United States Department of Transportation
Federal Transit Administration
Beyond Traffic: The Smart City Challenge

Smart City Cleveland
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CITY OF CLEVELAND
Mayor Frank G. Jackson

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Project Summary

The *Smart City Cleveland* demonstrates that the City of Cleveland and its partners are committed to improving surface transportation, while improving public safety, transit service and energy security. The *Smart City Cleveland* team represents the key institutions necessary to exact lasting change, including the Greater Cleveland Regional Transit Authority (GCRTA), the Northeast Ohio Areawide Coordinating Agency (NOACA), the Ohio Department of Transportation (ODOT), Cleveland State University (CSU), and the National Aeronautics & Space Administration (NASA). *Smart City Cleveland* aligns with Vision Elements contained in the Notice of Funding Opportunity, as well as Ladders of Opportunity initiatives. By improving the mobility and safety of Greater Cleveland residents, and connecting them to centers of employment and education, *Smart City Cleveland* will promote workforce development, contribute to community revitalization, and create pathways to jobs by servicing groups that have been historically disadvantaged. At the same time, Smart City Cleveland will reduce greenhouse gas emissions and foster mode shift by increasing the desirability of sustainable transportation options.

I.   Smart City Vision & Challenges

Smart City Cleveland seeks to connect people, places, and opportunities. The goal of this project is to use technology to improve public safety, increase access to education and services through enhanced mobility, and further economic development in the Greater Cleveland region, all while reducing greenhouse gas emissions by creating smart transportation options. This project will use Smart City information and communication technology to engage citizens, deliver city services, and enhance urban systems through the integration of technological networks and the built environment. This project will result in cost and resource efficiencies, a more resilient infrastructure, and an improved urban experience.

Smart City Cleveland is comprised of five (5) strategic programs: Smart Traffic, Smart Transit, Smart Sensing, Smart Grids, and Smart Communication.

The Challenges

A prerequisite to achieving renewed prosperity is understanding the formidable socioeconomic, environmental, and infrastructure challenges facing Cleveland's economy today. Although the American economy has progressed toward recovery, the Greater Cleveland region was slower to rebound. Cleveland can be considered two cities – one is a growing city, where the downtown district and select neighborhoods are thriving, while the other a city where the less fortunate are not connected, have lower educational attainment, and in many cases are unable to fill the job requirements of the future. While Millenials and empty-nesters are the fastest growing segments in the developing sectors, Cleveland has neighborhoods where crime rates are higher and residents often fear for their safety. Large vacant areas created by the mortgage

foreclosure crisis are blighting influences on neighborhoods, preventing businesses from making investments.

Some socioeconomic and environmental challenges include:

Population loss: Cleveland, once the fifth largest city in America, now ranks 45th in population.[1] U.S. 2010 Census data indicates that 35.4% of Cleveland residents live below the poverty level, compared to the national average of 15.4%.[2]

Job Loss: Over the past several decades, the City of Cleveland has lost a significant amount of its manufacturing jobs, as companies have moved to suburban areas and other parts of the nation and the world.   Between 1980 and today, Cleveland lost about 150,000 manufacturing jobs, or almost 50% of its manufacturing employment. This was far more severe than the 21.1% loss for the nation as a whole. These jobs have not been fully replaced by equally high-paying jobs in growing sectors of the economy.

Unemployment Rate: The 2014 American Community Survey (5-yr estimates) data indicates that Cleveland's unemployment rate is 19.2%, compared to the national unemployment rate of 9.2%[3]

Educational Attainment: The 2010 U.S. Census data indicates that only 77.4% of Cleveland residents have obtained a high school diploma, compared to the national average of 86.0%. The percentage of Cleveland adults holding a bachelor's degree is the fifth lowest among the nation's 100 largest cities.[4] More education generally translates to higher income, and in turn enables the City to provide an array of important services for all of its residents. With higher educational rates, Cleveland assets such as Cleveland State University, The Cleveland Clinic, and the institutions at University Circle, including University Hospitals and Case Western Reserve University, could be better capitalized upon.[5]

Air Quality: Coupled with these challenges, Cleveland has an air quality problem. Northeast Ohio is currently ranked the 10th worst of 220 metropolitan areas nationwide for year-round particle air pollution. This is despite a 17% decrease in ozone air quality from 1990 – 2010.[6] One consequence is a high concentration of the population diagnosed with asthma – 6-8% of Cleveland children suffer with asthma.[7] From 2002 to

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[1] United States 2010 Census, Retrieved 1-30-16, From: http://www.census.gov/2010census/
[2] United States Census Bureau Quick Facts, Retrieved 1-30-16, From: http://quickfacts.census.gov/qfd/states/39/3916000.html
[3] American Community Survey, Retrieved 1-30-16, From: http://factfinder.census.gov/
[4] United States Census Bureau Quick Facts, Retrieved 1-30-16, http://www.census.gov/quickfacts/#table/EDU635214/00,3916000
[5] Cleveland City Planning Commission, Retrieved 1-27-16, From: http://planning.city.cleveland.oh.us/cwp/pop_trend.php
[6] Northeast Ohio Areawide Coordinating Agency, Retrieved 1-30-16, From: http://www.noaca.org/modules/showdocument.aspx?documentid=606
[7] Northeast Ohio Areawide Coordinating Agency, Retrieved 1-30-16, From: http://www.noaca.org/modules/showdocument.aspx?documentid=606

2007, asthma costs the U.S. about $3,300 per person each year, as a result of medical expenses, missed school and work days, and early deaths.[8]

Cleveland's historical reliance on manufacturing, heavy industry, electricity generation from coal, and single-occupancy vehicles has contributed to ongoing air quality issues. The Cleveland metropolitan region remains in Nonattainment for four of the six National Ambient Air Quality Standards (NAAQS): ground-level ozone, lead, fine particulate matter ($PM_{2.5}$), and sulfur dioxide. Furthermore, concentration levels of the two pollutants most closely linked to mobile emissions – ozone and fine particulate matter – have fallen by a smaller margin than lead and sulfur dioxide.[9] Cleveland's persistent air quality problems appear more acute when compared to Ohio's three other largest cities: Cincinnati, Columbus, and Toledo. Three-year ozone concentrations for the Greater Cleveland region remain above the 2008 ozone NAAQS (75 parts per billion (ppb)) and considerably above the new 2015 ozone NAAQS (70 ppb). Cleveland is also the only region in Ohio, and just one of nine in the nation, to be in Nonattainment for the 2012 $PM_{2.5}$ NAAQS (12 µg/m^3).[10][11] Given the relationship between mobile emissions and ozone and $PM_{2.5}$ concentrations, transportation is a major contributor to Cleveland's air pollution. In Cuyahoga County, 64% of emissions come from vehicles. The *Smart City Cleveland* objectives for implementation under this proposal include countermeasures that are proven to reduce congestion, encourage alternate fuel vehicles, and increase transportation choice, all of which will contribute significantly to reduced mobile source emissions and improved air quality.

In addition, the Cleveland's socioeconomic challenges, the current transportation communications infrastructure is obsolete, as it has reached the end of its useful life. Due to budgetary constraints, the City and its partners have been unable to invest in upgrading communications equipment. The existing antiquated technology prevents being able to exchange information in real-time to stakeholders, resulting in poor communication and inefficient data collection. The antiquated technology also hinders the City's ability to deliver basic services to the impoverished and transit-dependent citizens of Cleveland.

Despite the Greater Cleveland region making a slower than anticipated economic recovery, the downtown Cleveland neighborhood has experienced an increase in commercial and residential development. From 2010 to 2014, more than $4.5 billion in development has been invested in downtown Cleveland. More than $600 million worth

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[8] American Academy of Allergy Asthma & Immunology, Retrieved 1-30-16, From: http://www.aaaai.org/about-the-aaaai/newsroom/asthma-statistics.aspx

[9] NOACA, *Air Quality Trends and Nonattainment Status for Northeast Ohio: 2015 Update* (retrieved 1.26.2016 from http://noaca.org/modules/showdocument.aspx?documentid=11187)

[10] According to a 2013 study, Cleveland's mortality rate from mobile-source $PM_{2.5}$ pollution (30.3) is second only to Baltimore among major United States cities (Caiazzo, F., Ashok, A., Waitz, I., Yim, S., and S. Barrett. 2013. "Air pollution and early deaths in the United States. Part I: Quantifying the impact of major sectors in 2005." *Atmospheric Environment* (79: 198-208)).

[11] Cleveland is also the only one of the three cities that has been in Nonattainment for carbon monoxide (CO), another pollutant closely linked to mobile sources. Cuyahoga County was a Nonattainment area for the 1971 CO NAAQS until 1994.

of investments came online in 2013, including Phase One of the Flats East Bank project, as well as the Cleveland Convention Center & the Global Center for Health Innovation.[12]

The Vision

With the recent surge of downtown economic development and increase in residential housing, the City of Cleveland is poised for economic recovery. Downtown Cleveland has undergone a boom of residential growth, with a 53% increase in residents since 2000 and growth is projected to continue, as momentum and demand build for more sustainable, affordable, and reliable mobility choices, making funding for a Smart City a critical issue to sustain economic viability of this region. Implementation of smart technology will ensure *Smart City Cleveland's* partners ability to deliver the needed services and is a key component in the effort to propel the Greater Cleveland region toward economic recovery.

Creating a Smart City where residents know when transit will arrive, can walk to the transit stop in a well-lit area because the City can monitor street lighting, and can feel protected because pole-mounted police-monitored cameras provide a safe environment will help students get to school and residents get to work. Enhancing access to school and work, supporting economic opportunities by offering transit access to educational and training opportunities, and facilitating partnerships and coordinated planning, particularly in low-income communities, are the key components of the Ladders of Opportunity initiative, and will lead the Greater Cleveland area to economic recovery.

Public transportation helps the entire community – commuters, the disabled, students, senior citizens, and even those who are not passengers. A strong public transportation system helps maintain and create jobs by connecting workers to employment, saves individuals money on transportation costs, and is critical to Greater Cleveland's economic and social quality of life. The fastest-growing segments of the downtown Cleveland population are the Millennial and Baby Boomer generations, many of whom choose to rely on public transportation as their primary transport option. Studies indicate that young professionals who choose to live and work in urban areas are the fastest growing segment of public transit users. They are also the largest segment of early-adopters of technology, and use technology to its fullest. Almost all Millennials (91 percent) believe that investing in quality public transportation systems creates jobs and improves the economy. When surveyed, over half of Millennials (54 percent) would consider moving to another city that has more and better transportation options.[13]

Smart City Cleveland's goal is to be a champion for sustainable transportation, not only in reducing miles driven by private automobiles, but also by reducing emissions and

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[12] Downtown Cleveland Alliance, retrieved 5-12-15, From:
http://www.downtowncleveland.com/media/233504/fast-facts-2014_list.pdf
[13] The Rockefeller Foundation, retrieved 1-20-16, From: http://www.rockefellerfoundation.org/about-us/news-media/access-publictransportation-top

conserving resources, achieving the triple bottom line -- people, profit, and planet. According to the 2014 American Public Transit Association (APTA) study, public transportation is estimated to reduce CO_2 emissions by 37 million metric tons annually and saves the U.S. the equivalent of 4.2 billion gallons of gasoline annually – more than 11 million gallons of gasoline per day.[14]   As downtown Cleveland economic development activity continues and the number of residents increase, demand for alternatives to the personal vehicle will continue to increase. It is therefore imperative that *Smart City Cleveland* be able to provide safe, reliable and economical transportation choices to the multitude of riders (non-drivers, seniors, persons with disabilities, students, employees) who utilize public transportation. At the same time it is crucial to seamlessly connect public transportation to other sustainable transportation options, including bike share and EV car share, so the entire system is integrated and easy to use.

A coordinated and integrated approach to planning and development is critical to making Cleveland competitive in the 21st century. Transit Oriented Development (TOD) is a key tool used by the City to integrate high density development near transit stations and nodes. Repurposing land around these assets with housing, retail, jobs and other amenities will create quality places and connect people to these nodes of activity utilizing public transit. Land use regulations, including form base zoning will facilitate the establishment of such places. RTA's TOD plan, the City's comprehensive plan, NOACA's on-going TOD Regional Plan, and the City of Cleveland's urban overlay district are all mechanisms to accomplish smart land use. Connecting people, places, and opportunities is a recurring theme throughout the *Smart Cities Cleveland* application. The City wants residents to "get on" transportation that connects them to the places they need to go and "plug into" the transit amenities that will help them improve their transit experience.

Through the *Smart City Cleveland* project, the City of Cleveland and its partners will improve safety, increase access to educational opportunity and services through enhanced mobility, and address climate change, while strengthening Greater Cleveland's growing economy and promoting sustainable transportation in this region.

II.	Population Characteristics

Located in Northeast Ohio, the City of Cleveland has the following population characteristics:
- 396,815 residing within the City limits;
- This population represents 22% of the urbanized area;
- Population density of 514 people per square mile.

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[14] American Public Transportation Associat6ion, retrieved 1-25-16, From:
http://www.apta.com/resources/statistics/Documents/caseforbusiness.pdf

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III.	Attributes of Smart City Cleveland

Listed below are the City of Cleveland's attributes, as they align with the USDOT's characteristics for a Smart City:

Existing Public Transportation System
Formed in 1975, the Greater Cleveland Regional Transit Authority (GCRTA), is a strong public transit agency located in the City of Cleveland, Ohio, operating in Cuyahoga County throughout 59 communities, including 38 cities, 19 villages, and 2 townships. GCRTA encompasses a service area of over 457 square miles, serving a population of approximately 1.26 million people. GCRTA is the State of Ohio's largest transportation agency, providing both bus and rail service, as well as Paratransit service, with 49.2 million trips annually.[15]

GCRTA operates the only rapid transit rail service in the state of Ohio, including both heavy and light rail trains. The rail fleet contains 60 heavy rail and 48 light rail cars. Rail service consists of four (4) lines: Red (heavy rail) and Blue, Green, and Waterfront (light rail), with a total of over 34 miles of track, and 3.4 million annual revenue miles. In addition to rail, the agency's fleet contains 428 buses, 39 rapid transit vehicles (RTV's) and 70 Paratransit vehicles.[16] In 1968, Cleveland was the first American city to connect its downtown district to its airport via rail rapid transit. In 1996, RTA completed a light rail transit extension from its downtown terminal to the lakefront and the attractions located there.

GCRTA has maintained a strong relationship with various federal agencies and prides itself on sustaining a solid record of meeting federal budget and compliance requirements. Throughout the years, GCRTA's exemplary service has been recognized through a variety of awards and accolades, including being named the 2007 Best Public Transit System by the American Public Transportation Association (APTA);

Environment Conducive to Demonstrating Proposed Strategies
The following demonstrate how *Smart City Cleveland* partners manage business in an environment conducive to the proposed strategies for the *Smart City Challenge*:

- *Euclid Corridor Projec*t: The Euclid Corridor Project, known as the HealthLine, demonstrates a history of completion of large scale public transit projects and is the region's first Bus Rapid Transit (BRT) line. In April 2013, the HealthLine BRT received the highest ranking for a BRT in the United States, from the Institute of Transportation and Development Policy (ITDP). The HealthLine has garnered national attention for GCRTA, as the $200 million project was the first BRT in the country to receive a full funding grant agreement (FFGA) in FTA's New Starts Program. Opened in 2008, it is still considered the nation's premier BRT line. The HealthLine has acted as a catalyst for redevelopment of Cleveland's Euclid Corridor,

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[15] Greater Cleveland Regional Transit Authority, retrieved 1-30-16, From: http://www.riderta.com
[16] GCRTA 2014 Annual Report

spurring over $6 billion in investment since its inception, the project is also being utilized as a national model, with components being replicated in transit systems in Oregon, Washington, California, Florida and Washington D.C. The corridor's traffic signal system was upgraded in 2015, decreasing travel times by over 10%.

- *LED Street Lighting Pilot Project*: The Cleveland Public Power (CPP) LED Street Lighting Project pilot was instrumental in determining a standard specification for LED replacements going forward. At the same time, the City has integrated LED lights with sensors in Public Square, center of Cleveland's downtown district, in support of an Intelligent City Initiative.

- *Build Up Greater Cleveland (BUGC)*: Formed in 1983, BUGC serves as a regional collaborative, supporting infrastructure investment. Its mission is to build partnerships between public, private, and civic organizations to focus on advancing Greater Cleveland's economic health and vitality through infrastructure, utility, and public transit investments. A program of the Greater Cleveland Partnership (Cleveland's Chamber of Commerce), BUGC provides advocacy and outreach services on all aspects of the Greater Cleveland infrastructure network.

- *The Greater Cleveland University Circle Initiative (GUCI):* Led by the Cleveland Foundation, and in partnership with the City of Cleveland, GCRTA, the Cleveland Clinic Foundation, University Hospitals, and Case Western University, GUCI addresses the specific challenges of some of Cleveland's most disinvested neighborhoods. GUCI starts from two convictions: 1) by working together, anchor institutions can achieve more than any single institution on its own; 2) while physical development is important to urban revitalization, neighborhoods cannot succeed unless the people living there are valued and empowered. This ten-year old program demonstrates the City and GCRTA's ability to partner with local institutions.

- *Cleveland 2030 District:* The Cleveland 2030 District is a coalition of 41 building owners in the downtown district and University Circle neighborhood, working to reduce energy use, water use, and CO_2 emissions from transportation. All members have committed to the following transportation goal for Automobiles and Freight: A minimum of 10% CO_2e reduction below the current District average by 2015 with incremental targets, reaching a 50% CO_2e reduction by 2030.

- *Northeast Ohio Sustainable Communities Consortium (NEOSCC)* – NEOSCC is a 12-county, 33-member organization that produced the American Planning Association's Award Winning Vibrant NEO 2040 Vision, Framework and Action Product. The committee continues to implement the recommendations on land use and development created in the plan.

Continuity of Continued Leadership
The following illustrate *Smart City Cleveland's* commitment to continued leadership and the capacity to fulfill the requirements of the *Smart City Challenge*:

- *Sustainable Cleveland 2019:* In 2009, Mayor Frank Jackson launched Sustainable Cleveland 2019, a 10-year initiative to design and develop a thriving and resilient Cleveland, leveraging assets to build economic, social and environmental well-being for all. This initiative is built on a model of shared leadership from across the community, helping ensure its dynamism, inclusiveness, and long-term success. Every year leading up to 2019, Cleveland focuses on one of the key areas fundamental to a sustainable economy. In 2016, the City is celebrating the Year of Sustainable Transportation. A committee made up of more than 30 organizations is making it easier for Clevelanders to take action at home, at work, and in the community around sustainable transportation.

- *Cleveland Climate Action Plan*: The Mayor's Office of Sustainability convened a 50-member Climate Action Advisory Committee with representatives from the commercial, industrial, educational, government, and non-profit sectors to create the Climate Action Plan. The Plan contains an overarching greenhouse gas (GHG) reduction goal of 80% reduction below 2010 emissions by 2050. Of the city's transportation emissions, gasoline fuel consumption (typically by passenger vehicles) is by far the largest contributor. The plan includes 33 actions, including six actions for Sustainable Mobility. The Plan will be updated in 2016-17, providing an opportunity to integrate fully with *Cleveland Smart City*.

- *Complete and Green Streets Ordinance:* The City's Complete and Green Streets ordinance, passed in September 2011 is helping create a more walkable, bikeable and public transportation-friendly city while also improving the environment. Some characteristics of Complete and Green Streets in Cleveland include enhanced transit waiting environments, bicycle lanes, pedestrian refuges, public art, crosswalk enhancements, ADA accessibility, way-finding signage, permeable pavement, green space, street trees and multi-use paths.

- *Bikeway Implementation Plan:* the City of Cleveland's Bikeway Implementation Plan is designed to increase the number of bikeway miles by 250% by the end of 2017. The plan builds on Cleveland's existing bike infrastructure and leverages the City's five year capital improvement program (CIP) to accomplish this significant increase while adding minimal cost to street projects. Since its release in January 2014, approximately 36 miles of bikeway have been added in the City.

Commitment to Integrating with a Sharing Economy

The City and all the project partners are fully committed to supporting, promoting, and integrating with the sharing economy. Some of the partnerships mentioned in Section II, such as the Build Up Greater Cleveland (BUGC) and The Greater Cleveland University Circle Initiative demonstrate the commitment of the City, the region, and private partners to resource and wealth-sharing for the greater good.

The City and GCRTA funded the initial bike share feasibility study in 2013, leading to rollout of a citywide bike share program in 2016 with support and leadership from many key partners, including Bike Cleveland and Cuyahoga County. Cleveland's bike share program utilizes a smart bike technology from Social Bicycles (SoBi). Each bike is

equipped with wireless connectivity and real-time GPS, which serves to deter theft, locate missing bikes, and gather extensive data. This aggregated data, in combination with fleet management software, enables actionable planning corridor by corridor.

Ridesharing services, along with traditional taxi companies, are both supported in the City. NOACA has a ridesharing tool available to all Northeast Ohio residents. NOACA has committed to updating this tool in 2016 to create a Transportation Choice program to assist individuals using alternative forms of transportation, including cycling, walking, carpooling, vanpooling, transit, etc. There are also two car sharing companies currently operating in the City – Zipcar and Enterprise CarShare.

Clear Commitment to Open, Machine-Readable Data
Smart City Cleveland is committed to open data sharing. While the team is in the early stages of this effort, there have been some early successes. Examples include:

- The City Planning Commission hosts a GIS portal to allow users to extract spatial related information. Data maintained by the Planning Commission includes zoning, land use, and census information;
- City Building Permit and Inspection Data are available online;
- All GCRTA schedule information is available online; companies have incorporated schedules into applications to download onto a computer/mobile device and plan a trip via transit, walking, or car with estimated arrival time. This application's capacity will be enhanced when GCRTA can provide real-time data accuracy;
- SoBi's bike share technology is based on open data, allowing access to the public, app developers, municipalities, operators, system administrators, and researchers;
- NOACA utilizes a GIS portal to make information available to the communities and people it serves. NOACA's GIS portal allows users to access and interact with data in an interactive and clickable web-based mapping environment. Data layers are grouped into categories such as bicycle and pedestrians, environmental, freight planning, safety, geographic, transit, roadway, and socioeconomics.

The *Smart City Cleveland* partners are working to make additional data available to ensure transparency and spur innovation. The ability to provide additional data that is readily available from new technologies will bring more entrepreneurial ideas forward.

IV.	**Annotated Preliminary Site Map**
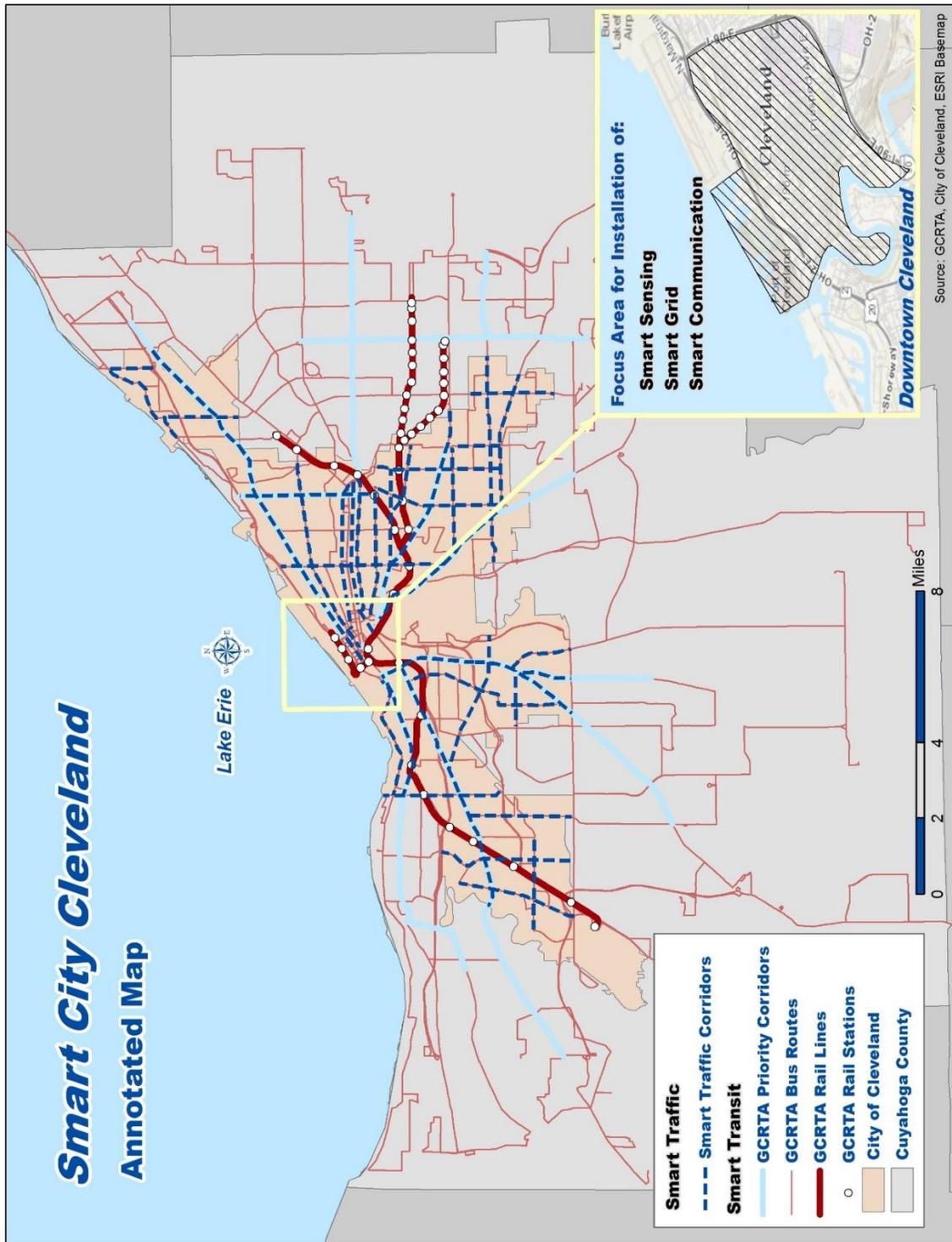
V.	Project Description and Vision Elements

Smart City Cleveland is comprised of five (5) strategic programs – Smart Traffic, Smart Transit, Smart Sensing, Smart Grid, Smart Communications, and Smart Applications that are described in detail in this section. This matrix summaries how the six smart programs address the twelve Vision Elements.

Table 1 – Summary of Project Benefits

Project Objective	Vision Elements											
	#1 Urban Automation	#2 Connected Vehicles	#3 Intelligent, Sensor-Based Infrastructure	#4 Urban Analytics	#5 User-Focused Mobility Services & Choices	#6 Urban Delivery & Logistics	#7 Strategic Business Models & Partnering Opportuni4es	#8 Smart Grid, Roadway Electrification, & Electric Vehicles	#9 Connected, Involved Citizens	#10 Architecture and Standards	#11 Information & Communications Tech (ICT)	#12 Smart Land Use
Smart Traffic	X	X	X			X	X			X	X	X
Smart Transit	X	X		X	X		X	X	X			
Smart Sensing			X	X	X	X	X	X	X			
Smart Grid				X	X		X	X				
Smart Communication			X	X			X		X		X	

Smart Traffic

Cleveland has 38 priority corridors where traffic regulation is most crucial. These corridors will be equipped with pre-emption/priority devices to regulate the flow of traffic. The City will partner with Cleveland State University's University Transportation Center (CSU-UTC) to determine strategy for implementation of these devices and the monitoring and measurement of their effectiveness.

Preemption devices provide the ability to change traffic signals when public safety forces (police/fire/EMS) are responding to incidents using lights and sirens. When public safety vehicles approach intersections, traffic signals will immediately change, allowing responders to pass through intersection safely without conflicting traffic movements, e.g., light turns green in the direction of the responding emergency vehicle.

NASA has developed the Aeronautical Mobile Airport Communications System (AeroMACS)—a transformational wireless enterprise communications and information sharing solution for multiple stakeholders—in close collaboration with the Federal Aviation Administration (FAA). AeroMACS is based on a version of the IEEE 802.16e international standard known as WiMAX. The FAA uses AeroMACS to ensure aircraft safety in flight and control movement on the airport surface. Network authentication mechanisms ensure that only authorized network users have network access. The technology used in AeroMACS will be applied to designated vehicles used by the City and its partners to establish connectivity.

Emerging standards exist that can be leveraged to facilitate a viable solution for the City and its partners. Similar to AeroMACS for airport surface communications, existing multiple standards can be leveraged for dedicated short range communications (DSRC) such as IEEE 802.11p, used for wireless access in vehicular environments (WAVE), cellular networks including LTE and the future 5G, and Wi-Fi networks that have been previously proposed.

In addition to preemption for public safety vehicles, intersections will have a soft type of preemption that will extend the green light time for designated non-safety public vehicles approaching intersections. Examples include public transit buses and snow plows.

The CSU-UTC has conducted research studies that utilize sensor data acquired from rapidly-deployable road-side sensors to characterize and measure traffic and driver behavior. These research studies have shown feasibility of using road-side sensors to compute traffic density and flow data, and to use such data to predict traffic flow and density downstream. Such data can also be used to create models for re-routing traffic in real time. CSU-UTD will use these capabilities in the implementation of preemption systems in a manner such that the priority vehicles are able to traverse the city as quickly as possible, while still creating an environment where the impact on the general public is minimized.

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In 2015, the HealthLine BRT, located on Euclid Avenue, a main thoroughfare that runs from the center of Cleveland's downtown district at Public Square through the neighboring suburb of East Cleveland, was upgraded with smart traffic devices, giving priority to HealthLine BRT's, resulting in reduced travel time by over 10%. The expansion of Automated Traffic Signals along key corridors throughout the city of Cleveland will allow GCRTA to improve on-time performance.

Data compiled and lessons learned from the Euclid Corridor HealthLine will assist the City in expanding to the 38 priority traffic corridors, which include GCRTA's ten (10) priority corridors. The Ohio Department of Transportation (ODOT) will collaborate with the City and GCRTA to provide data on standard signal design components such as vehicle detection, cabinet and controller types, and communication methods that will enable the Smart Traffic real-time data to be utilized by ODOT, to communicate incidents and travel time in its existing variable message sign network.

Vision Element(s) Addressed:
1 – Urban Automation: Implementing a traffic system with preemption devices will increase safety for emergency or priority vehicles, as well as the general public. Preemption devices allow priority vehicles to operate more efficiently when navigating high traffic areas.

2 – Connected Vehicles: Priority vehicles will be connected to a network that will receive information as to its location and movement in real time, increasing efficiency and reducing congestion.

3 – Intelligent, Sensor Based Infrastructure: Road-side and other sensors will feed information into an intelligent infrastructure, which will respond and accommodate traffic flowing through the city.

6 – Urban Delivery and Logistics: implementation will allow goods to be more easily transported.

7 – Strategic Business Models and Partnering Opportunities: By partnering with NASA and CSU-UTC, the City will leverage stakeholders to advance innovation.

10 – Architecture and Standards: Will allow communication of Smart Traffic data to ODOTS existing ITS system.

11 – Information and Communications Technology: Integrated traffic services will allow for unified communications and the ability for application development using open traffic data.

12 – Smart Land Use: Implementation will lead to a better connected community and sustainability.

Smart Transit
Real-time data is key to public transportation and its customers. Replacing GCRTA's antiquated radio and fiber optic systems is paramount to making Cleveland a Smart City. The integration of these systems will determine how data transmits from the

control center to passengers, municipal government, and businesses throughout Greater Cleveland. The City and GCRTA will provide data on the coordination of bus routes and schedules with public improvement projects; deployment of vehicles in the event of an unforeseen disaster; and public alerts to passengers, pedestrians, and drivers when public safety is at stake.

The City of Cleveland collects data through an Automated Vehicle Location (AVL) system that includes a Computer Aided Dispatch (CAD/AVL). The collection of data from the AVL systems allows administrators to track, monitor, and manage public services and safety. GCRTA also uses a CAD/AVL system, in conjunction with its radio system, to manage its fleet and provide quality service to passengers. Each vehicle is equipped with an Integrated Vehicle Logic Unit (IVLU), acting as an onboard computer and stores vehicle and schedule information, text messages, operator manifests, audio announcements, etc.

The mobile equipment that operates the software was developed in the 1980s. The Integrated Vehicle Logic Unit (IVLU - computer) and Mobile Data Terminal (MDT) that operate the software are now obsolete, and the operating system, which is DOS based, has not been supported for more than ten (10) years. This technology is outdated, preventing GCRTA from providing real-time information, customer communication, and data collection. Fuel economy is measured using static reports, with no indication for improving fuel economy and emission reduction. There are no navigation devices on GCRTA vehicles and operators must rely on route books. GCRTA uses camera software to monitor operator performance, with two cameras on board each bus. Hard braking, fast turns, etc. are measured using this software, but it is not integrated with any other software applications.

GCRTA currently provides manual text message updates for rail service delays only; it does not provide text message updates for bus route detours or service delay information. Current community information is shared using static media and is updated manually. Updating ADA announcements are cumbersome and time consuming to update. Vehicle inspections are performed manually and tracked using a paper card system. There is currently no Wi-fi access available to passengers on any GCRTA vehicles.

GCRTA will replace its radio and fiber optics systems to accomplish the following:
- Enhance rider and operator safety: An onboard data network that includes a turn-buy-turn navigation system will allow GCRTA's Integrated Communications Center (ICC) and Transit Police access to both audio and video onboard all vehicles, granting better access to emergency situations. GCRTA will communicate with the City's public safety forces (police/fire/EMS) in real-time. Integrating a turn-by-turn navigation system will improve safety and efficiency. ADA announcements will be made in real-time;
- Provide real-time information: Increased technology will provide custom text messages for both bus and rail services, notifying riders of any detour or service

related information. Real-time weather, news and other relevant information will be delivered through LCD screens at rapid stations, transit center or on vehicles;

- Provide on-board Wi-Fi: Passengers will access onboard Wi-Fi without having to use their own data plan;

Vision Element(s) Addressed:

1 – Urban Automation: Integrating a turn-by-turn navigation system, operator performance monitoring, and real-time information are three examples of automated transportation.

2 – Connected Vehicles: Disseminating real-time information and measuring on-time performance will increase efficiency, mobility, safety, and allow bus operations to maintain headways and bus spacing.

4 – Urban Analytics: Tracking operator performance, emission tracking, on-time performance, and real-time information will have an impact on safety, mobility, network efficiency, and environmental sustainability.

5 – User-focused Mobility Choices: Real-time information, including ADA information and turn-by-turn navigation enable efficient use and management of mobility services.

7 – Strategic Business Models and Partnering Opportunities: Implementation will include partnering with CSU, NASA, and private vendors.

9 – Connected, Involved Citizens: Real time information will proactively engage and inform citizens to increase mobility.

10 – Architecture and Standards – Radio and fiber systems will confirm to ODOT regional standards to communicate real-time traffic information and be integrated into ODOT's ITS system.

Smart Sensing

The first step to establish connectivity is to equip vehicles and infrastructure with Smart Sensing technology. The Smart Sensing objective contains three focuses areas: emissions, streetlights, and parking.

The City and GCRTA will partner with the NASA Glenn to implement autonomous vehicle and infrastructure technology to assist in preventive and predictive vehicle maintenance. NASA has a significant history in developing and fabricating smart sensors and electronics systems used for processing data storage, wireless communication, power, and operation, even in harsh environments. Miniaturized, stand-alone packages are tailored for each application and can be adapted for technologies such as safety, security, diagnostic monitoring, human health, environmental, and improved control systems. The ability to provide real-time information regarding vehicle systems or external environments improves efficiency and performance, and decreases environmental impact.

Examples of NASA technology include:

- "Lick and Stick" smart sensor systems including sensor arrays, processing electronics, wireless communication, and power that fit into the surface area of a postage stamp;
- Harsh environment technologies that characterize engine performance and identify maintenance issues;
- Ground-based multiple emission measurement technologies from airplane jet engine as an indicator of engine health;
- Miniaturized chemical gas sensors that can measure a person's breath, as well as emissions from an engine;
- Fire and environmental monitoring systems concentrating on quantitative chemical species measurements and elimination of false alarms;
- Complex fabricated electronic devices that operate for thousands of hours in near–glowing, red hot conditions.

NASA Glenn emission sensor technology will be used to measure chemical species such as carbon monoxide, carbon dioxide, nitrogen oxides, oxygen, hydrocarbons and particulate matter. Adapting this technology for designated vehicles, coupled with wireless transmission of the data to a central processing source can be used to monitor the environmental impact and vehicle performance. This will include developing prototype sensors and a pilot test, followed by fleet rollout.

Cleveland Public Power began two pilot projects to install new street lighting and fixtures that contain LED lights, cameras and sensory technology on Prospect Avenue and Public Square in downtown Cleveland. The sensory technology is cloud based and tracks traffic and pedestrian movement, on-street parking utilization, and sounds such as gunshot recognition.

The expansion of the CPP LED lighting pilot projects throughout the key transportation corridors within the Central Business District (CBD) will significantly aid the City of Cleveland in monitoring the performance and safety of the CBD. It will also enable the City and its partners to share data and communicate traffic and on-street parking information to the general and traveling public.

Smart parking technology includes the installation of sensors at parking lot entrances and on parking garage ramps to count available parking spaces and direct incoming vehicles to those spaces. Installing technology at parking lots and garages owned by the City and GCRTA allows agencies to more efficiently manage their existing infrastructure while providing real-time information to those wishing to park.

The private parking facility owners are able to collect valuable information on parking space utilization by location and time of day. This data allows the owner to more efficiently manage the available space, price parking facilities appropriately, program unused space, and allocate the appropriate number of spaces for alternative uses such as electric vehicle charging stations, carpool spaces, and overnight spaces.

Users of the parking facility are provided the immediate benefit of knowing how many spaces are available and the location of those available spaces. The parking utilization data would be in an open data format and would be incorporated into a web-based platform that would be available to parking lot customers from their mobile devices. During special events, downtown parking facilities and parking lots at transit stations fill up quickly. Providing real-time web-based parking space availability data to potential users will save time, miles, and frustration. Instead of driving from lot to lot hoping to find a space, the user can drive directly to the lot or garage that they know has availability.

Vision Element(s) Addressed:

3 – Intelligent, Sensor-based Infrastructure: Installation of emission sensory technology on vehicles will allow the City and its partners the ability to reduce maintenance costs via predictive maintenance, ensuring a state of good repair, as well as monitoring fuel emissions. The lighting and parking sensory technology will make available real-time information to connect parking availability to the traveling public

4 – Urban Analytics: Tracking operator performance, emission tracking, on-time performance, and improved vehicle maintenance can all be used to improve infrastructure management and reduce maintenance costs.

5 – User-Focused Mobility Services and Choices: Real-time parking information with street performance will enable efficient use and management of mobility services.

6 – Urban Delivery and Logistics: Improved vehicle maintenance and emission tracking improve travel time reliability, reduce fuel consumption, and reduce labor and vehicle maintenance costs. Tracking of off-street parking will aid all delivery and logistics providers.

7 – Strategic Business Models and Partnering Opportunities: Implementation will include partnering with NASA Glenn, CSU-UTC, and private vendors and private parking facilities owners and operators.

8 – Smart Grid, Roadway Electrification, and Electric Vehicles: Will improve the street lighting network with energy-efficient LED, parking, and street performance data.

9 – Connected, Involved Citizens: Real time information will proactively engage and inform citizens to increase mobility.

Smart Grid

Analysis of state and local data clearly illustrates a tremendous potential for expanding the level of EV infrastructure and vehicles in Cleveland. While publicly available and shared data reveal only a handful of existing Level 2 and DC Fast Charging stations (public-access, as well as private or workplace–only) within the City of Cleveland, the project team is ready to accelerate this transition.

BEYOND TRAFFIC: THE SMART CITY CHALLENGE
SMART CITY CLEVELAND

In 2013, Clean Fuels Ohio released an electric vehicle (EV) readiness plan for the State of Ohio. The number of EVs in the Cleveland MSA is projected to exceed 10,000 by the year 2020, and rapidly expand to over 100,000 by 2030. Over 80% of drivers commute less than 50 miles a day in the Cleveland MSA, well within the range of all-electric vehicles in the market today. In order to meet the projected increase in EVs by 2030 for the Cleveland MSA, the plan estimated there would be approximately 50,000 residential and approximately 2,000 non-residential EV charging stations installed by 2030.

A key element of this readiness plan was analysis by the Electric Power Research Institute (EPRI) to evaluate the impact on the grid from an increase in EV adoption. Based on projected adoption rates of EVs for the immediate future, increased demand for electricity is not expected to outpace production capacity, or the ability of the existing grid infrastructure to deliver power.

The project team is ready to take the steps necessary to implement the EV Readiness Plan for the State of Ohio. For example, the City of Cleveland is applying to the State of Ohio to develop an Electric Vehicle and Alternative Fuel Feasibility Study for the City's fleet and two private fleets. This plan, to be complete in 2016, will prioritize which vehicles to prioritize for switching to EV. In collaboration with Vulcan and SAFE, the team would like to further develop and implement these plans in order to dramatically increase the number of public and private fleets that are electrified, while ensuring the deployment is strategic and well-coordinated. Key pieces of this plan will include:

- Identify priority locations in the City for approximately fifty (50) EV charging stations;
- Coordinate with organizations interested in expanding their EV fleets;
- Prioritize and implement opportunities to reduce the "soft costs" of going EV, including streamlining of permitting approvals; and
- Work with the City, and likely a private vendor, to plan an all-EV car sharing program in the city that looks to incorporate wireless charging technology.

While implementation will focus will be on electrifying public fleets, existing partnerships and initiatives will enable private fleets to lead as well. For example, the Cleveland 2030 District consists of 41 building owners working to reduce energy use, water use, and CO2 emissions from transportation. All members have committed to the following transportation goal for Automobiles and Freight: A minimum of 10% CO_2e reduction below the current District average by 2015 with incremental targets, reaching a 50% CO2e reduction by 2030. These leaders, representing 168 properties in the City of Cleveland, represent a built-in set of early adopters needed to scale up EV in the city.

Cleveland is ready for this transition. We are three years into implementing the Cleveland Climate Action Plan, which calls for decarbonization of the city's electric supply (80% reduction in CO_2e by 2050). As the city continues to become less dependent on coal, EV will only grow in importance over the next decade. This project would provide us the expertise and resources to accelerate that necessary transition.

Vision Elements Addressed:

4 – Urban Analytics: Data collected will be used to determine future implementation and operational strategies to meet the projected demand.

5 – User-Focused Mobility Services & Choices: The locations of all electric vehicle charging stations (and EV car sharing locations) will be made available through a mobile application, enabling users to locate and utilize stations/cars when needed.

7 – Strategic Business Models and Partnering Opportunities: The City will partner with private institutions to install EVs at strategic locations;

8 – Smart Grid, Roadway Electrification, & Electric Vehicles: Establishing the electric vehicle infrastructure to accelerate the adoption of EVs in Cleveland.

Smart Communications

Smart City Cleveland seeks to connect people, places, and opportunities. The City's goal is to utilize a technology platform designed to be a meaningful, everyday presence in the lives of a vibrant downtown city. This objective will be achieved in two ways: smart kiosks and the development of innovative applications and communication tools.

While mobile devices are tools that can help communicate transportation conditions and other issues relating to mobility, there is disconnection between real time activity and the City's ability to capture information and disseminate it in a timely manner. To combat this, the goal is to have a technology platform that is easy to use and does not require access to a smart phone, but will provide data that is available on a smart device.

To make this connection, smart kiosks will be located near assets such as public parks, trails, and transit amenities, where citizens can benefit from technology. Utilizing a touch screen, the interface will be immediately understandable without training or familiarity. A clear service offering, simple language, and large type will ensure that these devices provide significant value to the cities sidewalks, transit hubs, public parks and many other areas, providing welcome services, for regular transit riders as well as visitors.

Smart kiosk services include:
- Safety and security: Citizens will be able to connect with emergency services, including police, fire, and EMS;
- Public announcements: The City will use this platform to make public announcements regarding civic and social events;
- Rider travel time information: information regarding routes, delays, etc. will be disseminated in real-time;
- Wi-fi connectivity and charging: Citizens will be able to connect with Wi-fi services, including the ability to charge mobile devices;
- Direct communication: Citizens will communicate directly with City representatives in real-time.

This "high tech/high touch" opportunity provides connection with residents who utilize the various amenities mentioned above. The use of Smart City technologies results in cost efficiencies, resilient infrastructure, and an improved urban experience.

In addition to the Smart Kiosks, the *Smart City Cleveland* partners believe that there is huge opportunity for mobile application development and enhancement of existing applications to utilize the open source data that our Smart Traffic, Smart Transit, Smart Sensor and Start Grid projects will provide to residents, commuters, students, and tourists of Greater Cleveland.

Utilizing the CSU-UTC and NASA Glenn resources, the City and its partners are proposing to host their own competitive *Smart City Cleveland* competitions and hack-a-thons, based upon proposed technology solutions. Using CSU-UTC and NASA to provide expertise, grant funding will provide seed money to local tech entrepreneurs and students. The City and its partners will base the technical assistance similar to NASA Glenn's Adopt-A-City Program partnership.

The NASA Glenn Adopt-A-City Program seeks to assist local manufacturers who desire growth and revenue through technical problem-solving. The initiative is a collaborative effort between NASA, the Manufacturing Advocacy and Growth Network (MAGNET), the City of Cleveland, and Cuyahoga County. Subject experts from the NASA are made available to selected candidates. Each company selected is eligible for up to 40 hours of NASA expert assistance and up to $50,000 in low interest loans from either the City of Cleveland or Cuyahoga County.

The *Smart City Cleveland* partners will use this model to kick start the develop applications using the open source data generated by the Smart projects. This initiative will attract partnerships within the existing technology incubators in the Cleveland area.

Vision Element(s) Addressed:
3 – Intelligent, Sensor-based Infrastructure: Utilization of Smart Sensors incorporated into Smart Communication efforts will allow for useful data communication throughout the City and region.

4 – Urban analytics: The ability to communicate directly will allow City officials to collect data, creating value.

5 – User-Focused Mobility Services and Choices: Open data applications and tools will improve mobility options for travelers.

7 – Strategic Business Models and Partnering Opportunities: The City will partner with private vendors and startups to implement technology that will best benefit its citizens.

9 – Connected, Involved Citizens: Open data platforms will increase citizen's mobility.

11 – Low-Cost, Efficient, Secure, and Resilient Information and Communications: Implementation will allow access, storage, and transmittal of information.

VI.	**Key Technical, Policy, and Institutional Risks**

The *Smart City Cleveland* partners are all experienced federal grant recipients that recognize the risks associated with a large ambitious grant program. The City and its partners have a track record of delivering projects funded through special USDOT grant programs such as TIGER (three projects), ARRA (multiple projects), and a FTA Full Funding Grant Agreement for the HealthLine BRT. In all cases, the City and its partners experienced and mitigated budget, schedule, organizational, conflict of interest risks. *The Smart City Cleveland* partners will address these as described below:

Budget Risk - Although not requested, a prepared preliminary budget allocation for each of the Smart Objectives for the scope and visions described in Section V is listed below. The budget includes a 10% general contingency and includes some flexibility in allocating costs between the objectives when preparing the more detailed scopes and budgets that will be required for the shortlisted cities.

The *Smart City Cleveland* partners believe that this preliminary budget is adequate to implement the proposed Smart Objectives particularly the backbone infrastructure in the Smart Traffic and Transit that is necessary for the other objectives to become reality.

OBJECTIVE	PRELIMINARY BUDGET
SMART TRAFFIC	$11.0 million
SMART TRANSIT	$16.0 million
SMART SENSING	$5.0 million
SMART GRID	$1.0 million
SMART COMMUNICATIONS	$3.0 million
SUBTOTAL	$36.0 million
CONTINGENCY	$4.0 million
TOTAL	$40.0 million

Schedule Risk – The NOFA anticipates that the proposed Smart City program will be in place in three years with a fourth year for the monitoring performance measures and success. *Smart City Cleveland* partners recognize that this is going to be aggressive to have all elements in place and operational in three years. Mitigation strategies will include a procurement strategy of preparing RFP and IFB packages during the period from when selected as the Smart City, to when the actual grant is executed to begin the procurement process as soon as the grant is executed. This strategy to have contracts in place within a couple of months of the grant award was utilized for the ARRA program. *Smart City Cleveland* partners will also be able to take advantage of $30 million of the $40 million of funding being available as early as October 2016 as FY2016 ends and FY2017 begins.

Smart City Cleveland partners will structure procurements so the longer projects with long lead item components are procured early to manage the schedule risk of those contracts. Fortunately, the City and its partners have pilot projects in place in the areas

of Smart Traffic, Smart Grid, and Smart Sensing that will decrease both schedule and budget risks from the lessons learned from the pilot programs.

Organizational Risks – When looking at the *Smart City Cleveland* partners as an outsider one could wonder, "How can these large bureaucratic, slow moving large organizations deliver the Smart City program? The reality is that in Cleveland, entities work together all the time, and come together for hosting and implementing programs of national importance. With the City as the lead, the *Smart City Cleveland* partners have delivered the 2013 National Senior Games, the 2014 International Gay Games, and in 2015 won the Republican National Convention and will deliver it in 2016. The *Smart City Cleveland* partners work with BUGC and the GUCI mentioned earlier are examples of the ability to work together. Each organization has key staff that will be dedicated, available and already experienced in working with the various partners to deliver *Smart City Cleveland*.

Conflict of Interest – In the time since the NOFA was issued on December 7, 2015 the Smart City Cleveland partners have been inundated with inquiries from current and former vendors, Fortune 500 companies, wanting to "assist" in the writing and scoping of this response, and small start-ups wanting to "partner" on this program. The Smart City Cleveland partners have intentionally written this proposal without any assistance and without naming any companies, in order to eliminate any appearances of Conflict of Interest. Going forward, the Smart City Cleveland partners will maintain a level playing field for all of the potential vendors for the contracts that this program will generate.
As experienced federal grantees, the *Smart City Cleveland* partners understand the need for an open procurement process.

VII. Strategic Partners

The City of Cleveland will partner with the following entities for the *Smart City Challenge*:

- Greater Cleveland Regional Transit Authority (GCRTA): The region's public transit service provider. GCRTA will be a sub-recipient of the *Smart City Cleveland* grant. See *Section III. Attributes of Smart City Cleveland* for additional detail;
- Northeast Ohio Areawide Coordinating Agency (NOACA): The region's metropolitan planning organization. NOACA is headquartered in Cleveland, Ohio, and serves the surrounding five (5) counties: Cuyahoga, Geauga, Lake, Lorain and Medina;
- Cleveland State University's University Transportation Center (CSU-UTC): CSU-UTC is a primary resource for preparing transportation personnel that effectively and safely rehabilitate and expand the region's transportation infrastructure. The CSU-UTC provides training, education, outreach, and research focused primarily on transit issues and highway construction safety. Operating since 2005 the CSU-UTC is a long term initiative that taps the research and educational expertise faculty from several colleges (the Washkewicz College of Engineering, the College of Education

and Human Services, and the Levin College of Urban Affairs) across the campus. Its goal is to improve all facets of transportation across the region;

- National Aeronautics & Space Administration (NASA) Glenn Research Center (NASA): NASA partners with U.S. industry, universities, and other government institutions to develop critical systems technologies and capabilities that address national aerospace priorities. The Center is well known for its unique blend of aeronautics, space flight, and project management expertise. The Center's work focuses on technological advances in space flight systems, power systems, nuclear systems, aero-propulsion, space propulsion, advanced communications, materials for use in extreme environments, and targeted technology that enables humans to explore in space. Glenn research, technology, and development efforts are vital to advancing exploration of our solar system and beyond, while maintaining global leadership in aeronautics;
- Ohio Department of Transportation (ODOT): The Ohio Department of Transportation will collaborate with Smart City Cleveland partners to provide data on standard signal design components such as vehicle detection, cabinet and controller types, communication methods, to integrate with its existing ITS system.

VIII.	Existing Transportation Infrastructure and System Features

The following describes the existing transportation infrastructure and system features of the Greater Cleveland region:

Arterial Miles
The City contains approximately 300 miles of arterial and collector roadways and 1,000 miles of residential city streets that provide access to all properties. It also includes 499 bridges, with the City bearing responsibility for the maintenance of 126 bridges and GCRTA maintaining 85 bridges.

Freeway Miles
The City is served by nearly 50 miles of limited access highways including three mainline freeways consisting of I-90, I-77, I-71, providing access from points east, west, and south, giving Cleveland direct freeway links to such places Boston, New York, Chicago, and the Pacific Coast. Cleveland is also served by I-480, I-490, and SR 176 (Jennings Freeway), that act as important connecting links between the mainlines and provide access to other portions of the City. In addition, Cleveland has access to I-80 (Ohio Turnpike) several miles to the south and I-271 through the eastern suburbs.

Transit Service
GCRTA operates an extensive system of bus and rapid transit lines throughout Cuyahoga County that provides transportation for tens of thousands of residents each day. GCRTA bus service consists of over 60 routes, including two (2) bus rapid transit (BRT) lines and a downtown Trolley service, as well as Paratransit services for the

disabled. In addition to its 108 rail cars, the agency's fleet contains 428 buses, 39 rapid transit vehicles (RTV's) and 70 Paratransit vehicles. GCRTA offers 8,800 free parking spaces available to commuters. GCRTA provides 49.2 million trips annually.

Shared Use Mobility Services

Bicycling in Cleveland is on the rise – the most recent U.S. Census numbers indicated an increase of 280% from 2000 to 2010 in the number of people commuting to work by bicycle.[17] To help continue this growth, the city is working to expand bike share in Cleveland, resulting in at least 30 stations and 250 bicycles by June 2016. The goal is to reach 70 stations and 700 bicycles within the next few years. Cleveland's bike share program utilizes a smart bike technology from Social Bicycles.

Car share is limited in the City, although two companies are currently operating small fleets based at Cleveland State University and in University Circle, in partnership with Case Western Reserve University. There are significant opportunities to increase the car sharing fleet in Cleveland and make it electrically powered, especially with the implementation of the proposed Smart Grid program.

Information and Communication Technology

Information and communication technology implemented or considered for the City of Cleveland includes the following:

* Health Tech Corridor 100 Gig Grant: The Cleveland Health-Tech 100 gig color logoCorridor has partnered with the City of Cleveland, OneCommunity, Case Western Reserve University (CWRU), and *ideastream* to supercharge economic growth in Cleveland. The team is in the process of installing the nation's fastest commercial fiber network, bringing 100 gigabit speed to the City. This fiber network will set the new standard for tech-infrastructure cities and will offer downloads and uploads more than 300 times faster than the national average. The 100 gigabit fiber network will allow companies in Cleveland to share medical images in milliseconds, making it easy to transmit and analyze remotely, accelerate the pace of R&D with instantaneous access to massive data sets, and eliminate barriers with next generation video conferencing, including 4D, holographic, and immersive conferencing;[18]
* LED Street Lighting Pilot: Cleveland Public Power, the City's municipal electric utility, recently completed its LED Street Lighting Pilot to determine which types of LED technology provide the best value (cost, energy savings, etc.). This pilot has been instrumental in determining a standard specification for LED replacements going forward. At the same time, the City has integrated LED lights with sensors in Public Square. This program will be greatly expounded upon with the implementation of the Smart Sensor program;
* Regional CIO Collaboration and Resource Sharing: consists of a partnership with regional CIOs (Cuyahoga County, ODOT, GCRTA, Cleveland Metroparks,

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[17] United States 2010 Census, From:http://www.census.gov/2010census/
[18] http://www.healthtechcorridor.com/what-does-100-gig-mean-for-the-city-of-cleveland/

Cleveland Metropolitan School District, etc.) to develop a regional resource sharing model with the initial agreements focused around fiber sharing;

- Opportunity Corridor Fiber Optic Project: A proposal has been made to place high-speed fiber along the proposed Opportunity Corridor to provide high-speed internet access for business to help spur economic development and to be used by local entities (GCRTA, City of Cleveland, etc.) to deliver and support key services is in the corridor;

Intelligent Transportation Systems
The Euclid Corridor HealthLine BRT has a smart traffic system infrastructure upgraded in 2015, giving priority to HealthLine buses. The corridor also uses a camera system shared by six (6) police departments located along the corridor. GCRTA secures, controls, collects, and houses the camera's data in a cloud-based system. This shared data and technology links directly to public safety agencies.

ODOT's Office of Traffic Operations maintains over 860 ITS devices statewide. ODOT utilizes the following ITS infrastructure: dynamic message signs, destination dynamic message signs, queue warning systems, ramp meters, CCTV, highway radio systems, and flashing beacon signs. ODOT also maintains the statewide 511 system, implemented in 2013. This system allows users to get specific real-time travel information for major routes in Ohio. This information is particularly valuable to manufactures, who rely on "just in time delivery" of inventory.

Smart Grid Infrastructure

Analysis of publicly available and shared data within the City of Cleveland geographical boundaries at dedicated web sites such as the crowdsourced plugshare.com and the Department of Energy's Alternative Fuel Data Center's Station Locator, reveal only a handful of Level 2 and DC Fast Charging stations (public-access, as well as private or workplace–only) currently installed today.

IX.	Data Collection

City of Cleveland Data Collection
The Cleveland's CitiStat Plus Office is a process and data driven program that identifies performance challenges and successes. It recommends strategies for continuous improvements through data analysis and process mapping. CitiStat works in conjunction with departments to capture data, analyze trends, forecast resource deployment, and monitor the effectiveness of service delivery to the citizens and stakeholders of the City of Cleveland. Practically every City department collects and tracks data that links directly to the expected outcomes of the Smart City Challenge: improved safety, enhanced mobility, and climate change. The following is a brief outline of the types of data the City of Cleveland collects that can be incorporated into the Cleveland Smart City collaborative.

Public Health:

- Division of Air Quality – gasoline dispensing and high priority facilities, fugitive dust, odor, and smoke
- Division of Environmental Health – nuisance and abatement

Public Works:
- Division of Traffic Engineering – signalization, signage, street markings, and bike lane facilities
- Division of Parking – meters, space, and garages
- Division of Streets Maintenance – street resurfacing, potholes, and snow removal
- Division of Water – water quality, water main breaks
- Division of Water Pollution Control – EPA compliance, manholes/catch basins
- Cleveland Public Power – street light replacement/repair, service outages, LED streetlight performance

Public Safety (Crime and Safety Data):
- Division of Police
- Division of Fire
- Division of Emergency Medical Services (EMS)

Office of Sustainability:
- Greenhouse gas emissions
- Sustainable Cleveland dashboard indicators (e.g. high school graduation rates, health indicators, cost of living, neighborhood Walk Scores, mode shift, etc.)

GCRTA Data Collection

TransitStat is a structured continuous management program that entails the frequent gathering, reviewing, and analyzing of day-to-day performance. This program is designed to improve performance through continual monitoring, reviewing, and improvement through data-driven reporting to create efficiencies, effect change, and provide an equitable tool. In the TransitStat forum, a problem is first defined. Department Directors and key staff create the Task Force Team, set goals and identify objectives for improvement.

The TransitStat Panel, consisting of the CEO, Deputy General Managers, and key staff, review the progress of each of the TransitStat projects. The Panel helps give direction and allocates resources quickly to ensure that projects move forward and strategic linkages between and within departments continue.

TransitStat has helped to develop cost saving measures, totaling over $59.8 million since 2008. These include:
- Inventory Reduction $3.9 mil
- Utility Savings $9.0 mil
- Engineering & Lighting Retrofits and Savings $2.3 mil
- Tow Reduction $1.0 mil

- Fuel Hedging Program $16.5 mil
- Propulsion Power Savings $8.2 mil
- 2008-2014 Overtime Savings $8.5 mil
- Safety Initiatives/Savings $6.6 mil
- Workers' Compensation Savings $2.8 mil
- P-Card Savings $0.6 mil
- Fare box Defect Savings $0.2 mil

Other Qualitative Savings result from shift changes, paratransit on-time performance, the Telephone Information Center, safety blitzes, and the implementation of a new strategic plan for GCRTA.

In addition to TransitStat, GCRTA TEAM is a labor-management sponsored employee program designed to reward all employees for their contribution to reaching the goals that drive the GCRTA Business Plan. The program is committed to recognizing, reinforcing and rewarding employees for improvements. TEAM tracks the following performance measures: preventable collisions, on-the-job injuries, number of miles between service interruptions, on-time performance, ridership, Ride Happy or Ride Free, attendance, and passenger fare collection.

NOACA Data Collection
NOACA utilizes a GIS Portal to make information available to the communities and people it serves. NOACA's GIS Portal allows users to access and interact with data in an interactive and clickable web-based mapping environment. Data layers are grouped into categories by topic or focus and includes categories such as:

- Bicycle and Pedestrians: sidewalk inventory, priority bike network, bike suitability, bike & pedestrian counts;
- Environmental: environmental justice areas, watershed boundaries;
- Freight: railroad lines & crossings, freight land use, freight counts;
- Planning: transportation improvement program (TIP), facility planning areas (FPA), long-range transportation planning (LRTP);
- Safety: crashes/crash frequency/crash rate, road safety audits;
- Geographic: NOACA planning area/boundaries, land use;
- Transit Routes: includes eight (8) public transit systems for the five counties served;
- Roadway: pavement conditions, bridge inventory;
- Socio-Economic: job density, census tract information;

X.	Approach to Existing Standards, Architecture, & Certification

The Cleveland area's Regional ITS Architecture is controlled and maintained by NOACA and ODOT and is consistent with the National ITS Standards. As Smart City Cleveland develops and implements its objectives and projects, our partners NOACA

and ODOT will be providing technical assistance to ensure that the data and information that we are producing is compatible with ODOT's current ITS System.

USDOT has also released its Version 2.1 updates of its Connected Vehicle Reference Implementation Architecture (CVRIA) and Systems Engineering Tool for Intelligent Transportation (SET-IT) platforms. NOACA and ODOT will be incorporating those tools, especially SET-IT, as we integrate our proposed Smart technology and communication tools into a seamless efficient system.

The Smart City Cleveland partner's participation in the existing Regional CIO Collaboration and Resource Sharing group provides an existing mechanism for our project to be compatible with the Regional and National ITS Standards.

XI.   Measurable Goals

The City of Cleveland, GCRTA, and its partners will use both quantitative and qualitative performance measures to determine this project's impact on improved safety, enhanced mobility, and climate change, and will partner with CSU-UTC to evaluate measurements before and after implementation of proposed technological upgrades.

Quantitatively, the *Smart City Cleveland* partners will use metrics of the CityStat and TransitStat processes to determine the following:

- Response time for emergency vehicles utilizing priority corridors: Preemptive traffic signals will reduce the response time for public safety vehicles (police/fire/EMS) en route to their destination, as emergency vehicles will receive priority;
- Level of service: Sensory monitoring will determine the level of service at key intersections within priority corridors;
- Number of motor vehicle accidents that occur in priority corridors: Preemptive signals will reduce the number of motor vehicle accidents, due to priority traffic signaling for designated vehicles;
- On-time performance for GCRTA public transit vehicles: GCRTA vehicles will have minimal stops while en route, allowing vehicles to adhere to a schedule and operate more efficiently;
- GCRTA bus operator performance: technology will allow GCRTA to monitor the performance of its operators in real-time;
- Greenhouse gas (GHG) emissions: GHG emissions will reduce as a result of vehicles being running more efficiently (e.g., less idling of public transit buses due between stops) and the increased use of electric vehicles and bicycles;
- Commuting Mode shift: monitor the transition from single occupancy vehicles to other more sustainable and healthy forms of transportation.
- Vehicle reliability: vehicle reliability, including predictive maintenance, based upon sensor technology developed by NASA, will be charted;
- Parking utilization for on and off-street facilities.

Qualitatively, the *Smart City Cleveland* partners will use the input of the community's stakeholders to measure performance. Stakeholders will be able to communicate with the City and its partners in a facilitated, official discussion online where residents can provide feedback. The City will share stakeholder input with its partners.

XII.   Project Capacity

The City of Cleveland and its partners have maintained a strong relationship with various federal agencies and prides themselves on sustaining a solid record of meeting federal budget and compliance requirements.

GCRTA has a history of successful oversight and administration of grant funds. The organization was a recipient of over $46 million in American Recovery and Reinvestment Act (ARRA) funds. Seventeen projects funded with these monies were successfully managed in accordance with federal guidelines and assurances. All of the funds have been expended and all three ARRA grants were closed before the September 30, 2013 deadline. Additionally, GCRTA has received and successfully administered or is administering the following competitive federal awards: $2.25M TIGGER (2009), $4.95M and $3.1M State of Good Repair Grants (2010 & 2011), $10.5M TIGER II (2010), $12.5M TIGER III (2011).

In April 2013, the HealthLine BRT received the highest ranking for a BRT in the United States, from the Institute of Transportation and Development Policy (ITDP). The HealthLine garnered national attention, as the $200 million project was the first BRT in the country to receive a full funding grant agreement (FFGA) in FTA's New Starts Program. The HealthLine acted as a catalyst for redevelopment of Cleveland's Euclid Corridor, spurring over $6 billion in investment since its inception. The project is being utilized as a national model, with components replicated in transit systems in Oregon, Washington, California, Florida and Washington D.C. GCRTA has successfully demonstrated its technical, legal and financial capacity in each of the Federal Transit Administration's Triennial Reviews.

The City of Cleveland's Chief of Governmental & International Affairs, Chief Information Officer, Chief of Sustainability, and Director of City Planning will conduct oversight of this project for the City. GCRTA's Deputy General Manager of Engineering & Project Management, CIO and Director of IT, and Manager of ITS will oversee implementation, in conjunction with NOACA's Executive Director. Cleveland State University's Director, Associate Director, and Associate Professor of the CSU-UTC will oversee their role in this project. NASA's Chief of Innovation and Integration and Technical Lead will supervise their role in the execution of this project.

The aforementioned grant awards have provide this team with the experience necessary to effectively execute this project while ensuring adherence to all required federal goals, rules and regulations.

XIII.	Opportunities to Leverage Resources

The *Smart City Cleveland* partners have been approached by a number of current and potential vendors to form partnerships to meet the Smart City Challenge. If the City were awarded this grant, it would initiate a number of RFP/IFB procurements in order to meet the procurement requirements as required by the USDOT, as well as local charter regulations.

In preparing this response, the City and its partners met with the following organizations that could enhance and expand the reach of the *Smart City Cleveland* proposal. These organizations include:
- Cleveland Foundation
- Cleveland Public Library System
- Cuyahoga County Library System
- Case Western Reserve University
- Port of Cleveland
- Cleveland Metropolitan School District
- Cleveland Metropolitan Housing Authority

The *Smart City Cleveland* partners anticipate that many of these organizations will have a role in this project, if the City of Cleveland is selected as a finalist.

Exhibit 1. Biographies of Key Project Parties

City of Cleveland

Valarie J. McCall – Chief of Government & International Affairs
Valarie J McCall is Chief of Government & International Affairs for the City of Cleveland. She serves as Mayor Frank Jackson's liaison to local and state governments, federal agencies and international organizations, as well as the Mayor's primary representative to several national organizations, including the U.S. Conference of Mayors, National League of Cities, and National Black Caucus of Local and Elected Officials. Most recently, she is the liaison to the Republican National Convention and the Chairwoman of the American Public Transportation Association.
Her many duties include overseeing the Jackson Administration's appointments to internal and external boards and commissions, and helping to implement the Mayor's policies to promote regional growth and cooperation. In addition to her domestic responsibilities, McCall has represented the Mayor and the City of Cleveland at overseas and is a Fellow at the German Marshall Fund.

Prior to being appointed to her current position, McCall served as the Cleveland City Council's youngest City Clerk and Clerk of Council in the city's history. Ms. McCall grew up in the City of Cleveland and is a graduate of Cleveland State University.