

BEYOND TRAFFIC: THE SMART CITY CHALLENGE

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1. Define Our Vision for Your Smart City

Introduction

The Smart City Challenge provides a unique opportunity to accelerate the City of Greensboro's vision for the community and its transportation system by leveraging existing communication and transportation assets. The City of Greensboro recognizes its location within one of the "Mega Regions" on the east coast at the confluence of major interstates, rail lines with direct access to east coast deep water ports and digital assets makes it uniquely positioned to become a leading example of a Smart City, and control its economic and civic destiny in the 21st century. As a Smart City, Greensboro will be ideally positioned to support advanced manufacturing, attract digital entrepreneurs, support freight movement, and create new jobs that pay a living wage. Taking advantage of the opportunities this century offers will require Greensboro to embrace new public and private partnerships, ensure on-going bold leadership, and exercise creative thinking to leverage our existing resources and infrastructure for bold initiatives of the future.

Table 1 outlines the Smart City goals, our challenges, and our vision for Beyond Traffic 2045 with unique local challenges.

Table 1. Alignment of Goals, Challenges, and Vision

Smart City Challenge Goals	Greensboro's Challenges	Greensboro's Vision
Improve Safety	<ul style="list-style-type: none">• Funding to Maintain Existing Transportation System• Budget Constraints for Existing City Services (Police and Fire)• Supporting Freight Movements	<ul style="list-style-type: none">• Deploy Enhanced Citywide Communication Network (including 27,000 new LED streetlights)• Deploy Smart-Infrastructure Corridors• Advanced Smart-Transit Systems• Smart Multi-Modal Corridors• Collaborative Aerial Autonomous Vehicle Environment
Enhance Mobility	<ul style="list-style-type: none">• Funding to Maintain Existing Transportation System• Funding for Existing & Future Public Transportation	<ul style="list-style-type: none">• Deploy Enhanced Citywide Communication Network• Deploy Smart-Infrastructure Corridors• Advanced Smart-Transit Systems• Smart-Multi-Modal Corridors
Address Climate Change	<ul style="list-style-type: none">• Community Awareness and Involvement• Sustainability (Climate Change)	<ul style="list-style-type: none">• Advanced Smart-Transit Systems (including electric buses)• Smart-Multi-Modal Corridors• Deploy Enhanced Citywide Communication Network (including 27,000 new LED streetlights)
Connect Underserved Areas	<ul style="list-style-type: none">• Infrastructure Connectivity• Open Communication• Accessibility to Data and Information	<ul style="list-style-type: none">• Deploy Enhanced Citywide Communication Network• Deploy Smart-Infrastructure Corridors• Advanced Smart-Transit Systems
Support Economic Vitality	<ul style="list-style-type: none">• Attracting Entrepreneurs• Supporting Freight Movements• Decreasing Poverty Level• Provide Environment for Job Creation (various skill levels)	<ul style="list-style-type: none">• Deploy Enhanced Citywide Communication Network• Deploy Smart-Infrastructure Corridors• Advanced Smart-Transit Systems• Smart Multi-Modal Corridors

As a Smart City, Greensboro will be positioned to more rapidly achieve its goals related to: (1) increasing access to economic opportunity, (2) connecting underserved communities, (3) improving safety for all transportation users; and (4) protecting the environment.

Today's Challenges

Greensboro needs jobs – but not just any jobs. We need good, sustainable, higher paying jobs. Greensboro and the broader Piedmont Triad region have experienced significant losses in the



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manufacturing sector over the last 15 years. While still economically distressed, the local economy is retooling and showing signs of revitalization. Moreover, unlike declining mono-industry economies such as Detroit's once solely automotive-focused economy, Greensboro is positioned as a poly-industry economy with a diverse mix of manufacturing, education, healthcare, service, and hospitality firms.

Global Opportunities Center (Source: Greensboro SC2 Challenge Winner)

The *Beyond Traffic 2045* study states that by 2050 emerging megaregions could absorb 75 percent of the U.S. population, with the greatest growth in the South and West. It will be essential to have a transportation system in place to meet the needs of the growing population and serve a poly-industry economy.

Many of the issues outlined in *Beyond Traffic 2045* have been identified as current or future challenges for Greensboro as well. They range from spurring and supporting economic vitality to providing robust transportation choices for both the millennial and older generations. Specific challenges identified by the City are included in Table 2.

Table 2. Key Challenges

Challenge	Issues
Economic Vitality	<ul style="list-style-type: none"> • Attracting Entrepreneurs • Supporting Freight Movements • Decreasing Poverty Level • Provide Environment for Job Creation (various skill levels)
Scarce Resources	<ul style="list-style-type: none"> • Funding to Maintain Existing Transportation System • Budget Constraints for Existing City Services (Police and Fire) • Funding for Existing and Future Public Transportation
Modernization (21 st Century)	<ul style="list-style-type: none"> • Infrastructure Connectivity • Open Communication • Accessibility to Data and Information • Managing and Analysis of Big Data
Human and Natural Environment	<ul style="list-style-type: none"> • Community Awareness and Involvement • Sustainability (Climate Change)

The poverty and employment statistics in Figure 1 demonstrate the key challenges listed in Table 2 are real. Strengthening economic vitality is crucial as we work to rebound from job losses and reduce the poverty rate. The lagging economy and decreased property tax revenues have resulted in reduced City services and capital investments. In addition, transit funding limitations have contributed to declines in our transit service since 2012 after ten years of robust system expansion and ridership growth. Securing funding for transportation projects (all modes) in North Carolina has become increasingly difficult due to a paradigm shift in how funding is awarded. The City of Greensboro is making strides towards entering the 21st Century and establishing a network that will provide accessible data. The City's primary purpose is to support its citizens, organizations, and businesses, as well as to provide them an environment where they can thrive. Not only is the City responsible for supporting the human environment, but also the natural environment. Providing a connected human environment will be fruitless if the natural environment has not been sustained. This too will be dependent upon partnerships at



Figure 1. Economic Profile from Gig G Proposal (SC2 Finalist)



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the local, state and federal levels. Technology will also play a key role in creating a sustainable future for Greensboro.

Despite the challenges, Greensboro continues to work to find resources to address these challenges. For example, Greensboro and the Triad were chosen as recipients of two federal grants as shown in Table 3.

Table 3. Recent National Grants Received by the City and Triad Region

Grant	Recipient	Description
Economic Development Administration's SC2 Economic Visioning Challenge	City of Greensboro	Awarded \$1million under the Strong Cities, Strong Communities Economic Visioning Challenge (SC2) to develop a comprehensive plan for leveraging five major industry clusters in and around the City in an effort to creatively influence the next 50 years of urban and economic growth in Greensboro.. The winning proposal chosen by the City to receive SC2 funding, Global Opportunities Center, focuses on the development of a Global Opportunities Center that would be housed downtown and designed to leverage the extensive resources of local colleges and universities, corporations, and community partners by connecting and educating students and businesses in innovative ways that result in new global business and career opportunities.
HUD Sustainable Communities Planning Grant	Piedmont Authority for Regional Transportation	In 2010, the Triad Region, through PART receive \$1.6 million grant to undertake a three-year effort to develop a regional plan for greater prosperity in communities across the region. The plan addresses a wide range of issues including jobs, housing, transportation, climate adaptation, green infrastructure, demographic shifts, food systems, energy efficiency, and healthy communities.

In November 2015 Greensboro was recognized as a top 10 Digital City by the Center for Digital Government. Currently, the City is being evaluated by **Bloomberg Philanthropies to become the next "What Works City"**. What Works Cities is a national initiative launched in April 2015 by Bloomberg Philanthropies to help 100 mid-sized American cities enhance their use of data and evidence to engage residents, make government more effective, and improves residents' lives.

Addressing the Challenges

Recently adopted, the 2040 Metropolitan Transportation Plan (MTP) also establishes a vision for the Greensboro MPO Planning Area's transportation system:

"To develop and maintain a safe, efficient, and environmentally compatible transportation system that provides convenient choices for accessing destinations throughout the Greensboro Metropolitan Area and the Triad, including well-integrated, connected public transportation, pedestrian, and bicycle networks."

In 2004, Greensboro adopted its first comprehensive plan, *Connections 2025*, establishing an aspirational vision for the City's future:

"...In the year 2025...the City is recognized throughout the nation as an exceptional place in which to live, work, and play."

These objectives include improving community safety, connectivity, access, sustainability, and opportunity.

Starting with the *2040 Metropolitan Transportation Plan and Connections 2025* the City Identified multiple ways technology could be used to improve the transportation system and enhance the quality of life for the citizens of Greensboro.

The vision of the City of Greensboro's *Beyond Traffic: Smart City Challenge* application is captured in the five initiatives below that align well with the USDOT goals for the Smart City challenge. This vision has the potential to significantly improve and be replicated to enhance the quality of life of citizens, especially those in underserved areas in a meaningful and sustainable manner.



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Table 4. High Level Overview of Greensboro's Vision

Greensboro's Vision Elements	
Deploy an Enhanced Citywide Communications Network	The City will expand a newly installed 150-mile state-of-the-art fiber optic network that spans over 200 square miles and runs the Greensboro Traffic Signal System to serve as the communication backbone for our Smart City. We will also affix communications devices (Dedicated Short Range Communications [DSRC] compatible and Wi-Fi) along 27,000 streetlight with incandescent bulbs that we are going to switch to LED lights.
Deploy Smart Corridors	In addition to the Citywide communications network, five smart corridors have been identified as candidates for installation of advanced sensors that will include secure, standard compliant, DSRC equipment to allow Vehicle-to-Infrastructure (V2I) communication. The corridors will serve as real world test-beds for manufacturers and other third party application developers to test connected and automated vehicle technologies. Two of the corridors are targeted specifically for commercial vehicle manufacturers.
Connected Unmanned Aerial and Ground Vehicle Network	Test and demonstrate concepts of operations of unmanned aerial vehicles (UAVs) on a Citywide level to enhance the capability of Emergency Management Services and Public Safety response to incidents and emergencies rapidly, and in a cost effective manner.
Advanced Smart-Transit Systems	Upgrade the transit fleet with a network of state of the art electrified buses that charge en-route. The buses will also be connected and responsive to road infrastructure, and possibly automated in the near future. In addition proposing to implement regional Bus Rapid Transit system that will have both electric and autonomous bus service.
Smart-Multimodal Corridors	Greensboro will leverage the presence of advanced sensors, the Citywide communication network, and the information compiled on the data portal to implement solutions that will enhance safety and comfort of pedestrians, cyclists, disabled and older adults as they navigate the transportation system.

The Citywide deployment of Wi-Fi/high speed internet Smart Corridors and the UAV testbed will attract vehicle manufacturers, startups, and entrepreneurs interested in testing technologies and building on data dissemination. The Citywide Wi-Fi/high speed internet, advanced transit systems and multimodal corridor initiatives will improve the quality of life of all residents and will give underserved areas of the City the opportunity to experience the benefits of a connected community.

Listed below illustrates what the City of Greensboro has achieved in respect to the five proposed Smart City initiatives, the role the Smart City Challenge grant could play in accelerating that process, and the benefits to the community. Also discussed is how each initiative coordinates with on-going USDOT connected vehicle and ITS programs and identify potential collaborators the City has reached out to, so far.

Deploy an Enhanced Citywide Communications Network

The underlying infrastructure for any Smart City is its Information and Communication Technology (ICT) network. Greensboro ICT network is robust, as the City recently deployed a 150-mile state-of-the-art fiber optic network that connects 495 traffic signals, 54 traffic cameras, 70 City facilities, and 50 Wi-Fi hotspots within the City. This network is also unique in the sense that it was planned, designed, and deployed jointly by the City's Transportation and IT Departments in collaboration with the NCDOT. This collaborative approach and shared ownership allows the City to tie in multiple public buildings and facilities such as City Hall and local libraries, saving the City more than \$480,000 per year in communications fees that were paid to third party vendors. Linking multiple public assets also creates a data-rich environment.

In 2014, the American Council of Engineering Companies selected the Greensboro Transportation and Information Technology departments for its Engineering Excellence Award because of the unique fiber optic/Ethernet communication protocol signal system the City installed. The award noted that *due to the improved and expanded signal system, the City of Greensboro's 277,080 residents now experience fewer delays along their roadways: the City estimates "green bands"—the progressive flow of traffic—have been improved by 20% on some corridors.*



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The 50 Wi-Fi sensors are currently installed along major arterials allowing City staff to wirelessly access the network while in the field. The City has identified 400 more locations along a network of 27,000 streetlights where 400 more Wi-Fi hotspots could be installed to create a Citywide communication network. When fully built out, the 400+ Wi-Fi hotspots will save the City an additional \$187,000 annually in communication fees currently paid to third party providers.

In addition to installing Wi-Fi equipment on the 27,000 streetlights, the grant would allow the City to upgrade the streetlights from incandescent bulbs to LED lights, and build in intelligent sensors for the streetlights that would enable smart management tools to greatly improve energy efficiency.

If awarded a Smart City grant, the City would install a combination of Wi-Fi and DSRC compatible roadside equipment to establish a City wide wireless network. This enhanced network will support data collection, connected vehicle technology, enhanced traffic management, and various Smart City related technologies. In summary, winning the grant will allow the City to:

- Build on and enhance an already existing communication and data transmission platform into a high-speed Citywide communication and computing network on which the Smart City related initiatives will run;
- Deploy a state-of-the-art energy efficient, sustainable and environmentally intelligent LED streetlighting system; and
- Realize significant cost savings (due to both the transition to LED lights and deployment of a more intelligent lighting system) that could be leveraged for other Smart City related applications

System applications would include real-time data collection and processing to support connected vehicle applications to improve vehicular safety and mobility. System applications would also include enhanced pedestrian signalization, pedestrian detection, and routing information for use by logistics and freight firms and other system users. It would help provide Citywide wireless communications, as well as enhancing public safety and enabling the provision of high speed internet connections to the entire City.

Prospective partners we identified include Duke Energy for collaboration on the streetlight infrastructure, the AT&T Alliance (including partners Ericsson and IBM), and North Carolina A&T State University for planning and upgrading the infrastructure.

Deploy Smart Corridors

In addition to the Citywide data and communication network, five candidate corridors have been identified based on *Connections 2025 and 2040 Greensboro Urban Area Metropolitan Transportation Plan (MTP)* for installation of advanced infrastructure for a test bed. The test bed would include state-of-the-art signal control equipment, advanced pedestrian and bicycle detection technologies, Bluetooth and Wi-Fi detection, and other sensors. Manufacturers could test Vehicle-to-Vehicle (V2V), Vehicle-to-Infrastructure (V2I), and Vehicle-to-Devices (V2D) systems. Pedestrians and equipped vehicles can experience the full benefits of connected vehicle technologies. System applications on the corridors will include real-time data collection and processing to support adaptive signalization and other system management tools. These include enhanced pedestrian signalization and detection, enhanced conditions/routing information, and can be leveraged for use by logistical freight firms or other system users.

Greensboro will develop detailed documentation of the technologies installed and share them with strategic partners such as automobile, transit, and truck manufacturers to test their vehicle technologies on the corridors. The City is partnering with surrounding communities to develop 1,400-acre Mega-site just south of the Guilford County line to attract a large auto or industrial manufacturer which would benefit from this test bed.



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Stakeholders will have access to a diverse range of roadway conditions to test and underserved communities will benefit from the emerging technologies in the selected corridors. Selected corridors are listed in Table 4 and will be revisited during the second phase of the grant application process. The goal is to have at least one freight-oriented corridor, one auto-oriented and an economic corridor.

Table 4. Initial List of Candidate Smart Corridors

Corridor Name	Brief Description	Type/Reason Selected
Gate City Blvd, from I-40 to South Elm-Eugene St.	4 lane arterial, 4.1 miles, has 14 signals	Enhanced Transit and Economic Corridor connecting Underserved Communities and Downtown to the Coliseum, Convention Center, Universities, and Shopping
Wendover Avenue from I-40 to US-29	4 lane collector, 8 miles, 11 signals	Economic Corridor – Connects Underserved areas of East Greensboro to Western Greensboro amenities.
Interstate 40 from I-73 to I-840 (Urban Loop)	8 lane freeway, 14.5 miles	High Volume East – West Freight Corridor
US Route 29 from I-40 to Urban Loop	4 lane freeway, 7.6 miles	High Volume North – South Freight Corridor
Market Street from Wendover Ave to US-29	4 lane collector, 3.9 miles	Economic Corridor – Connects underserved areas to downtown, NC A&T, UNCG, Greensboro College

The Volvo Group North America is based in Greensboro and is a leader in truck automation. They are a key collaborator in the USDOT Commercial Vehicle Infrastructure Program. The City held initial discussions with Volvo and it is prepared to share some of its truck platooning and automation concepts it has been developing in the US and Europe. Discussions also centered on a pilot program to equip compatible commercial vehicles in the City's fleet with Volvo On Board Equipment to demonstrate V2V and V2I applications. In addition, local non-profits such as Code-For-Greensboro, part of Code for America, are interested in developing transportation applications and mobility solutions using the massive amount of data generated from this initiative and make it readily available on our Greensboro Open Data Portal Other stakeholders include FedEx (with a major ground sorting facility near Greensboro and its Mid-Atlantic Hub at Piedmont Triad International Airport in Greensboro), XPO Logistics, AT&T, Ericsson, IBM, and Norfolk Southern Railway (which operates a major intermodal transfer facility in Greensboro).

Connected Unmanned Aerial and Ground Vehicle Network

The Greensboro Police Department has explored using UAVs to assist in response to emergency situations. The US Air Force has awarded one of our local universities, North Carolina A&T, a \$5 million grant to assist the agency develop concepts of operations to deploy multiple autonomous vehicles working together collaboratively to conduct air, ground, on-water, and underwater missions.

The Smart City Grant will provide the opportunity to develop and test the operation of UAVs for a range of emergency response and safety applications in a real world environment. As an example, in the case of a roadway incident, a UAV with a camera system deployed to the scene can provide information on number of vehicles involved in the incident, whether there is a fire response needed and roadway conditions so that appropriate assets can be deployed. With the presence of the enhanced communication network that will be in place, the UAVs can access the network to transmit data and photos to a command center. Uses for the UAV include:

- NCDOT, Greensboro DOT- Data collection to identify critical needs in more systematic way and project development.
- Freight- Use real time data to assist in making logistical decisions.
- Police- Use to assist in finding missing persons and identify resources needed to respond to major incidents.



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- Fire- Use to assist in fire pre-planning to inventory large commercial or industrial buildings.

The City will lead a team made up of researchers at North Carolina A&T University (a USDOT UTC center), AT&T, the Greensboro Police Department, and the Greensboro Fire Department to develop test and deploy the UAV concept as part of our Smart-City initiative.

As noted in *Beyond Traffic 2045*, increased production of oil and natural gas will strain existing pipeline capacity and pipeline infrastructure replacement and repairs will be key to safety. A section of a key national pipeline from Houston, Texas to Linden, New Jersey, and operated by the Colonial Pipeline Company runs through Greensboro. On multiple occasions the company dispatches aircraft to monitor and survey sections of the pipeline. If the UAV application is a success it could be expanded to survey such key national assets.

Advanced Smart-Transit Systems

There are two transit related initiatives the City wants to pursue as part of this grant. The first is to integrate electric buses with enhanced data collection and intelligent vehicle applications into the transit fleet. The other is a bold plan to collaborate with the Piedmont Authority for Regional Transportation (PART), our regional multi-jurisdictional agency for bus transportation to test the concept of a semi-automated transit bus service.

A key concept of our Smart City is a state-of-the-art transit system that is electrified, connected and responsive to road infrastructure, as well as potentially automated. In November of 2015, the City of Greensboro began its due diligence process to prepare for the purchase of electric buses. Greensboro has secured funding and plans to procure five electric buses including quick charging stations that can recharge a bus within five to ten minutes. Over the next two to five years the City of Greensboro will need to replace fifteen buses that will have exceeded their useful life and plans to procure all electric vehicles.

Replacing fifteen to twenty buses with electric buses and fast charge stations will offer significant savings in energy usage, maintenance savings, and will substantially reduce carbon emissions. Integrating intelligent vehicle components and Mobileye technology into the transit fleet will provide enhanced user information and improve safety through automatic crash detection and avoidance. Funds from the Smart City grant would also be used to install a solar shed at the new 15 acre GTA maintenance and operations facility which will be used to recharge electric buses.

The Greensboro Smart City will also establish a new electric bus circulator route along Gate City Boulevard from the Koury Convention Center to downtown and will provide quick and convenient access. The circulator route will feature (15) to (20) minute headways and will serve as a test-bed for autonomous bus implementation.

The Smart City grant will allow the City of Greensboro to accelerate its plans to procure electric buses, and will also foster collaborations with the NC A&T University Autonomous Vehicle Research Center and the University of Pennsylvania's UTC research center to test various levels of automation on the City's transit system.

Another bold and creative application we want to explore with this grant opportunity is to test public acceptance of autonomous and connected transit. In cooperation with PART, the region is considering the pursuit of a federal New Start Transit grant to create the Triad's first Bus Rapid Transit system between Greensboro, High Point, Winston Salem and the Piedmont Triad International Airport. The City would like to take advantage of the Smart City initiative to develop capabilities for at least one of the Bus Rapid Transit buses to be fully autonomous. The autonomous bus could be initially deployed on specific day and times, with a driver on board initially, similar to how Google autonomous cars have been tested. Our region is one of the few in the country with a multi-regional transportation agency (PART) and also has two



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USDOT Challenge criteria cities (Greensboro and Winston Salem) within 25 miles from each other. This will give residents of two target cities the opportunity to experience the benefits of autonomous technology.

Smart-Multimodal Corridors

A major obstacle facing bicyclists is the lack of detection at signalized intersections. As a result, bicyclists are forced to either dismount to use the pedestrian push button or run the red light if no other vehicles arrive to trip the loop. Understanding this issue, the City of Greensboro has installed loop detectors in bicycle lanes to assist bicyclists cross busy intersections safely and conveniently. However, the loop detectors are not perfect for this task. The City would like to upgrade this technology with more accurate and reliable sensors under the Smart City grant. The bicycle detection information can be utilized with vehicle location data, and real-time Signal Phase and Timing (SPaT) information to generate a range of safety applications as described the Pedestrian Mobility application concepts in the USDOT Connected Vehicle Reference Implementation Architecture (CVRIA).

The Smart City grant will provide the City of Greensboro the opportunity to expand pedestrian and bicycle detection and merge the data generated with CVRIA. It is expected that stakeholders like Code-For-Greensboro and the AT&T Alliance (Ericsson, IBM) will partner with us to mine the data and create applications for the public.

Summary of Greensboro's Smart-City Vision

The Smart City grant will accelerate progress on a variety of initiatives already underway and will allow Greensboro to partner with universities and the business community to further develop bold transportation initiatives that will improve transportation safety and mobility, and to connect underserved areas in our community. Table 5 highlights Smart City initiatives the City is already pursuing through the Bloomberg Philanthropies "What Works City", and federal programs like the Transit New Starts program. We believe Greensboro could be transformed into a hub for vehicle and technology development that could greatly influence Greensboro's and the Region's economic future.

Table 5. Overarching Scope of Smart City

Proposed Initiative	Resources in place/planned	Role Smart Cities Grant	Role of Other Sources
Deploy an Enhanced Citywide Communications Network	\$24 Million Signal System featuring a 150-mile Fiber Optic Ethernet Network which controls 495 traffic signals, 50 CCTV, 40 Wi-Fi hotspots and expanded service that includes all City facilities and 400 Wi-Fi hotspots	Expand the 150-mile fiber optic Ethernet system and replace 27,000 streetlights with LED lights and DSRC Road Side Equipment to create a communications mesh that will support a variety of Smart City Initiatives.	Accelerate deployment plan through collaboration of the Bloomberg Grant
Deploy Smart-Infrastructure Corridors	State-of-the-art traffic signal system signal.	Install V2I DSRC equipment on 5 corridors.	Advanced signal control equipment through CMAQ
Connected Unmanned Aerial Vehicle Network	Developing operating concepts of the UAV network.	Deploying and demonstrating UAV equipment with UTC Center at NC A&T State University	
Advanced Smart-Transits Systems	Purchase 5 electric buses. Deploy BRT System	Purchase additional buses, deploy autonomous BRT System in collaborating with PART	Expand City fleet of electrified and autonomous vehicles.
Smart-Multimodal Corridors:	2 automated bike detection locations/ Expand # of locations for bike/pedestrians	Integrate data in portal and DSRC RSE.	Expand number of detection locations.



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Program Management

This will be a large project and needs to be managed in a systematic manner. The City will follow standard industry Program and Project Management (PPM) practices in managing the project. Several of the City staff are certified program management professionals (PMP) and hold Certified Government Chief Information Officer (CGCIO) accreditations. They are:

- Doug Hanks, PMP Level II, MPM (Master Project Manager) – Certifications from the Defense Acquisition University and the American Academy of Program Management
- Aimee Walker, PMP and Certified Government Chief Information Officer
- Rodney Roberts, Certified Government Chief Information Officer
- Gerrad Biffle, Certified Government Chief Information Officer

Doug Hanks will lead program management efforts which will define the activities and tasks guiding the team and other project managers in managing the scope, schedule, and cost of a project. We will develop a comprehensive road map of tasks, deliverables, tools, and procedures at the onset of the project.

The Project Startup phase includes six components of project management 1) work plan management; 2) risk management; 3) change management; 4) issues management; 5) quality management; and 6) knowledge transfer management. The effort will be customized to meet the specific needs of this grant to enable the project manager to effectively manage the uncertainty and changes that are part of every project. The project manager will establish schedules based on project metrics and milestones while balancing risk management and quality assurance to meet project objectives.

2. Population and Characteristics of Greensboro

The City of Greensboro is the third largest City in North Carolina. Greensboro can be defined as a mid-size City with a 2010 Census Designated Place population of 269,666. Also, Greensboro's population density is 1456 people per square mile. The percentage of the population which resides within the Greensboro Urbanized Area is 86.31%. More information on Greensboro's demographics can be found in the [2016 Growth and Trend Report](#).

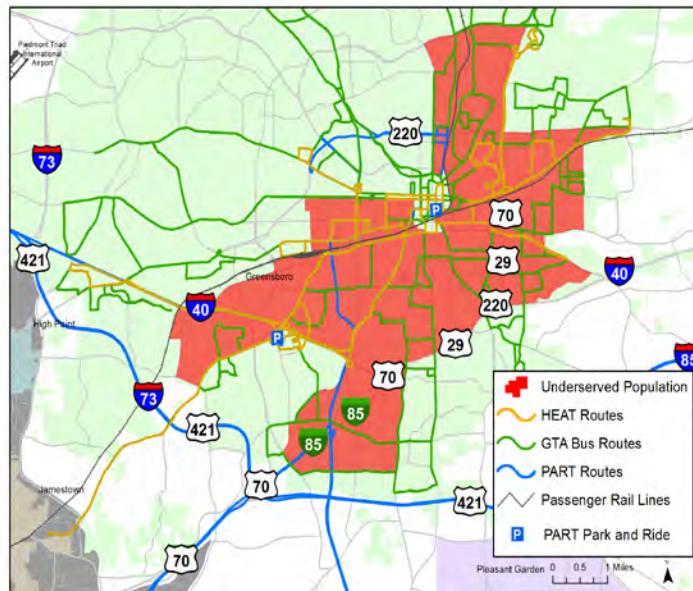


Figure 2. Dense Public Transit Coverage

3. Characteristics of Greensboro and How They Align with USDOT's Characteristics for a Smart City

A Public Transportation System that Connects Underserved Communities

Public transportation in and around Greensboro is provided by the Greensboro Transit Authority (GTA), Guilford County Transportation and Mobility Systems (TAMS), and PART. GTA provides transit and para-transit services within the City. TAMS provides para-transit within the county. PART connects the cities of the Piedmont Triad (Burlington-Graham, Greensboro, High Point, and Winston-Salem). These three agencies provide residents of the City and the region with transportation options other than personal



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automobile for their daily activities. Figure 2 illustrates the area's existing fixed bus routes, passenger rail routes, and park-and-ride lots. Below is a summary of their services.

Greensboro Transit Authority (GTA)

GTA was created when the City of Greensboro took over local transit services from Duke Power's Transit division in 1991. Today GTA operates a substantially improved range of fixed route services, a Higher Education Area Transit (HEAT) service targeted at university students, and SCAT a shared-ride service for eligible riders who have a disability that prevents them from using the fixed route bus. A menu of services is provided in Table 6.

Table 6. Menu of Transit Services

Service	Description
Standard routes	16 fixed routes, 14 with service every 30 minutes during daytime hours connecting at the Depot
Connector routes	One fixed route with hourly service that extends the service area of standard routes
HEAT Routes	Four fixed routes with hourly or more frequent service that are targeted at college and university students
SCAT	Specialized Community Area Transportation, a Citywide paratransit service that provides transportation for users with disabilities
Sunday Routes	Seven hourly fixed routes that are modifications of the weekday routes

Guilford County Transportation and Mobility Services

Guilford County Transportation and Mobility Services provide transportation services for elderly individuals and Medicaid recipients throughout the county. Outside the Greensboro and High Point urban areas, TAMS provides rural shared-ride transportation for individuals with disabilities and the general public.

Piedmont Authority for Regional Transportation (PART)

Established in 1997, PART operates the regional transit system and provides regional planning and support function. Its members include the four Triad MPOs (Burlington-Graham, Greensboro, High Point, and Winston-Salem), the major Cities, and the surrounding counties. PART's system includes regional bus service connecting the City bus systems of Greensboro, High Point, and Winston-Salem and surrounding counties; a Regional Ridesharing/Vanpool Program; regional out-of-county non-emergency medical transportation/express bus service to the UNC Hospital System. In addition, PART plans for future regional transit services including fixed guideways such as BRT.

Environment that is Conducive to Demonstrating Proposed Strategies:

Greensboro has considerable assets in place that make it well suited to be the site of the USDOTs *Beyond Traffic: The Smart City Challenge*. The City of Greensboro has:

- State of the Art Signal/ITS System with an expansive fiber optic Ethernet network.
- A well connected and integrated transportation system/network.
- A prime location within the east coast "Mega Region" with 4 major interstates providing access within a one (1) days drive of several major metro areas (Atlanta, Nashville, Louisville, Cincinnati, Columbus, Pittsburgh, Philadelphia, Baltimore, Washington DC, Norfolk/Virginia Beach). Two major rail lines and an intermodal port with direct access to the deep water port of Norfolk.
- Proactive and Resourceful Partners

Expansive Fiber Optic Network

The City of Greensboro **fiber optic network** spans 200 square miles across our municipality providing Ethernet communications to traffic signals, CCTV cameras, Wi-Fi hotspots, public facilities (libraries,



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recreation centers, parks, coliseum) and public safety facilities (Police, Fire, E-911). The fiber optic network provides staff and citizens access to high-speed connections and forms the base for enterprise services and other Internet-based services for the small, mid-tier and enterprise level businesses.

Through the fiber optic Ethernet system, the City has the ability to connect three separate data centers at speeds from 1 Gigabit to 40 gigabits. This combined ICT and IT Network is vast and constantly growing, supporting the 495 traffic signals and 550 video surveillance nodes at busy intersections as well as at 70 Greensboro facilities.

The project to replace the traffic signal system began in 2008 and was completed in 2013. At \$24 Million, the Greensboro traffic signal system was the largest signal system project of its kind ever undertaken in North Carolina and one of the first Ethernet based systems in the United States.

The communications network which enables a central computer to communicate with each traffic signal was updated with fiber optic cable which spans over 150 miles throughout the City.

During the planning of the new signal system the Transportation Department partnered with the Information Technology Department and identified deficiencies in their network which connects various municipal facilities throughout the City. As a result, the IT Department funded 29 miles of additional fiber optic cable that was installed concurrently with the signal system cable. This enabled the City to extend the reach of the signal system to key corridors on the perimeter of the City and to connect to several City facilities that had previously been outside the IT network.

In addition to the benefits afforded by the fiber optic cable, the system itself is state-of-the-art with many capabilities beyond those of the previous signal system. New 2070 style traffic signal controllers, which communicate directly with the central computer, are installed at each intersection. These controllers are capable of more complex signal phasing patterns than were available previously. The controllers are capable of concurrently controlling other devices such as school flashers and sending an e-mail to signal technicians when a malfunction is detected. Additionally, 54 GDOT-owned CCTV cameras are installed to monitor traffic conditions at critical intersections. **The signal system is easily expandable to control 1000+ signalized intersections. This expansion capacity along with advanced traffic control features and the stability of a fiber network will enable effective management of traffic well into the future.**

In 2014 the Greensboro Traffic Signal System won the International Institute of Transportation Engineers(ITE), Intelligent Transportation Systems (ITS), "Project Achievement Award, Best New Project" award.

Connected and Integrated Transportation System

In Beyond Traffic 2045, the letter from Secretary Fox notes three strategies for addressing future transportation demands:

- Taking better care of our legacy transportation systems
- Building what is new and necessary, taking into account changes in living patterns and where products will move to and from
- Using technologies and better design approaches that will allow us to maximize the use of our old and new transportation assets

Given that the City of Greensboro's transportation system has experienced extensive growth, Greensboro has partnered with the Greensboro Urban Area MPO and NCDOT to diligently implement similar strategies. The Greensboro Urban Area MPO Planning Area (approximately 70% of the population resides in the Greensboro) has been strategic in its use of federal and state funding to strengthen the transportation system. The Greensboro Urban Area MPO's MTIP FY 2016-2025 provides for substantial investment in the



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area transportation system of \$896,591,000 according to MPO analysis. This equates to an average annual investment level of \$89,659,100 over a ten-year period. Of this, 68% of the funding was for roadways, while 14% was for transit and 3% was for bicycle and pedestrian projects. The Urban Area has been able to develop a well-functioning system over the last 20 years and now must explore creative ways to maintain it.

The City of Greensboro is committed to an ongoing and prioritized sidewalk construction program. Since 2006, 133.3 miles have been added, 44.2 by independent sidewalk projects, 25.5 miles by City or NCDOT road projects, and the rest primarily through development ordinance requirements. The City currently has 123 miles of sidewalk projects at various stages of design, right-of-way, and construction.

In 2007, Greensboro hosted a kickoff for Greensboro Shares the Road and implemented its first annual Bicycle Safety Month. The City partnered with NCDOT in 2014 for the Watch For Me NC campaign. The Watch for Me NC program involved two key elements: 1) safety and educational messages directed toward drivers, pedestrians and bicyclists, and 2) enforcement efforts by area police to crack down on related traffic safety violations. The City has also been designated as a **Bronze Level Bicycle Friendly Community 2009-2017**.

Greensboro is partnering with public interest foundations and the private sector to build a four-mile greenway loop corridor around the central business district. The downtown greenway will be the central hub of the regional greenway network and has emerged as a powerful catalyst to the redevelopment and densification of the central City. With only $\frac{3}{4}$ miles of the Downtown Greenway currently complete, over \$200 million in private development has occurred near or adjacent to it, with more underway and planned. This project in its own way can help the City achieve its Smart City objectives while removing barriers and reconnecting communities.

Public transportation directly increases accessibility and mobility of people and promotes quality of life by providing more travel choices. Since GTA took over transit services in 1991, ridership has increased significantly from 500,000 passenger trips per year in 1991 to 4,500,000 trips per year in 2015. GTA's fleet has grown from 39 vehicles in 1991 to 104 vehicles in 2015.

The J. Douglas Galyon Depot is the City's transportation hub which serves as the central transfer point for connects GTA's fixed route services as well as hosting the PART regional bus system, Greyhound/Trailways interCity buses, Amtrak passenger rail service, and local taxi services. More than any previous generation, Millennials, those born between 1980 through the mid-2000s, are choosing to live in communities where cycling, walking and transit are preferred options.

A Proactive and Resourceful Partner

The City of Greensboro is very proactive and consistently seeks opportunities to efficiently utilize resources, reduce costs, and secure alternative funding sources to supplement normal federal and state funding. Recent successes include:

- Greensboro partnered with BrightFields Transportation Systems and a grant from Nissan North America to install electric vehicle charging stations in downtown Greensboro, including a level-3 fast charge station.
- The City partnered with PART to install **Plug-in-Electric Vehicle (PEV)** Charging Stations using funds provided by a Clean Fuels Advance Technology grant. Five stations were installed across the Triad, including one inside of the City's parking deck.
- City's Transportation and IT Departments in coordination with FHWA and NCDOT collaborated to build a fiber optic network through the new signal system that tied in multiple public buildings and facilities such as City Hall, local libraries, Fire Stations, Police Substations that enabled the City to save over \$480,000 per year in communications fees.



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- The planned expansion of existing 50 Wi-Fi sensors to 400 more locations will save an additional \$187,000 annually in communication fees.
- Greensboro MPO, in cooperation with other Triad MPOs, PART, and NCDOT applied for and were awarded the SHRP2 Grant for the Implementation Assistance Program in the area of **Innovative Local Freight Data**. The grant award was used to assist in completing Phase I of a three-phased approach to identifying and collecting freight data to support the Travel Demand Model.
- GTA has used partnerships, marketing and education, regional coordination, infrastructure and technology, and transit supportive development as strategies to attract additional riders and expanding transit markets. Since that time, GTA has exceeded ridership goals through a mix of facility improvements, new services, and partnerships with local universities.

If Greensboro is awarded the "Beyond Traffic: The Smart City Challenge" grant our focus will not only be on spending the funds on technology, we will also solicit key stakeholders to share costs.. Our proposed initiative to swap out incandescent streetlights to LED is projected to save the City about \$1 million in annual operating expenses will greatly reduce energy requirements and carbon emissions and can only be accomplished through our partnership with Duke Energy.

Prime Location



Figure 3. Strategically Located

The City of Greensboro is anchored at the crossroads of four interstates (I-40, I-85, I-73, and I-840) and seven major NC and US routes. The City's mid-Atlantic location and interconnected network provides efficient access to three international airports (within 2 ½ hours) and 5 major ports (within 6 hours.) Greensboro is less than a two-hour drive from Winston-Salem, Raleigh, Charlotte, Durham and Fayetteville – four other cities that meet the USDOT population criteria. By selecting Greensboro, there is a high probability that any initiative being tested in Greensboro will be experienced by residents of these cities and **successful proof-of-concept applications could be rapidly replicated and deployed** in those cities with USDOT and NCDOT coordination. **Greensboro is the only City in the list of USDOT cities that is within 2 hours driving distance of 5 of the target cities.**

Greensboro is also home to Piedmont Triad International Airport which houses the FedEx Mid-Atlantic Hub and Honda Aircraft Global Company's Headquarters. Two Class I railroad lines converge in the City and Greensboro houses one of Norfolk Southern's major intermodal terminals.

Our region is one of the few in the country with two of the USDOT Challenge criteria cities (Greensboro and Winston Salem) within 25 miles.

Committed Leadership with Continuity and Capacity to Execute Projects

The City of Greensboro is committed to implementing the proposed Smart City initiatives that have been described in the "Beyond Traffic: Smart City Challenge" grant application. The Greensboro City Council along with The Transportation Advisory Committee (TAC) of The Greensboro Urban Area Metropolitan Planning Organization (GUAMPO) have enthusiastically endorsed the City's participation and have



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committed the necessary resources and leadership to implement the projects which have been identified in the City's application.

Commitment to Integrating with the Sharing Economy

The City has worked with various entrepreneurial firms in the sharing economy:

- UberX has operated in Greensboro since late June, 2014. The State of North Carolina has enacted laws allowing ride sharing services.
- The University of North Carolina at Greensboro's (UNCG) Parking Operations and Access Management Department has multiple ride and bicycle sharing programs. UNCG offers a carpooling club for special parking rates with a website to pair riders, a bike sharing service, and is a Zipcar partner which allows short term hourly car rentals.
- PART, cooperates in the Share the Ride NC carpooling website and offers vanpooling services for commuters who live at least 10 miles from work.
- Area stakeholders are currently working with the City to scope and plan a bicycle share system that would place bicycles at major destinations areas including universities and major shopping destinations. Efforts are currently focused on identifying needed capital funding and a sustainable revenue stream to support operating costs.

Commitment to Open and Accessible Data (Machine-readable) Platforms

The City of Greensboro is committed to making open, machine-readable data accessible, discoverable, and usable by the public to fuel entrepreneurship and innovation. We have recently launched our Open Data Platform at <https://data.greensboro-nc.gov>. Our portal allows citizens and organizations to access public data via bulk/ filtered data download and via an Application Programming Interface (API). The API allows citizens, 3rd party organizations, and groups to develop web and mobile applications that collect and disseminate the data to the public. We have a vision to implement scores of datasets to achieve the following goals:

- Increase transparency and accountability
- Leverage program performance data to connect stakeholders, enable collaboration across silos, and to drive data-driven and evidence-based decision making
- Expand self-service access to information for citizens, employees, and businesses
- Accelerate the delivery of digital services on web and mobile platforms
- Improve communication and community engagement
- Enable employees to deliver their programs more quickly and efficiently, and
- Create opportunities for developers and entrepreneurs to innovate in our economy.

These efforts will assist with facilitating government transparency, promote community engagement, and stimulate local and regional innovation and entrepreneurship. To further this initiative, the City has committed to maintaining an open dialog with Code for Greensboro, businesses, non-profit organizations, and to our citizens. **The IT Department has also authored an Open Data Portal Policy** which is currently under review with senior leadership.

Finally, we are planning an **active and robust media campaign** to inform, educate, and engage citizens on the merits and benefits of the City's Open Data program.

4. Annotated Preliminary Site Map

See Annotated Map Insert at end of the narrative.



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5. Integrated Approach Alignment with USDOT Vision Elements

Table 7 below lists the proposed initiatives from the City of Greensboro and provides a high level view of how they align with USDOT priority areas. The totals in the last row highlight the fact that a large number of our initiatives align well with the highest priorities areas (1 to 3), and hence our vision as defined is likely to lead to implementation of goals that are of high priority to the USDOT.

Presented below is more detail about each USDOT vision area and how our plans align with those areas.

USDOT Highest Priority Vision Elements – Technology

Vision Element #1 Urban Automation

The City of Greensboro's Enhanced Citywide Communication Network would support smart vehicle technology, enhanced traffic management, and technologies that improve public safety. The System would also feature the replacement of all 27,000 streetlights with LED lights that include communication devices to support the expanded communication plant.

- Once augmented with the City-wide DSRC and Wi-Fi roadside equipment the existing fiber optic Ethernet, which supports the traffic signal system, will become the communication backbone that will support data transmission to and from connected and autonomous vehicles, and will also be utilized to enhance traffic management.
- The installation of the DSRC and Wi-Fi equipment will be linked to the replacement of 27,000 incandescent streetlights with LED which will offer multiple benefits including:
 - Increased energy efficiency and environmental savings: estimate saving of 12,000,000 kWh per year (equivalent of the energy use of 1000 homes) and save Greensboro \$1 million in streetlight operation costs.
 - A 12 million kWh per year reduction reduces the carbon footprint by 12,000 to 13,000 tons of CO₂ per year (U.S. Energy Information Administration - <https://www.eia.gov/>) and saves 5000 tons of coal from being burned, reducing coal ash emissions by 500 tons. Adding Solar Cells could create further savings.
 - LED Lighting enhances safety as it provides more light per watt (80 lumens/watt versus 58 for conventional streetlights), focused versus diffused lighting, and can vary brightness with pedestrian detectors.
 - LED lights can self-report to the data portal if not functioning.
- The City will take advantage of the ubiquity of the streetlights and leverage them as communication nodes to install DSRC compatible and Wi-Fi devices to enhance communications with smart vehicles and communication/data enhancements to improve logistics and freight movement.
- The communication network can be utilized to build out a wireless communications infrastructure throughout the City, which can be used for a variety of "Smart City" initiatives to enhance public safety as well as the potential to provide Wi-Fi/high speed internet connection throughout the City.
- We will also develop a Transportation Data Portal/Center, with an open-source component that will house all the communication over our network.

The existing fiber network infrastructure will provide the platform for Vision Element #1, Urban Automation.



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Table 7. Concept Smart City and USDOT Priority Areas

Proposed Initiative	Activities/Projects	US DOT Vision Priority Areas												# of Priority Areas
		1	2	3	4	5	6	7	8	9	10	11	12	
Enhanced Citywide Communications Network	- Expand reach of 150-mile Fiber Optic Network													5
	- Upgrade 27,000 street lights to LED													3
	- Expand 40 Wi-Fi hotspots to more than 400 Wi-Fi and DSRC compatible RSE													2
	- Develop Open Transportation Data Portal/Center and connect to fiber optic network													5
Deploy Smart-Infrastructure Corridors	- Install additional sensors and detectors (DSRC) on Smart Corridors to enable V2I communications, city may also install OBE on commercial fleet													4
	- Upgrade existing state of the art signal control system on Smart Corridors													4
	- Transmit data to Transportation Data Portal/Center and develop analytic applications													8
Connected UAV Environment	- Develop operating concepts													4
	- Deploy off-the-shelf UAVs to test concept													4
	- Transmit data to Transportation Data Portal/Center and develop analytic applications													6
Smart-Transits Systems	- Purchase Electric Buses for transit corridors													3
	- Develop and deploy BRT System													2
	- Deploy autonomous Electric Bus on BRT and transit route													6
	- Transmit data to Transportation Data Portal/Center and develop analytic applications													7
Smart-Multimodal Corridors:	- Expand network of bike and pedestrian detection equipment													3
	- Link equipment and transmit data to Transportation Data Portal/Center													7
	- Transmit data from Greenway and other initiatives to Transportation Data Center and develop analytic applications													7
Initiatives that align with US DOT Vision Priority Areas		7	10	11	6	5	3	8	2	8	9	4	7	



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Vision Element #2 Connected Vehicles

Connected vehicles require real time transportation data to analyze driving conditions. This will be accomplished utilizing the City's fiber network and new DSRC wireless equipment to link vehicles to open transportation data sources. These sources will include dynamic information from traffic signal system sensors which will communicate road conditions, lane closures, traffic congestion, and accident information. This system will interface with Public Safety to report and retrieve information on incidents affecting traffic conditions. Interfaces with social apps will be available by providing transportation data in a machine readable format on the City's open data portal.

Vision Element #3 Intelligent Sensor-Based Infrastructure

The fiber connected LED network will use sensors to gather and analyze data that will be utilized in the traffic signal system network to address current traffic situations. The sensors will communicate with the traffic signal system as well as vehicles and social apps providing traffic and situational information. Cameras, Radar/LIDAR and other visual systems can be integrated to measure traffic speeds, traffic volumes, and public safety monitoring. Vehicles will receive information on lane closures, turning restrictions, travel directions, speed, congested traffic areas, streamlined routes, parking and loading availability, etc. The sensor network will provide a range of V2I and ITS capabilities including:

Table 8. V2I and ITS Features

Features	Capabilities
Safety Monitoring and Warnings	Hazardous Roadway conditions, Speed limits, Obstacle Discovery, Accident Reporting
Traffic Management	Variable Speed Limits, Adaptive Traffic Control, Emergency Responder accommodations, Freight, Transit, pedestrian detection and signalization
Driver Assistance	Speed Control, Lane Control and Cruise Control
Travel Related Information	Route Optimization Tourist Information, Maps, Location based information Support a future bike share program

USDOT High Priority Vision Elements – Urban Transportation

Vision Element #4 Urban Analytics

Analysis of available and newly collected datasets would enhance the potential of data-driven decisions about transit routes and schedules, infrastructure investments, integrating new smart technologies, and would create efficiencies in updating how the transit network functions. A more holistic view of the current state of the transportation system would result by acquiring transit data from entities such as our GTA fleet, PART, Uber, and Amtrak. Such data could then be analyzed alongside public transportation data, traffic counts, as well as bike and pedestrian data. This would allow and provide foresight on planning for the future of Greensboro as a Smart City. An example of the possibilities includes combining economic, census, and transit GIS data to allow mapping of employment locations accessible to various neighborhoods via public transit within a given commute time. Information of this type would be invaluable as the City makes decisions on improving its transit network, and makes the case for more citizens to utilize public transit.

Some of the benefits the planned Data Center provides include:

- Allowing for real-time analysis of network conditions
 - Quantifies Short term and Long Range Planning Opportunities
 - Integrates Entire Road Network to work Cohesively
- Provides Public Facing API's (Application Program Interface) and machine readable data formats (CSV's, Shapefiles, databases)



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- Freight and Logistics Companies could access the data in real-time to make decisions
- Provides Data to app creators/Spurs Innovation; Code for America/Code for Greensboro

Vision Element #5 User Focused Mobility Service and Choices

Using the transportation data that is collected from the sensor network we will be able to analyze traffic patterns and develop more efficient transit routes based on high demand. This data analysis can also include Uber drop off and pick up locations. Uber can be utilized to provide a first and last mile transportation interface with bus transit routes. Real time GPS information from connected buses will provide up to the minute route information which can be accessed by smart phones, smart bus stops, and smart vehicles. Social bus routes using electric buses will focus on popular destinations including shopping, dining, entertainment, universities, and medical facilities.

Vision Element #6 Urban Delivery and Logistics

The fiber communications network and data from sensors will be the platform for building intelligence into the transportation infrastructure to communicate optimal routes, optimal time, speeds, signal synchronization, loading zone and parking availability, and situational data. The 5 Smart Corridors can be utilized by strategic partners such as automobile, bus, and truck manufacturers to test their vehicle technologies on the corridors. Greensboro will develop detailed documentation of the technologies installed and share with strategic partners.

Vision Element #7 Strategic Business Models and Partnering Opportunities

The City of Greensboro is partnering with surrounding regional entities to encourage the development of high-speed broadband networks to meet the technological needs of current and future businesses, public institutions, educational institutions, healthcare, transportation, and local residents. The initiative called TriGig, is a collaboration between the City of Greensboro, City of High Point, City of Burlington, Guilford County, UNC-Greensboro, NC A&T State University and the Piedmont Triad Regional Council. The goal is to establish our region as a world class broadband community driving enhancements in economic development, education, healthcare, transportation, and other quality of life components of the region.

The TriGig Initiative seeks to work with internet service providers to make access available to a common pool of assets, services, and infrastructure to support the deployment of gigabit speed broadband throughout our community including underserved areas of the City. Developing a comprehensive high speed broadband network in Greensboro and the surrounding area will provide greater opportunities for V2I interfaces, ability to process and analyze large amounts of transportation data, and robust interfaces with autonomous vehicles to deliver real time information.

Greensboro is currently being evaluated by Bloomberg Philanthropies to become the next "What Works City". What Works Cities is a national initiative launched in April 2015 by Bloomberg Philanthropies to help 100 mid-sized American cities enhance their use of data and evidence to engage residents, make government more effective, and improve residents' lives. Bloomberg is the nation's most comprehensive philanthropic initiative helping local leaders identify and invest in what works.

Our partnership with Bloomberg Philanthropies will enable the City to leverage their assistance and expertise to engage our community to advance smart City solutions through the use of an open municipal data platform.

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

The potential for partnering with Vulcan to facilitate an accelerated transition to a low carbon transportation system is exciting for the future of Greensboro and is consistent with the City's Sustainability Action Plan. These actions will supplement many of the City's ongoing efforts to improve sustainability. To date, some



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of the City's efforts towards energy sustainability include solar, solar thermal and geothermal building energy conversions, implementing solar powered lights, converting facility and streetlighting (at a handful of locations so far) to high efficiency LEDs and replacing GTA diesel buses to hybrid buses.

Greensboro is in the progress of pursuing electric vehicle replacements for a number of buses within our existing fleet. The grant will allow the City to advance long range plans of a fully electric transit fleet. Electric buses will utilize fast charging stations that could be deployed at the Galyon Depot multimodal facility, the GTA maintenance facility, and at key stop locations along bus routes throughout the system. The GTA Maintenance and Operation Facility would also be equipped with a solar shed that would provide electric power to the charging stations. Additionally, the City will also explore converting its entire fleet of vehicles to electric vehicles and would lead by example which should help spur electric vehicle adoption within the local economy.

As consumer adoption of electric vehicles progress, we also see expansion of publicly available electric charging stations as a priority. We have deployed two charging stations already, but would look to expand that network by pursuing partnerships for expanding our electric vehicle charging infrastructure.

While Greensboro does not have a City owned electric power service, we are committed to supporting Duke Energy's efforts to transition to Smart Grid Technologies. As highlighted earlier, the City would also plan to replace over 27,000 streetlights with more energy efficient and effective LED lights. It's expected that these lights would reduce energy consumption by over 12,000 kWh per year and would save the City approximately \$1 million per year. Some of the key benefits of our transit applications include:

- Economic and Environmental Impacts
 - Reduces emissions by 11,000 tons over a 12-year life
 - Saves \$350,000 in maintenance and fuel costs which could be used to expand service. Total Savings ~\$5,250,000 over lifetime
 - Rapid charging stations could be partially powered by solar
 - Data provides safety hot spot analysis and driver training
- Telematics: Location Awareness, Bus Stop Arrival and Departure Times, Fare Purchasing from App, Integration with ITS for Signal Preemption
 - Mobileye will add their Shield+ driver assistance technology to every bus in the fleet to provide blind spot pedestrian and cyclist detection
 - Data provides safety hot spot analysis and driver training
- Improves access along Gate City Boulevard, an innovation corridor
 - Provides fast transit between the Koury Convention Center, Coliseum Complex, UNCG, Union Square, NC A&T State University, and Downtown
 - Could involve electrifying the roadway to allow constant recharging without having the buses return to the depot

Vision Element #9 Connected, Involved Citizens

The City of Greensboro is in the process of building its Open Data program. Becoming a more transparent organization and finding ways to spur and encourage innovation and entrepreneurship are two of the challenges that the City is currently trying to solve and enhancing the current Open Data program will assist with these challenges. The City has recently set up an open data portal that currently serves 6 datasets - <https://data.greensboro-nc.gov/>.

Plans are in place to rapidly expand the number of open datasets available to the public on the portal. The portal allows citizens and organizations to access public data via bulk or filtered data download and via an API. The API allows citizens, organizations, and groups to develop web and mobile applications that aggregate and publish the data to the public. Businesses can use this public data in their analyses,



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business decisions, and product development, creating new business opportunities and a generation of skilled employment opportunities. Open data initiatives being pursued include:

- Engaging the City's local Code for America Brigade - Code for Greensboro to develop applications that utilize the data on the portal.
- Providing live General Transportation Feed Specification (GTFS) data combined with live GPS feeds of bus locations would allow the development of 3rd party transit applications.
- Providing content to online and mobile transportation services such as Google Maps, Apple Maps, Waze, etc. to develop applications.
- Sharing new smart technology data such as new transportation network sensor data, and V2I data would add an additional level of utility to the City's Open Data program.
- Expanding the City's open data offerings with GIS data such as street centerlines, address points, greenways, trails, zoning, and other layers.
- Conducting an active and robust media campaign to inform, educate, and engage citizens on the merits and benefits of the City's Open Data program.

The City of Greensboro is being considered by Bloomberg Philanthropies for a What Works Cities Grant which would assist with the build out of our Open Data Program and Open Data Portal.

USDOT Priority Vision Elements – Smart City

Vision Element #10 Architecture and Standards

Architecture

In order to ensure interoperability and to allow for future regional or national deployments, the City of Greensboro will integrate the proposed Smart City elements within the context of the regional ITS Architecture and will utilize accessible, open, and well-defined standards. This will ensure that as the system expands vehicles and travelers may move from system to system seamlessly without loss of service.

The City of Greensboro is an integral part of the Triad Regional ITS Architecture which was developed as part of a Statewide ITS Strategic Deployment and included involvement from stakeholders throughout the region. As part of this project, the City would work with local and regional stakeholders to update the regional architecture to reflect changes to the system and include new systems and technologies. This will mean reference and inclusion of the Connected Vehicle Reference Implementation Architecture (CVRIA) as an integral part of the expansion of the ITS architecture. Additionally, project architecture will be critical to guide the development of the project and ensure interoperability and compliance on the regional level.

Standards

USDOT has worked with industry leaders to advance standards in ITS and Connected Vehicle arenas. These standards are critical in a connected vehicle environment because they ensure that there is a common language amongst various systems. While many of the ITS standards are mature and proven, the Connected Vehicle (CV) standards require further testing. Greensboro Smart City CV deployment would closely involve FHWA and industry representatives to test and further develop these standards. This project would adhere to those standards to the maximum extent whenever implementing technologies.

One known example is DSRC. DSRC along with its supported standards are seen as the future for Vehicle-to-Vehicle and Vehicle-to-Infrastructure communications. The proposed system would integrate several key corridors with DSRC equipment for Vehicle-to-Infrastructure communications to enable a variety of CV applications. This would be integrated using the latest DSRC standards with a priority being placed on data security. Integrated systems would take advantage of the SAE J2735 message set with a particular focus



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on sharing of BSM (Basic Safety Message), MAP (Map Data), SPaT (Signal Phase and Timing) and TIM (Traveler Information Message)

Vision Element #11 Low Cost, Efficient, Secure, and Resilient Information and Communications Technology

Cyber Security Program

The City of Greensboro has developed and implemented a risk based cyber security program based on ISO/IEC 27001 standards. The goal of the cyber security program is to ensure compliance to laws and regulations and protect the City of Greensboro from advanced threats and cyber-attacks that aim at compromising smart devices, connected vehicles and all City of Greensboro systems and applications. The ISO/IEC standards place a lot of emphasis on measuring and evaluating how well security controls perform. For this reason, the City of Greensboro security controls are constantly monitored and measured to ensure effectiveness. Improvements to the cyber security program are continually made based on changes to business requirements, compliance requirements and industry threats.

The City of Greensboro has also designed, developed and implemented a multi-layer architecture that provides a defense in-depth approach to protect against advanced threats and cyber-attacks. The defense in-depth architecture provides a solid foundation that ensures the security, integrity and availability of smart devices, connected vehicles and all City of Greensboro systems and applications.

Vision Element #12 Smart Land Use

The City of Greensboro realizes the impacts of the Smart City on land use will be profound and that it will need to take steps on several fronts to seek to capitalize on the opportunity. First, the City can facilitate and promote more efficient and sustainable land use outcomes by improving safety and comfort for walking, biking, and transit including through Smart City elements. For example, the Downtown Greenway and other complete streets projects are already encouraging the redevelopment, densification, and mixing of complimentary uses in the downtown and the surrounding areas. Smart City elements such as automated pedestrian and bicycle detection, smart LED lighting, and data collection will help the City to optimally operate and manage these facilities to maximize the positive impact on urban form and location choices. Second, Smart City Transit elements will increase the convenience, comfort, and safety of the public transportation experience, which will in turn encourage transit-oriented and transit-supportive development along and near to bus routes. The City has already seen such transit-oriented land use change with the HEAT service in the form of concentrated construction of private market student housing along the routes. Finally, the City realizes that fully automated vehicles will change the way many people and freight operators choose to travel, potentially including an increase in long distance commuting and shifts in freight activity patterns. Therefore the City will work diligently in cooperation with the MPO, the NCDOT, and regional partners in an effort to stay on top of and effectively manage such emerging trends from the transportation planning and operational perspectives.

6. Key Technical, Policy, and Institutional Risks Associated with the Deployment and Plans to Mitigate Risks

Risks have been outlined Table 8 below and measures that can be put in place to mitigate them.



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Table 9. Preliminary Risk Assessment

RISKS	RATING	MITIGATION STRATEGIES
Technical		
Broadband Capacity	Low	Currently building a 40 gig backbone
Managing & Analyzing Big Data	Medium	Identifying company to form partnership
Technical Capacity	Medium	Existing knowledgeable staff and would expand with cost savings from project
Policy		
FAA Drone Operation Permission	Low	NCDOT has created a permitting process for UAS operators in N.C.
No N.C. Legislation for Driverless Vehicles	Medium	N.C. General Assembly is considering Senate Bill 600 and House Bill 782 to study how to implement autonomous vehicles on N.C. roadways
State/ Federal Funding Instability	Medium	Seek external grants, leverage bond funds, and participate in public/private partnerships
Institutional		
Citizen Acclimation	Medium	Creative Public Outreach and Marketing

7. Key Team Partners and Stakeholders

The City has received local endorsements from: North Carolina Agriculture and Technology State University (NCA&T), UNC Greensboro, Guilford Technical Community College, Pennsylvania State University Transportation Institute (UTC Member), Volvo North America Group, Unifi, AT&T Smart Cities, Duke Energy, North State Communications, Airsage, Transit Alliance of the Piedmont, NC Center for Global Logistics, VF Corporation, BrightFields Transportation Solutions, Proterra, NCDOT and PART to name a few. The City also launched a marketing campaign with a website and survey to engage citizens about the Smart City Initiative.

8. Existing Transportation Infrastructure in Greensboro

Table 10. Summary of Transportation Infrastructure

Facility Type	Details
Roadway Miles	76.41 Freeway Miles and 237.71 Arterial Miles
Transit Services	<ul style="list-style-type: none"> • The Greensboro Transit Authority (GTA) offers 16 standard routes operating at half hour intervals during daytime hours, one connector route which extends their service area • HEAT (Higher Education Area Transportation) has four fixed routes that are targeted at college and university students • SCAT (Specialized Community Area Transportation) City wide paratransit service, and hourly fixed Sunday Routes. All routes connect at the J. Douglas Galyon Depot where riders can transfer to PART regional buses, Greyhound and Trailways interCity busses, and Amtrak Passenger rail service • PART offers a regional transit system through PART Express and regional ridesharing and vanpool programs • The Guilford County Transportation and Mobility Service (TAMS) coordinate with SCAT to provide transportation and mobility services for Medicaid recipients and the elderly in Guilford County



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Facility Type	Details
Shared-Use Mobility Services	<ul style="list-style-type: none"> UberX has operated in Greensboro since late June, 2014. North Carolina has enacted laws which allow for ride sharing services. The University of North Carolina at Greensboro's Parking Operations and Access Management Department has multiple ride and bicycle sharing programs. UNCG offers a carpooling club for special parking rates with a website to pair riders, a bike sharing service, and is a Zipcar partner which allows short term hourly car rentals PART cooperates in the Share the Ride NC carpooling website and offers vanpooling services for commuters who live at least 10 miles from work The City and Greensboro MPO are working with interested stakeholders to develop a bike share program serving key destinations. Efforts are underway to identify start-up funding and a sustainable source of operating funds
Information and Communication Technology	<ul style="list-style-type: none"> 200 sq. mi. of fiber optic network with attached signal systems, lights and controls, public facilities and public safety Public access to high speed connections to enterprise data and Internet Digital traffic system monitored and managed remotely with ability to operate if issue arises. Programmed to notice the failure in a route around the disconnection resulting in high-level redundancy Connects three separate data centers and in addition to remote management centers at speeds from 1 Gigabit to 40 gigabits
Intelligent Transportation Systems	<ul style="list-style-type: none"> Completed a \$24 million expansion of its central computerized traffic signal system in 2013 Upgraded over 450 traffic signals to new 2070 style controllers and cabinets and integrated over 54 closed circuit television cameras Constructed a new Transportation Management Center as part of this project and linked video with the NCDOT Triad Regional Transportation Management Center (TRTMC), Greensboro Transit Authority (GTA) Maintenance Facility and the Greensboro Metro 911 Communications Facility
Smart Grid Infrastructure	<ul style="list-style-type: none"> Two electric vehicle charging stations for use by the public on City-owned property available 24 hours a day.

This combined ICT and ITS Network is vast and constantly growing supporting the 495 traffic signals and 550 video surveillance nodes in and around Greensboro's 70 managed facilities.

9. Existing Greensboro Data Collection Programs

Table 11. Data City Currently Collects

Street Centerline	Crash data (vehicle to vehicle or vehicle to bike or pedestrian)
Street Centerline	Crash data (vehicle to vehicle or vehicle to bike or pedestrian)
Bus Routes and Stops	Travel Time Data (via INRIX)
Address Points	Pedestrian Volumes
Public Transportation On-Time Arrivals	Bicyclist Volumes
Traffic Counts	Sidewalk Location
Freight Nodes	Greenway and Trail Locations
Streetlight Locations	Signal Locations
Cell Tower	Crime Data
Redevelopment Areas	Fiber Locations
Natural Features (streams, lakes, parks)	Future Transportation Projects
Bottleneck Locations	Miles of Roadways Resurfaced by Functional Class
Miles of Bike Facilities Constructed	Miles of Sidewalks Constructed
Number of Public Transportation Riders	Public Transportation Weekday Boardings
Number of Park-n-Rides Lots	Number of Buses with Bike Racks
Public Transportation Headway Variance	Miles of Sidewalk adjacent to Bus Stops



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Bicycle and Pedestrian Data Collecting and Analysis

Bicycle and pedestrian data collection and analysis is key to identify issues, to develop countermeasures, and to plan effectively for critical pedestrian and bicycle infrastructure. Such data and analysis will be useful to determine countermeasures including Smart City elements such as Connected Vehicle-to-Pedestrian (VTP) technology.

Crash analysis: Greensboro MPO staff utilizes bicycle and pedestrian crash data and to analyze problem locations, crash trends, and contributing factors such as weather, lighting, and driver/bicyclists/pedestrian attributes and behavior. These analyses are helpful for the City to identify problem areas and to develop mitigation strategies. This crash data will be a valuable input to support Connected VTP technology and crash avoidance systems.

Counting program: The City of Greensboro is expanding a rich dataset of bicycle and pedestrian counts. These counts have been collected using different equipment and technology, such as video recording (MioVision), Eco Pyro Box, Pneumatic Tube, TRAFx counter, and radar equipment. This information has already helped the City to develop more effective safety counter measures and to refine design concepts in light of actual pedestrian and bicycle movements and patterns. In addition, in 2014, the City of Greensboro was selected to participate in the *NCDOT Pilot Bicycle and Pedestrian Counting Program* with four permanent bicycle and pedestrian counting stations at representative locations in Greensboro. The data collected will help researchers develop pedestrian and bicycle count factors for use in similar areas statewide.

Multi-Agency Use of Existing and New Transportation Data

New Message Sets for CV Applications

With the implementation of DSRC and Roadside Units for communication with connected vehicles, we will gather and transmit a variety of new data. SAE J2735 is a standardized message set that was designed for this purpose. The City would design these systems with security in mind, utilizing existing standards and protocols to ensure data anonymity.

Signal Phasing and Timing Data (SPaT) consists of data that describes the current state of a traffic signal and its phases as it relates to specific lanes or lane groupings. While much of this data is currently available within our traffic signal system software, it is not shared with outside sources. Through this grant, the City would utilize the SAE J2735 standards to make this data available through DSRC communications to end users. This would enable Connected Vehicle applications to help improve the safety and mobility of the transportation system.

Probe Data Messages (PDM) are messages/information that is collected and provided by vehicles that provide snapshots of position, speed, acceleration, status and time. This real-time information will provide a robust data source which can be used to operate our existing transportation systems (signals, transit, ITS) and can be utilized to identify existing deficiencies and to plan for infrastructure improvements.

The City's local Code for America Brigade - [Code for Greensboro](#) is currently engaged in dialogue with City staff and is actively working on developing applications that utilize the data on the portal. By providing existing and newly collected public data, encouraging 3rd party application development, and data analysis, the City's citizens and businesses will be able to make better decisions about their daily travel. This in turn will save them time, money, and provide a better transportation experience.

A process to maintain live General Transportation Feed Specification (GTFS) data combined with live GPS feeds of bus locations would allow the development of applications that help citizens make better decisions about their travels. Businesses would also benefit in many ways, such as citizens having extra time to catch the bus after checking the bus location and arrival time on a mobile phone, or a public digital display, inspiring them to purchase an extra cup of coffee.



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Becoming a content provider for online and mobile transportation services such as Google Maps, Apple Maps, Waze, etc. would enable our citizens and businesses to utilize popular online and mobile mapping services to consume local transit data and make real-time data driven decisions about their day. Data provided to these online transportation mapping services (and published on the City's Open Data portal) could include road construction schedules and locations, street lane closings, road closures, new roads, street name changes, public safety data such as automobile accidents, and kidnappings. Also, providing this data in real-time would allow citizens, public transit, and freight companies to re-route their travel to avoid congestion, saving time and money, and allowing citizens to be more aware of their surroundings thus improving public safety. GTA is already a Google Transit member and enhanced traveler information will enhance the Google Transit Application.

Providing new smart technology data such as new transportation network sensor data, and V2I data would add an additional level of utility to the City's Open Data program. Enhancements such as variable speed limits, and adaptive traffic control could be provided as a live feed to applications providing up to date turning restrictions, number of lanes, current travel direction on one way roads, and current speed limit data to travelers.

Expanding the City's open data offerings with GIS data such as street centerlines, address points, greenways, trails, zoning, and other layers would open additional vast opportunities for the community and local businesses to employ spatial analysis and mapping in their 3rd party applications and transit based decision making. Taking a survey of national and international open data standards and working with local and regional governments and businesses to coordinate updating relevant datasets to a common standard would greatly amplify the wider usability of the data. This in turn will enable the City to be seamlessly integrated with systems and applications at the region and national levels.

Using External Information to Improve Transportation

The City of Greensboro is in the process of actively building its Open Data program and developing an Open Data policy. This initiative will advance transparency spurring innovation and entrepreneurship in the City. The expansion of the Open Data program and providing currently available transportation data to the public in real-time or near-real-time will have many benefits to the City, citizens, and the local economy. A process to maintain live General Transit Feed Specification (GTFS) data combined with live GPS feeds of bus locations would allow the development of applications that help public transit citizens make more efficient transportation choices. Becoming a content provider for online and mobile transportation services such as Google Maps, Apple Maps, Waze, etc. would greatly enhance these services and enable our citizens and businesses to better utilize these popular online and mobile mapping services. This real-time data combined with the popular mobile applications will allow citizens, public transit, and freight companies to re-route their travel to avoid congestion, save time, and money, and would make citizens more aware of their surroundings thus improving public safety. Providing new smart technology data as open data such as new transportation network sensor data, and V2I data would add an additional level of utility to the City's Open Data program. Enhancements such as variable speed limits, and adaptive traffic control would allow the City to modify the transportation network based on current conditions. This data could be provided as a live feed to applications providing up to date turning restrictions, number of lanes available, current travel direction, and current speed limit data to travelers. This information could be used to reroute City personnel such as Police, Fire, inspectors, or trash collection routes should congestion or grid-lock occur. Expanding the City's open data offerings with GIS data such as street centerlines, address points, greenways, trails, zoning, and other layers would open additional vast opportunities for the community and local businesses to employ spatial analysis and mapping in their 3rd party applications.

Analysis of available and newly collected data sets would enhance the potential of data-driven decisions about bus routes and schedules, infrastructure investments, integrating new smart technologies, and would



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create efficiencies in updating how the transportation network functions. Enhanced data from the open and connected data program will provide valuable information for planning the future of Greensboro as an even smarter City. An example of the possibilities includes combining economic, census, and transit GIS data to allow mapping of employment locations accessible to various neighborhoods via public transit within a given commute time. Information of this type would be invaluable as the City makes decisions on improving its transit network, and makes the case for more citizens to utilize public transit.

10. Use of Existing Standards, Architectures, and Certification Processes for ITS and Connected Vehicle-based Technologies

Architecture

In order to ensure interoperability and to allow for future regional or national deployments, the City of Greensboro will integrate the proposed Smart City elements within the context of the regional ITS Architecture and will utilize accessible, open, and well-defined standards. This will ensure that as the system expands vehicles and travelers may move from system to system seamlessly without loss of service.

The City of Greensboro is an integral part of the Triad Regional ITS Architecture which was developed as part of a Statewide ITS Strategic Deployment and included involvement from stakeholders throughout the region. As part of this project, the City would work with local and regional stakeholders to update the regional architecture to reflect changes to the system and include new systems and technologies. This will mean reference and inclusion of the Connected Vehicle Reference Implementation Architecture (CVRIA) as an integral part of the expansion of the ITS architecture. Additionally, project architecture will be critical to guide the development of the project and ensure interoperability and compliance on the regional level.

Standards

USDOT has worked with industry leaders to advance standards in ITS and Connected Vehicle arenas. These standards are critical in a connected vehicle environment because they ensure that there is a common language amongst various systems. While many of the ITS standards are mature and proven, the Connected Vehicle (CV) standards require further testing and it is the expectation that this deployment would serve as a test bed for CV deployment and would work closely with FHWA and industry representatives to further develop these standards. This project would adhere to those standards to the maximum extent whenever implementing technologies.

One known example is DSRC. DSRC along with its supported standards are seen as the future for Vehicle-to-Vehicle and Vehicle-to-Infrastructure communications. The proposed system would integrate several key corridors with DSRC equipment for Vehicle-to-Infrastructure communications to enable a variety of CV applications. This would be integrated using the latest DSRC standards with a priority being placed on data security. Integrated systems would take advantage of the SAE J2735 message set with a particular focus on sharing of BSM (Basic Safety Message), MAP (Map Data), SPaT (Signal Phase and Timing) and TIM (Traveler Information Message)

Cyber Security Program

The City of Greensboro has developed and implemented a risk based cyber security program based on ISO/IEC 27001 standards. The goal of the cyber security program is to ensure compliance to laws and regulations and protect the City of Greensboro from advanced threats and cyber-attacks that aim at compromising smart devices, connected vehicles and all City of Greensboro systems and applications. The ISO/IEC standards place a lot of emphasis on measuring and evaluating how well security controls perform. For this reason, the City of Greensboro security controls are constantly monitored and measured to ensure effectiveness. Improvements to the cyber security program are continually made based on changes to business requirements, compliance requirements and industry threats.



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11. Measuring and Monitoring Vision Goals and Objectives

Table 12. Measuring and Monitoring Goals and Objectives

Smart City Challenge Goals	Objectives	Monitoring Measures
Improve Safety	<ul style="list-style-type: none"> Reduce fatalities by 15% system wide and 50% on identified Smart Corridors by 2030 Reduce % of bike and pedestrian fatalities by 50% on Smart Corridors by 2030(system) Reduce Incident Response time by 15% by 2030. 	<ul style="list-style-type: none"> Total number of annual vehicular fatalities between 2020 and 2030 Total number of annual cyclist and pedestrian fatalities between 2020 and 2030 Emergency Management Services and Public Safety response time between 2020 and 2030 <p>Sources: NCDOT TEAAS¹ and BPCDT² databases, EMS and Public Safety Dispatch Data</p>
Enhance Mobility	<ul style="list-style-type: none"> Reduce the daily hours of recurring congestion on identified Smart Corridors by 25% by 2030 Reduce peak travel-time delay on identified Smart Corridors by 25% by 2030 due to transient events (traffic incidents, special events, and work zones) Increase alternative mode usage by 30% by 2030 on Smart Corridors and Multimodal Corridors 	<ul style="list-style-type: none"> Hours per day at LOS F Peak Period Bottleneck Frequency Annual Vehicle Hours Traveled between 2020 and 2030 Annual travel-time during transient events between 2020 and 2030. Bike and Pedestrian Counts <p>Sources: City Traffic Counts, Hourly Travel Times, Transit ridership, Cyclist and Pedestrian Counts database, NCDOT TIMS³</p>
Address Climate Change	<ul style="list-style-type: none"> Reduce total vehicle fuel consumption by 20% by 2030 on Smart Corridors Reduce total transit vehicle fuel consumption by 30% by 2030 on Smart Corridors Reduce carbon footprint by 12,000 tons a year by 2020 	<ul style="list-style-type: none"> Total fuel consumed by average vehicle Total fuel consumed by transit vehicles Total number of incandescent streetlights converted to LED streetlights <p>Sources: Average vehicle miles traveled by facility type, Average fuel economy, Hours of delay, City Streetlight Inventory</p>
Connect Underserved Areas	<ul style="list-style-type: none"> Increase Accessibility to underserved areas by 25% by 2030 	<ul style="list-style-type: none"> Total miles of Smart Corridors implemented adjacent to underserved areas Total miles of transit routes adjacent to underserved areas instrumented with electrified and connected buses <p>Sources: GIS Street Centerline file, GIS Underserved file, and GIS Transit Routes file</p>
Support Economic Vitality	<ul style="list-style-type: none"> Increase total number of jobs by 10% by 2020 Decrease freight hours of delay by 20% by 2030 on Smart Corridors Decreasing Poverty Rate by 3% by 2020 	<ul style="list-style-type: none"> Total number of companies relocated to Greensboro as a result of the implemented smart technologies Total number of new jobs created to support the implementation of the smart technologies. Annual freight hours of delay between 2020 and 2030. <p>Sources: Greensboro Partnership, NC Global Center for Logistics</p>

¹ TEAAS- Traffic Engineering Accident Analysis Software

² BPCDT- North Carolina Pedestrian and Bicycle Crash Data Tool

³ TIMS- Traveler Information Management System



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12. Capacity to Execute Project

Provide evidence that establishes your capacity to take on a project of this magnitude including executive commitment, workforce capacity, degree of infrastructure readiness, data and performance management capabilities

Executive Commitment

Resources through in-kind services and leadership will be provided by the City Manager's Office, the Department of Transportation, the Planning Department, the Information Technologies Department, the Police Department and the Fire Department. The City Council is on board as well. One City Council member actually read about Secretary Fox's "Beyond Traffic: Smart City" grant in "Wired Magazine" and notified City staff of the opportunity, along with his enthusiastic endorsement, before the grant was officially announced. The City has also secured endorsements from local Universities and Businesses pledging their commitment to assist the City of Greensboro in implementing the Smart City initiatives. The North Carolina Department of Transportation has also pledged their support of the City's grant and has committed in-kind resources to assist with implementation.

Workforce Capacity

IT

The Information Technology (IT) Department consists of approximately 60 employees with 8 divisions dedicated to leading management, accountability, and performance objectives for the City of Greensboro. With more than 70 active long and short term projects/initiatives occurring at any one time. The IT department has dedicated talent and expertise in multiple disciplines such as Enterprise Solutions, Application Services, GIS, Public Safety, Telecommunications/VOIP, Network Services, Security/Compliance, and Project Management. We have an executive municipal government commitment to achieve our yearly project goals while ensuring stakeholder timelines are met for implementation, costs are not exceeded by effectively planning and executing scope of each effort, and by validating performance requirements both in our lab and our production environments. The IT Department also operates and staffs a 24 x 7 Service Desk capable of supporting more than 3000 end users. This Service Desk responds to more than 7000 calls per year with 80% of their high priority calls closed within 1 day of initial contact. As the demands for a more expansive state of the art infrastructure has consistently grown in and around our City, the IT Department has responded by increasing our system architecture from a 10G backbone to a 40G backbone in our data center, while at the same time has already provided an extensive fiber network that is ready and operational for our Smart Cities initiatives.

GDOT

The Greensboro Department of Transportation (GDOT) has eighty one (81) City employees and Two Hundred (200) contracted employees in four (4) divisions all dedicated to enhancing safety, improving mobility, and enhancing the quality of life to for citizens and visitors to Greensboro. GDOT has a highly skilled multidisciplined staff of Engineers, Planners, Project Managers, and Technicians, that manage a variety transportation improvement projects and grants. GDOT's operating budget is \$32 Million, and GDOT manages over \$100 Million in transportation improvements annually through local bonds and Federal and State grants. The Engineering and Operations Division manages and operates the City's traffic signal system, including the 150 mile fiber optic Ethernet system, and in 2014 oversaw construction of the \$24 Million traffic signal system replacement project. The MPO Planning Division oversees all MPO functions including development and implementation of improvement projects that utilize the MPO's annual direct apportionment of approximately \$4 Million in STP-DA, \$1.8 Million in CMAQ, and \$350,000 in TAP-DA. The MPO Planning Division is one of the leaders in North Carolina through their work with NCDOT and FHWA in developing funding strategies and implementing critical transportation infrastructure improvements such



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as the completion of the Greensboro Urban Loop, the renovation of the Galyon Depot, the new GTA maintenance and Operations facility, as well as numerous sidewalk and greenway improvements. The Public Transportation Division oversees one of the largest and fastest growing transit systems in North Carolina through an annual budget of \$23 Million which includes oversight of two hundred (200) contracted employees who operate and maintain a fleet of 103 transit vehicles. The Public Transportation Division manages \$5.4 Million in FTA and State grants each year which are used to supplement annual expenses.

Infrastructure Readiness

The current This Architecture was developed as part of a Statewide ITS Strategic Deployment and included involvement from stakeholders throughout the region. If awarded the Smart Cities grant, the City would work with local and regional stakeholders to update the regional architecture to reflect changes to the system and include new systems and technologies. This will mean reference and inclusion of the Connected Vehicle Reference Implementation (CVRIA) as an integral part of the expansion of the ITS architecture. Additionally, a project architecture will be critical to guide the development of the project and ensure interoperability and compliance on the regional level.

13. Leveraging Federal Resources, Cost share, In-kind Donations, and Partnering

In addition to leveraging the efforts and resources of partners to this Smart City application, an award of Smart City funds to Greensboro will build off of extensive and ongoing investment in the transportation system. A key example is the recently completed Signal System. This project was made possible by a substantial investment of Federal funds (\$8.8 million CMAQ, \$7.1 million SAFETEA-LU High Priority funds, \$3.6 million STP-DA) and City funds (\$6.3 million) plus additional local investment in facilities and additional fiber connections (\$500,000). Greensboro's Smart City bid proposes to capitalize on this investment which provides a prerequisite base level of state of the art technology from which to expand. Additionally, the pedestrian and bicycle elements of the Smart City will also build off of extensive local and federal investment including an estimated \$20 million in Federal STP-DA spent on high priority sidewalk construction over the last ten years.

Transit enhancements such as MobilEye and electric charging infrastructure and buses will similarly build off of extensive and ongoing investments in the transit system. Highlights include new GTA Administration, Operations, and Maintenance Facility, funded with \$7.7 million in STP-DA, \$5.5 million in ARRA funds, a SAFETEA-LU earmark of \$1.9 million, and \$1.2 million in Local and State matching funds. This also includes an extensive commitment to modernization of the transit fleet, with approximately nine clean fuel replacement buses already funded in FY 2016 and 2017 for a total of \$3.3 million in CMAQ funds and \$820,000 in local matching funds.

The City of Greensboro, the MPO, and the NCDOT will utilize the Smart City Challenge grant funds to integrate with and further develop transportation initiatives already underway in our region as well as future transportation enhancements.



Oak Ridge

150

Kernersville

40

421

40

421

68

Piedmont Triad
International
Airport

73

City of
Greensboro

High Point

Sedalia

Jamestown

Pleasant Garden

Wireless Network Coverage is determined by
final network implementation. Greensboro's goal
is to offer free wireless internet across the city.

0 ½ 1 2 Miles

