Interchange Data Collection

The Project will incorporate mode-specific data collection services in order to optimize transportation performance as well as information service delivery. The Project will address, at minimum, the modes shown in Table 3. Data will also be collected at key transit interchanges (Figure 6), to support optimization of transit systems while interfacing with ridesharing and other proposed elements.

Smart Land-Use Management

Land use has a significant impact on the demand for transportation, the ability to effectively and efficiently satisfy that demand, and on the livability of an urban environment. The City is in the process of updating its Comprehensive Plan for the first time in roughly 50 years. In the interim, while attempting to attract economic development, City planners permitted development of large areas of land with limited oversight – as urban sprawl. The City now recognizes critical benefits associated with smart land-use management, including support for a blossoming urban corridor, as well as potential for interface with other City goals, including deployment of green and smart technologies and systems. The planning process for the Project is expected to generate significant input and insight into how land use interplays with transportation demand. To best take advantage of this unique opportunity, the City proposes to cross-pollinate Project design

phase activities with the City's Comprehensive Plan update, enabling smart city-oriented goals, objectives, and policies to be deployed within the City's regular planning outlook.

From a data collection and analytics perspective, the proposed sensor-based and probe-based data collection system, combined with Smart City analytics capability, will allow the City to identify new insights into how land use affects transportation and city management. This information will help refine SARTA's and the City's future goals, beyond the Project, with respect to smart city planning and urban development. It will also empower the City and other cities in the region to define smart land-use policies that provide multiple benefits, including close interface with transportation infrastructure and optimization of service delivery. Ultimately, through efficient information connectivity proposed under the Project, the City will leverage its mobility hubs to provide better connectivity and a richer user experience overall, for both residents and visitors.

Smart Parking

The Project team will plan and deploy a smart parking system within the Canton downtown area. The proposed system will have event management capabilities, smart payment capabilities, and will provide a revenue management suite for parking operations. Smart parking will also support variable parking fees. Briefly, the system will deploy sensors as needed to evaluate parking demand in real time, and adjust price accordingly. Price adjustments could be made for the sole purpose of optimizing revenue, or also to encourage people to use alternate parking infrastructure during times of congestion.

5.3 Innovative Approaches to Urban Transportation Elements

Advanced Urban Analytics

The Project team recognizes that a much larger amount of data is now available regarding current operating conditions on the existing transportation network than is effectively utilized by the City or by the applicant. The cost of sensors has been reduced and the availability of crowdsourcing techniques, such as motion analytics and sentiment analysis of social media, is providing transportation practitioners with unparalleled insight. The impending tidal wave of connected vehicle data adds to this richness while providing challenges and opportunities for integration into smart city systems.

To get the very best from this new availability of data it will be necessary for a Smart City to adopt best-of-breed big data and data analytics techniques. This will involve going beyond data measurement and reporting into behavioral and predictive analytics, collaborative ideation, and, eventually, development of a "sentient city," all of which illustrate the underlying mechanisms affecting transportation performance. The Project will facilitate big data utilization and analytics through its proposed Integrated Data Warehouse and Unified Data Architecture systems (refer to Section 9.2), which will be deployed in coordination with the proposed SMC, TMC, and EMC.

Traffic Management Initiative

A proposed traffic management initiative will expand on Canton's existing traffic management initiative, by providing sophisticated traffic controllers linked by telecommunications to the central TMC. These roadside devices will be capable of managing traffic signal timings,

collecting traffic data and collecting data from smart devices and other data sources. This will be extended to include major corridors of demand from the airport to downtown Canton and hotels. The system will also include deployment of adaptive, coordinated traffic signal control technology and advanced sensors to enable the collection of data to drive smart traffic signal timing. This system will also be expected to provide a feed into the data management system for overall performance management of the whole trip chain.

Information Services and Management

Mode specific information services deployed under the Project will provide real-time decision quality input and choices to travelers in a context-sensitive manner. Utilizing physical and computing infrastructure proposed under the SMC and TMC, the proposed context-sensitive system will take account of current mode of travel, location, and other conditions that affect travel. On modes within the total trip chain, information services will be delivered to enhance the user experience and provide decision quality input to the traveler. It is expected that these will include, at minimum, the following:

- User engagement to involve users in the smart city system at the outset of a trip, and to continue to contribute user-generated content (including reviews, helpful tips for fellow travelers, feedback on local businesses and services, etc.) through the end of their trips;
- Opportunities to engage service providers in dialogue;
- Location- and mode-specific services;
- Travel information including cost of travel, timing, reliability, and optional modes and routes;
- Travel time on current mode and options.

At interchange nodes within the total trip chain, information services will be delivered to enhance the user experience and provide decision quality input to the traveler. It is expected that functionality at service nodes will include similar services to those identified for mode specific information, above.

Smart Grid

As shown in Figure 6, the Project will deploy an integrated smart grid, which will build on SARTA's and the City's existing infrastructure, and existing advanced, energy-efficient transit systems. The proposed anaerobic bio-digester, located at the City's existing sewage plant, will be the primary source of renewable energy to the smart grid, which would also include utility grid power connection, an optional solar array having a capacity in the hundreds of kilowatts, and optional battery storage. The smart grid will connect these power sources to the existing sewage plant, to the recharging station for the battery electric autonomous vehicles, and to ridesharing service vans. Hydrogen from the proposed fuel cell (see prior discussion) will be transported, via pipe, to SARTA's hydrogen fueling station, while refined renewable CNG will be compressed and deployed at SARTA's existing CNG fueling stations.

Smart grid functionality will allow the proposed battery-electric vehicle charging center to use charging electric vehicles as a temporary source of power, which would be sent back onto the

smart-grid during periods of high utility demand. The smart grid will have a control system (the EMC, described above), which will configure the energy production, storage (in compressed hydrogen, CNG, and optional batteries both on the smart-grid and in the charging battery electric vehicles), and energy exchanged on the utility grid, so as to maximize the benefit to the transit system. The EMC will coordinate closely with the TMC and weather and traffic predictions to develop a strategy for energy production, storage, and exchange with the utility grid.

Connected, Involved Citizens

Recent statistics show that more than 90% of people have access to a cell phone and that more than 60% of the cell phones are capable of operating as a smart phone. For example, it is possible to purchase a track phone from Walmart for $10 with full voice, text and Internet access capabilities. It is becoming obvious that the cell phone and a smart phone are becoming powerful tools in connecting and involving citizens. It is expected that the Project will feature extensive use of these devices for both information delivery and for probe data collection techniques in order to gain a detailed understanding of people movements and the use of the various modes within the multimodal travel chain. It is also expected that citizen and visitor sentiment with regard to their transportation experiences will be measured on a continuous basis using the same devices.

Advanced Logistics Management

A significant proportion of urban transportation demand is generated by the need to move goods around the City. An efficient smart city will be able to sense and understand the ebb and flow of freight delivery and logistics demand and provide insight in how to optimize this element of transportation. The Project will partner with private companies, including UPS and FedEx, and possibly other service providers such as the US Postal Service (USPS). Facilitating urban delivery and logistics means addressing and even anticipating the bottlenecks and pinch points in the current system, something that can be better understood in terms of the related data. An urban freight delivery project will be conducted in close association with FedEx and UPS. The objectives of the urban freight delivery project will be to take full advantage of new data, combined with data available from FedEx and UPS, and to make use of the analytics capability of the back office infrastructure. This project will result in new insights into optimum routing and timing for the routes taken by urban freight delivery and Utica shale support vehicles.

Smart Apps and Crowdsourcing

An expanded range of smart apps will be developed to provide enhanced basic services and pay-as-you-go premium services (i.e., initially focusing on parking and transportation services, with potential for expansion to other services over time), as well as services to reach out to the underserved. The proposed smart apps will interface with and/or expand on SARTA's existing suite of transit oriented apps, and will also support social sentiment analysis to determine traveler satisfaction on a continuous basis. The proposed data management system (see prior discussion) design and interface will explicitly consider the requirements of smart phone app developers with respect to ease of accessing a logical data hub on which to build their services. The apps will also help to link the underserved with aid groups such as foundations helping specific portions of the underserved community, as well as public aid. Smart apps will also be

incorporated into crowdsourcing data collection efforts, to help acquire critical data related to current mode of travel and current travel conditions.

User Experience Management

A specific focus will be placed on the use of data and analytics and the new understanding of the total trip chain to optimize user experience through a variety of management techniques. It is expected that these management techniques will use information delivery via smart phone and other information display devices, connected vehicle technology and will address both the rectification and mitigation of associated issues.

6.0 Risks and Risk Management

The team has designed the Project to minimize risk as practicable. Nonetheless, some degree of risk is unavoidable. Key areas of risk include technical risk, policy risk, and institutional risks associated with deployment of the proposed Project/vision.

Technical risks of the Project can be broken into two primary categories: risks associated with reliance on and interfacing with existing infrastructure (existing tech risks), and risks associated with the proposed infrastructure and systems/operations (potential tech risks). Existing tech risks stem from the proposed reliance on systems that may be founded on older standards or older infrastructure, and which may not be fully compatible with the proposed system. Based on a preliminary review of available infrastructure, the Project team anticipates that these types of risk will be limited. SARTA's existing data management, tracking, and clean energy equipment and systems are up-to-date, fully functional, and are expected to be compatible with the proposed infrastructure and systems. The Project team will further minimize risk by completing a compatibility review for all existing and proposed systems during the Project design phase. The City's data systems are somewhat older, but are expected to maintain interface capability with Teradata's proposed systems (see Section 7, below). Potential tech risks are related to the potential for failure of proposed systems due to deficiencies or inadequacies in the proposed equipment, or improper planning and deployment of the proposed equipment. The Project will minimize these potential risks through continued reliance on commercially available and tested/proven infrastructure and data collection and management systems. Additionally, the team will vet all proposed technologies during the design phase.

Policy risks relevant to the Project are limited. Ohio does not presently maintain restrictions or guidance on the deployment of unmanned vehicles, as is the case in some states. City and SARTA policy are considered favorable to deployment of the Project, which is strongly in line with the goals and objectives proposed under SARTA's current 5-year plan. City policies and planning are currently under revision (under a separate initiative), and the City plans to use the design phase of the Project to fully evaluate and update City policies to ensure compatibility with the proposed Project, as warranted. Where unanticipated conflicts or deficiencies in policy are identified for SARTA or the City, both entities are committed to deploying the Project, and would work quickly to alleviate such issues.

Institutional risks for the Project team would also be limited. The Project would align very closely with SARTA's existing strategic direction (as discussed above and in Section 12.1), and

also with the City's charge to support economic development, safety, and environmental sustainability. The Project would not include elements that would conflict with or interfere with institutional governance or management. While the Project would involve participation by universities (see Section 7.1), equipment and facilities would be deployed almost entirely off-campus and without being owned or operated by a university, minimizing potential for institutional risks. Although institutional risks are anticipated to be minimal, the project would complete a thorough review of potential institutional risks during the Project design phase, in order to ensure compatibility. Any potential risks identified would be minimized in collaboration with DOT as warranted.

7.0 Partnership

7.1 Team Partners and Stakeholders

The Project would involve a diverse team of public entities, private corporations, and university/research organizations that would collaborate to design and deploy the proposed Project. Final roles of each project team member and partner will be definitively finalized during the initial planning process. Nonetheless, the following list of partners and stakeholders provides an inventory of Project participants, while highlighting anticipated roles. Key team partners and stakeholders include:

SARTA

As the local transit agency and lead applicant, SARTA will play a significant role in the development and operation of the Program. SARTA maintains a long-term, forward-looking commitment to deploying smart systems, including smart and low/no emission vehicles, as well as intelligent interfaces designed to support ease of use/user convenience, system optimization, energy savings, and deployment of enhanced services to underserved communities. SARTA will also make available provide transit and other data that it collects under existing conditions, and under the proposed Project, for use by the proposed Data Management Centers. SARTA maintains a long-term commitment to deploying advanced transit technologies and systems, and is already establishing itself as a leader and regional hub for the integration and deployment of clean transit systems, having successfully won $8.9 million in prior federal grant funding in 2014. SARTA is currently pursuing additional grant funding from a number of sources and strategic partnerships. Finally, SARTA is committed to providing outreach and services to the underrepresented. The primary population that SARTA serves maintains an income of under $17,000 per year, and over half of SARTA's ridership is of African-American descent. For more about SARTA's existing transit system, see Section 3.1.

City of Canton

Canton maintains extensive experience in effectively administering, and rapidly and successfully deploying federal grant programs, including homeowner support programs through the US Department of Housing and Urban Development (HUD), as well as community development block grant and emergency solutions grant programs. Canton maintains a wide array of existing public services and infrastructure, described throughout this proposal, which it will bring to support the Project.

During the planning and deployment phases of the Project, the City will work closely with SARTA to help manage development and implementation of the Project, while also coordinating internal resources and supporting outreach and collaboration with other Project partners.

CalStart

CalStart is a national strategic broker for the clean and smart transportation industry, dedicated to growth of a clean transportation industry that will create high quality economic opportunities, reduce GHG emissions, and support smart growth and infrastructure development. CalStart oversees and manages tens of millions of dollars in grant funds each year, and will provide administration support and documentation of benefits/successes for the Project.

Ohio Department of Transportation (DOT)

The Ohio DOT oversees transportation-related infrastructure within the state. Ohio DOT supports conventional automotive transit, as well as smart transit solutions, including but not limited to enhancement of bicycling and other alternative transportation opportunities. As relevant to the Project, the Ohio DOT is expected to play a significant advisory and regulatory role in all surface transportation elements of the Project. It is envisioned that Ohio DOT will also provide traffic and other transportation data, which will be fed into the proposed data management system.

Akron-Canton Airport

Akron-Canton Airport is a commercial airport serving the Project area and greater vicinity, located approximately 10 miles northwest of Canton. In operation since World War II, the airport currently serves primarily as a regional passenger airport. The Airport is in the process of implementing a 10-year, $110-million Capital Improvement Plan, which will culminate in 2018. Akron-Canton Airport will be expected to provide data with regard to aircraft arrivals and the flow of travelers to and from the airport, to support multi-modal travel management under the Project. The airport will also be expected to play an active role in the understanding and enhancement of the user experience through the airport phase of user trips.

Ohio State University (OSU) and Additional Public Partners and Stakeholders

The Ohio State University, Center for Automotive Research (OSU-CAR) is an acknowledged international expert in sustainable mobility, active since the 1970s. OSU-CAR will support ITS and will also contribute Big Data management, data sensors, data analytics, ride sharing, electric vehicles, and renewable energy deployment. Other public partners and stakeholders include the Ohio State University, Kent State University Stark, and Stark State College.

NFL Hall of Fame

The NFL Hall of Fame is the focal tourist attraction in the City. The organization is currently in the process of planning a major expansion which, as discussed elsewhere in this proposal, will deploy an amusement-park-like Hall of Fame Village focused on providing in-person and interactive experiences to incoming visitors on one centralized campus. As such, the Hall of Fame will require careful

planning and integration with the proposed smart city system, relying on public and private transit opportunities as well as parking services to support its proposed use. Transportation will be a critical element for the Hall of Fame Village's employees and visitors, and will play into visitors' first experiences of the updated Hall of Fame campus. Within the Project the organization will be expected to provide data and also play a significant role in enhancing the user experience. As a private sector organization it will also be expected that this partner will be seeking to identify ways to monetize the detailed understanding of the trip and to end user experience, to better support tourism at its facility and in the region generally.

Airline Partners

Willing airline partners will be solicited during the planning phase of the Project, for incorporation into the Project team. Airlines will be expected to provide data about aircraft schedules and status, as well as the flow of travelers into and out of the Canton system. The airlines will play an active role in the understanding and enhancement of the user experience through the airline phase of the trip and through user reservation and related research.

Verizon

Verizon will be expected to provide data plus communication infrastructure required to collect probe data from both vehicles and pedestrians, transmitting this data back to a central location for use by the data management systems in support of the Project. The Project team may also work with Verizon to acquire additional user location and other available data, as available and as needed in support of the Project. As a private sector company, Verizon will also be expected to identify ways to monetize the new insights and information regarding overall trip experience

Teradata

Teradata is a global leader in the deployment, analysis, and utilization of Big Data, specializing in deploying big data analytics, as well as data warehousing and integration with existing and proposed data sources. Teradata will provide the primary smart city technology needed to integrate the proposed data sets from the various stages and elements of the Project, through the overall end-to-end trip, and the adaptive "sentient" capability required of a smart city. Teradata will also provide the professional services required to extract, transform and load data into a central repository, and manage new big data resources that will grow even during the duration of Program deployment. The company will also provide a total hardware and software solution enabling the data to be managed and analytics and discovery activities to be conducted on the integrated data set. During the Project planning process, Teradata will work closely with SARTA, the City, and other Project team members to design a feasible and high-benefit smart city system, in line with DOT proposed benefits.

Freight Carriers

The smart transit system will coordinate closely with freight carriers such as UPS, FedEx, and USPS to ensure that goods, as well as people, can move through the system efficiently as well as safely. By coordinating human trips with the planned movement of goods, all parties will benefit. Thus, freight carrier cooperation is strongly supported, because the TMC will be able to provide guidance on how to effectively plan trip deliveries. Human transit will benefit through being able

to coordinate and optimize trips with the movement of goods. In addition, the movement of freight can garner some signal priority consideration (enhancing signal length when possible to aid delivery vehicles). Finally, freight carriers can make excellent use of the full data set, applying their own analytics to determine better ways to complete their individual missions.

	City of Canton	Akron - Canton Airport	Ohio DOT	SARTA	NFL HOF	Airlines	Verizon	Teradata
Connected vehicles			□					
Intelligent sensor-based infrastructure	□	□	□	□		□	□	
Smart parking	□	□			□			
Advanced traffic management	□		□					
Back office infrastructure			□				□	□
Crowdsourcing					□		□	
Smart apps					□		□	
Urban freight delivery	□							
Smart land-use management								□
Interchange information	□	□	□	□	□	□	□	
Interchange data collection	□	□	□	□	□	□	□	
Mode specific data collection		□	□	□	□	□		
User experience management	□		□	□		□		
Performance management	□	□	□	□		□		
System engineering			□					
Urban automation and smart vehicles	□				□			
Hydrogen fuel cell buses				□				

Table 4: Roles and Responsibilities

7.2 Demonstration Governance Process

As the Project applicant, SARTA will ultimately be responsible for the implementation and success of the Project. However, the Project team recognizes that each team member will carry explicit responsibility in deploying the Project. Chief among these, along with SARTA, is the City of Canton, which oversees deployment and governance of all non-SARTA facilities located within its boundary. One key strength of the Project is that it will involve stakeholders; however, governance of shared resources can prove challenging. The Project's structure carefully considers this potential challenge in light of local conditions. SARTA already manages transit systems throughout the entire Project area, thereby providing a cohesive governance entity for applicable facilities across the Project area. Remaining non-transit facilities will remain under the control of the local agencies where applicable physical facilities and equipment are located, but shared status will be maintained through contractual agreements or equivalent, as applicable.

7.3 Public and Private Partnerships and University Research

Lead by SARTA and supported by the City, the Project will rely on extensive partnering among the proposed Project team, as shown above. During the Project development phase, team leaders will solicit input from all team members to flesh out the details of the proposed vision for the Project. University partners listed above have already expressed interest in collaborating as part of the Project team, or in an advisory role in support of the Project, and their roles will be refined and more closely defined during the initial design phase. Moving to deployment, SARTA and the City will also work closely with team members to develop specific partnership structures that

will be deployed upon Project initiation. If the Project is ultimately selected for deployment, the team will implement the proposed partnerships to collectively support deployment of the proposed Project. The team will also seek out opportunities to incorporate university research and/or learning opportunities where possible.

8.0 Existing Transportation Infrastructure

The Canton Urbanized Area (the Project Area) maintains a total of 272 miles of arterials, 79.5 miles of freeway, and a transit service promulgated by SARTA that includes 34 fixed routes plus shared-use mobility services (see Section 3.1 for additional detail). SARTA maintains existing Intelligent Transportation Systems (ITS) and Intelligent Communication Technology (ICT), including transportation management centers and field equipment within its existing service area, supporting its existing operations, as discussed in Section 3.2. There is no smart grid or electric vehicle charging infrastructure within the Program Area, although SARTA is completing construction of an advanced hydrogen fueling station designed to support its fleet of advanced fuel cell buses, which will be deployed starting in late 2016.

9.0 Available Data

9.1 Data currently collected by SARTA and the City

SARTA currently collects a substantial amount of real-time data on its existing transit fleet and operations. SARTA uses these data to help commuters to use SARTA's services more effectively, and also to provide a means for internal tracking and optimization of SARTA systems and operation. Data collected by SARTA currently includes real-time speed and location information for each transit vehicle in SARTA's service; passenger counts as they enter and exit buses; point-to-point vehicle tracking; data collected through automated phone user interfaces, which allow ride reservations through SARTA's accessibility programs; bus scheduling information; and data that allows for optimization of pickup, drop-off, and routes for accessibility services. The City currently collects data from its existing signalized intersections.

9.2 Data Sharing and Use, Candidate Data, and Cross-Cutting Partnerships

The Project team's current data collection, storage and analysis functions are conducted on an agency-by-agency basis. This has created disjointed data silos, reducing the potential for data sharing and collaboration among agencies and potential smart city participants. Worse yet, because these data silos are created for use by individual agencies, data in the silos is transformed by standard business practices applicable to each. Where collaboration and data sharing is needed, for example to support multimodal travel, or development of mobility hubs that incorporate needs of urban freight and logistics, these silos remain on the sidelines. In contrast, the Program will require flexibility to connect data at a level of detail that has been lost through agency specific practices.

Best-practices in data management will center on the creation of Integrated Data Warehouses (IDW), which will enable development of new data-driven services by acting as a functional repository that allows query by any user at any time. Agency-specific business practices can be integrated into the IDW, and data is stored only once while being available for use many times for different purposes. Under the Program, a logical IDW will support the collection and

verification of data from all sources across the smart city including sensor-based, probe-based and transit-vehicle-based data sources. It will enable data to be utilized from systems such as existing advanced traffic management and electronic payment systems, and also from nontraditional data sources beyond transportation, such as smart card transactions and smart electricity grid management systems.

The Unified Data Architecture (UDA) shown in Figure 8 is recognized by information technology analysts as best practice for enterprises that are centered on creating value from data, such as smart cities. The logical IDW acts as both a data hub and a data lake, providing the capability for all source data integration and the information distribution required by local transportation partners and private sector partners.

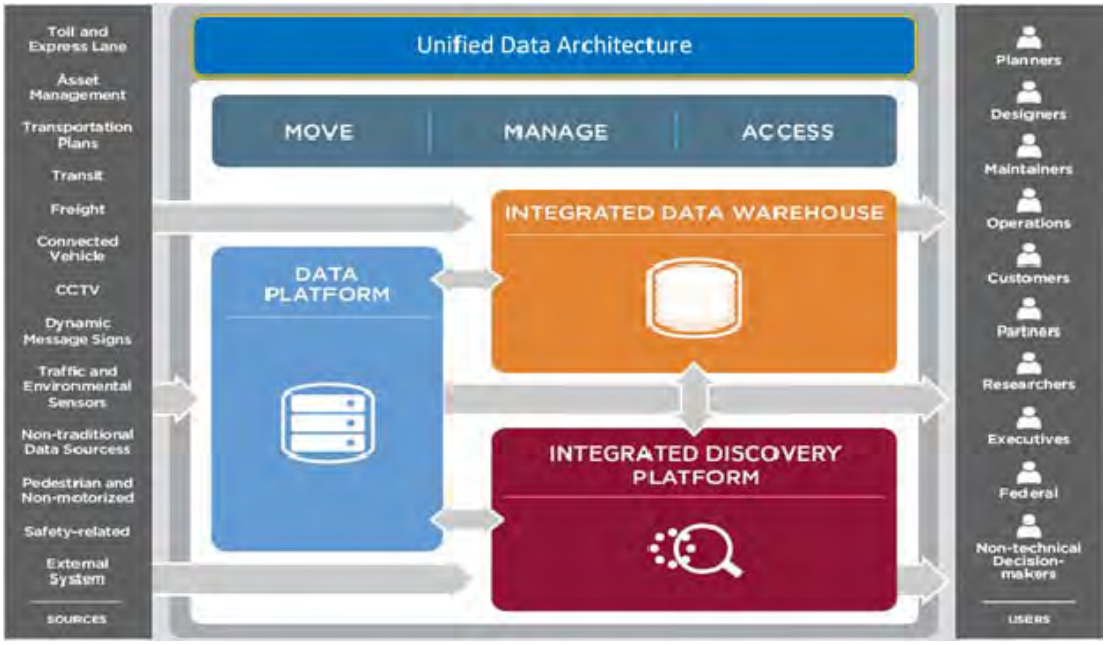


Figure 8: Proposed Data Management Architecture

The proposed logical IDW/UDA system represents a critical advancement in data management for the Project team, extending far beyond the simple integration of data by providing a means for facilities and managers to capture and utilize unstructured data sources from the Internet of Things, as well as mobile and consumer/commercial Internet applications. Within the proposed architecture, the proposed data platform supports the ingestion and verification of data from many sources, while allowing discovery of trends and patterns in the data and analytics to guide planning, Project delivery, and operations and maintenance for the smart city. Collectively the UDA system will provide a secure, coherent framework for integrating data and distributing data with one logical data infrastructure, the UDA will provide a framework for maximizing the utility of data collected in support of the Project, including supporting key goals of improved safety, efficiency, or customer experience using real-time data analytics techniques to provide fast insights and management flexibility. Additionally, the proposed integrated system will break down existing barriers among team partners by enabling cohesive use of the system, replacing current individual and disjointed data management systems. The proposed system will strongly

facilitate cross-cutting partnerships in support of data sharing, primarily between the City and SARTA, but also among project team members including universities and private partnerships.

9.3 Data Integration

The proposed logical IDW/UDA described above will facilitate data use for variety of applications under the Project. Ultimate details regarding data use and utility, in light of a new collaboration-oriented data management system, require planning level input from Project team partners, and will be determined during the planning phase of the Project. Nonetheless, the Project team anticipates that transit data will be used not only to optimize transportation systems under the Project, but also to deploy safety measures and enhance services provided by SARTA and the City. Other data, including crowdsourcing and other available data, would also be integrated into the proposed TMS, to further support Project goals.

9.4 Policies

The City does not currently maintain Comprehensive Plan policies relating to the collection, management, or sharing of data under the Project. Nonetheless, as described previously, the City is presently in the process of updating its milestone Comprehensive Plan, providing opportunity to implement additional guidelines and policies relevant to support smart city deployment.

9.5 Candidate Data for Sharing

Key targets for data sharing (i.e., candidate data) will focus primarily on transit-related data, which is relevant the City and SARTA, as well as many of the other Project team members. Certain data subcategories, however, will remain proprietary. For example, sharing of parcel delivery and management data, where it overlays with or mimics data currently collected by UPS and other parcel delivery partners, may be restricted in order to protect proprietary information managed by those entities. Other candidates for data sharing will include data used to support enhanced user safety, as well as energy management.

9.6 Data Integrity, Sharing Procedure, and Policies

The proposed Unified Data Architecture will feature a defense-in-depth approach to information security. Combining this approach with an integrated data warehouse (IDW) reduces the automatic dispersion of data storage and minimizes unintentional release of data, while increasing the overall effectiveness and manageability of a comprehensive security program. When data is in an IDW, security efforts can be focused and easily monitored and maintained without the risk of weaknesses in a single uncontrolled database exposing the entire enterprise environment to risk. Security features will include: user-level security controls, increased user authentication, support for security roles, enterprise directory, integration, network traffic encryption, and auditing and monitoring controls.

10.0 ITS and Connected Vehicle Technologies

10.1 Deployment Per Existing Standards, Architectures, and Certification

To harness the highest value from technologies, services, and products, the Project planning phase will include development of a framework that explains how the various elements will fit together and will work together to achieve the objectives. This will involve the development of a

smart city architecture, supported by a capability maturity model that will provide details regarding Project implementation and deployment. The framework will also define the standards to be incorporated into the Project. These will include connected vehicle standards that are currently developing for transit signal priority, freight, and emergency vehicle applications. Current standards will be deployed, including traffic management data dictionary and the SAE J1708/J1587 standard for transit vehicle area networks. Vehicle safety applications that use V2V and V2I communications will make use of secure, wireless interfaces facilitated by DSRC. Standards that have already been identified that will be adopted for DSRC elements include the IEEE 802.11p amendment for wireless access in vehicular environments (WAVE); the IEEE 1609.2, 1609.3, and 1609.4 standards for Security, Network Services and Multi-Channel Operation; the SAE J2735 Message Set Dictionary; and the emerging SAE J2945.1 Communication Minimum Performance Requirements standard.

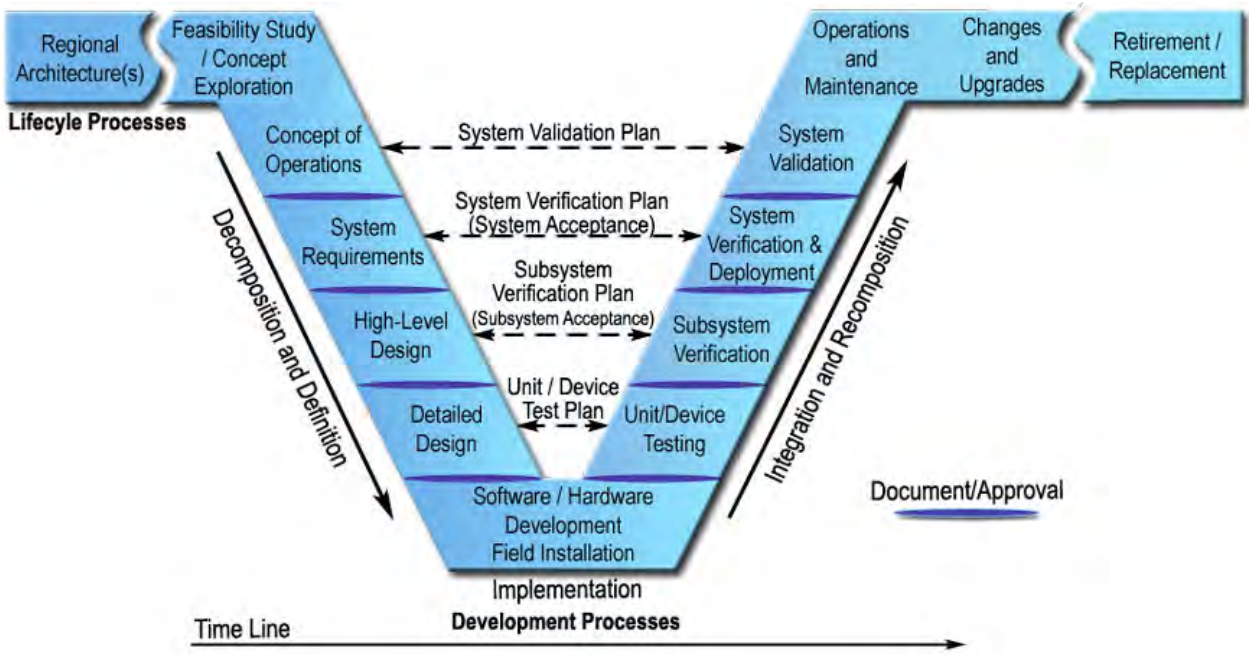


Figure 9: System Engineering and Planning Approach.

The Project team recognizes that standards development activity is dynamic, and that currently available standards for many smart city technologies and systems are fluid and still developing. One ongoing facet of the Project will be to review emerging and available standards on a periodic basis, so that the latest versions may be incorporated as relevant into further development of the proposed smart city elements, as relevant and to the extent practicable.

All system engineering and planning associated with the project will be conducted in accordance with Federal Highway Administration rules 940.1 through 940.13 and Federal Transit Administration policy as published in the Federal Register: January 8, 2001 (volume 66, number 5, pages 1455 to 1459). This will involve the application of a formal structured system engineering approach, making use of the process illustrated in Figure 9. The activities and work products defined therein will be resourced/developed as Project's system engineering approach.

10.2 Standards Improvement

The Project team will document experiences with deploying the frameworks identified under item 10.1 in support of the Project, as part of its reporting to the DOT under the Project. Reporting will identify any observed deficits in applicable standards, to ultimately help industry and standards developers to define and/or refine existing and future standards. The Project team will focus on lessons learned while deploying applicable standards, especially those in the early phases of development. In addition to providing this information to DOT, the Project team will make this information available to standards developers upon request and approval.

11.0 Program Goals and Objectives

The mission statement for the Project includes the following major goals and objectives:

- Develop a data-driven understanding of the complete multimodal trip chain from origin to destination for visitors arriving in Canton;
- Develop trip chain multimodal performance management approaches based on this understanding, using the latest in data collection and analytics techniques to provide world-class user experience across the trip chain;
- Define and implement a coherent, integrated framework of technologies, products and services that will be supported by suitable commercial and organizational arrangements; implement the smart city system in a collaborative and sustainable manner, not simply creating a collection of unrelated projects;
- Maximize social equity by providing enhanced basic services as well as premium transit services on a fee basis;
- Strongly encourage and facilitate participation of small businesses and disadvantaged business entities (DBEs) in the proposed smart city system;
- Deliver the maximum value in terms of enhanced user experience, improved safety and increased efficiency in the transportation service delivery for the Canton region;
- Obtain maximum leverage from the Project team's previous investments in transportation and transportation management systems by using these as the foundation for the Smart City transportation approach;
- Develop a renewable energy strategy to supply the transit system, enabling low to no emissions from well to wheels, not just at the tail pipe;
- Develop a microgrid system to enhance energy management and utilization within the Project area;
- Use automated, intelligent, and connected vehicles to enhance mobility, improve safety, and reduce emissions;
- Use/deploy zero-emission (electric and hydrogen fuel cell) and low-emission (CNG) vehicles to move the city onto an environmentally sustainable path with reduced to zero carbon emissions and reduced to zero pollutant (NOx, CO, particulates, etc.) emissions;
- Reach out to the underserved, so that the aging, handicapped, and poor can have enhanced and high-quality mobility at the lowest cost to the user and the taxpayer;
- Facilitate the movement of goods and people in the Program Area through the use of data collection, and traffic coordination and management;

- Integrate and facilitate the sharing economy into the smart cities design to enhance the efficient movement of goods and people while reducing transit costs, increasing safety, and reducing emissions;
- Implement features of intelligent and connected vehicles to promote safety (including the enhanced safety of the movement of emergency vehicles through the city), enhanced mobility of people and goods, and reduced energy consumption and emissions including: green drivers aid, V2V and V2I communications, and accident avoidance systems;
- Develop transit-oriented development standards as well as data management and other smart city-related standards, to integrate with and support the City's Comprehensive Plan;
- Develop a smart city vision with a holistic approach that integrates efficient transit, an environmentally conscious urban plan, the ability to walk and bicycle safely, renewable energy production, energy conservation, and zero carbon and air pollutant emissions into a plan that can put Canton on the path to economic revitalization.

While satisfying the above goals and objectives, the Project will also provide a world-class showcase opportunity that will take advantage of the presence of hundreds of thousands of visitors to Canton every year, exposing them to smart city transportation and management technology as well as providing superb service to our citizens and businesses.

12.0 Applicant and City Capacity for Project Deployment

12.1 Executive Commitment

The Project applicant has demonstrated strong executive level commitment to the Project, and to deploying a Smart City within its service area, in collaboration with the proposed team. SARTA's board has passed a resolution to submit this grant application, and to wholly support the Project. Additionally, the Project represents a furthering of SARTA's existing goals of developing data integrated transit systems that safely serve underprivileged and other citizens within its service area. Specifically, the Project would enable SARTA to further enhance its key services, while also supporting deployment of additional renewable energy use for transit, as well as other technologies and systems as proposed. SARTA aims to become the regional leader in clean transit, as well as service through smart systems deployment and implementation, and the Project would strongly support SARTA's goals and objectives, as defined within its Five Year Development Plan.[2] Finally, SARTA has already received an Ohio grant for coordination, and the organization is moving forward with a transit review for the Hall of Fame Village regardless of the outcome of this grant application. The City also strongly supports the Project at the executive level, and is in the process of passing a resolution that will strongly support the Project, including its initial design phase, and its implementation, if the award is received.

12.2 Workforce Capacity

As the Applicant, SARTA maintains a strong commitment to deploying the project, including at the day-to-day management and implementation level. SARTA's existing staff carry strong experience in grant management, deployment, and administration, and maintain sufficient capacity to deploy the initial planning phase of the grant. If the deployment grant is awarded, SARTA plans to commit existing staff to deploying the Project, yet recognizes that additional

[2] http://www.sartaonline.com/transit-development-plan-tdp-2015

staff may be needed in order to install and operate all aspects of the Project. SARTA will assess the potential need for additional staff during the Project design phase, and will acquire additional staff, or retrain existing staff, as needed to support the Project. The City also maintains a strong commitment the project, and plans to commit staff with relevant engineering and design, leadership, and grant administration and deployment experience in support of the Project. Staff would be initially sourced from existing, qualified City resources. However, the City will also consider hiring additional, qualified staff as needed for deployment of the full Project, if awarded. The City will evaluate available and anticipated staffing needs during the design phase of the Project, and will incorporate additional hiring as warranted if full funding is received.

12.3 Infrastructure Readiness

SARTA's existing infrastructure is discussed in Sections 3.1 and 3.2, above. Briefly, SARTA maintains a fleet of 100 transit vehicles, including 40 converted low-emission CNG vehicles, plus a minimum of 7 additional hydrogen fuel cell vehicles that will be deployed by the close of 2017. SARTA's transit vehicles are data-enabled, and include GPS and feedback functionality. Other relevant SARTA infrastructure includes an existing centralized data management system that interfaces with and supports SARTA's user services (see Section 3.2, above). SARTA also maintains infrastructure and computing power dedicated to system optimization and optimal, real-time tracking and management of its fleet of transit vehicles. These elements are deployed via SARTA's transit centers, located in the City core, Massillon, and Belden Village. Finally, SARTA owns and operates a CNG fueling station for its fleet of natural gas vehicles, which is slated to be upgraded to a combined CNG/hydrogen facility in the near future. The City employs data collection and management functions within its municipal boundaries, including signal monitoring and optimization abilities. The City also maintains ownership and operation of its existing sewage treatment facility, and associated infrastructure and electrical systems, which would be modified under the Project. The Project vision has been carefully designed to interface with and expand on these elements, to be cohesive with existing facilities, while providing additional and enhanced smart systems functionality. Thus the Project will incorporate available infrastructure into the proposed smart city system. A preliminary review of available infrastructure and proposed technologies indicates that available infrastructure could be utilized to support the proposed smart systems. This will be confirmed during the Project planning phase.

12.4 Data Performance and Management

SARTA and the City will maintain overall oversight of data performance and management, as they do currently. However, the two entities will be supported by Project partner Teradata through deployment of the Project. Teradata's IDW (see Section 9.2) system boasts linear scalability (by adding physical machines linearly with growth in data), low cost of ownership, and high reliability needed to support growth in data volumes. Teradata's UDA (see Section 9.2) deploys industry-leading best practices for data performance and management, specifically designed for rapidly emerging new data sources, as would be deployed under the Project. Teradata's three-tier architecture which separates the tasks of (1) loading data, (2) structuring it in such a way that any query can be supported for any user at any time, and (3) enabling any agency to develop a specific view for its purposes with its rules. The Project team anticipates that this will allow Project participants to create data-driven applications that draw on the data of the entire enterprise, by loading it once and using it many times, avoiding the need for multiple environments each with its own performance service levels and management costs. Maintaining

one single source copy of enterprise data is consistent with applicable standards, while creating new sources of value from the white space that frequently exists between data silos. The proposed UDA augments the best practice IDW with the Data Platform environment, where any data can be captured/managed at low cost, and the Discovery Platform, which is tailored for linking data across the data platform and integrated data warehouse.

13.0 Other Financial Resources

The Project team is committed to advancing infrastructure and pursuing smart city systems in the Project area. To this end, the team is already aggressively seeking and securing additional outside funding, that will ultimately support Project implementation and deployment. The City and SARTA view the Project as a potential planning device for their operations and future development, and plan to seek additional funds to support that vision. The Project team and anticipates that in-kind match may be available, in the form of labor and/or facilities that would be forwarded by the Project team. With respect to additional cash funding, SARTA has already secured $8.9 million in prior federal grant funding in 2014, which is supporting deployment of advanced hydrogen fuel cell vehicles, to be deployed alongside the Project, and utilized by the Project. SARTA has also received grant commitments totaling $4 million from the Ohio DOT, $5.4 million from the National Fuel Cell Program, and $2 million from the Federal Transit Authority section 5307. SARTA is also in the process of pursuing several additional sources of grant funding, including through strategic partnerships with Ohio State University, as well as public/private partnerships relating to the deployment of advanced clean transit technologies.

Various other potential funding mechanisms may be available to help support the Project. For example, as recently as 2013, SARTA, the City of Canton, and the State of Ohio collaborated to deploy major transit updates within the Mahoning Road Corridor and 12th Street. The project includes multiple phases totaling over $56 million in work, made available primarily through state grant funds, with some additional local funding. It is a pinnacle project that closely interfaces with other smart city/complete streets elements, including those proposed under the Project. Key features will include new transit facilities, bike lanes, road modifications, new traffic control systems and a traffic control center, safety improvements, and roadway lighting, supporting select elements of transit-oriented development. The Project team will work internally and with other local, state, and possibly federal agencies to help identify additional match funding during initial project development.