U.S. DOT
Notice of Funding Opportunity
Number DTFH6116RA00002

"Beyond Traffic: The Smart City Challenge."

Smart City Program
for Newark, New Jersey

Submitted By:

City of Newark
Department of Engineering
Division of Traffic and Signals

Prepared By:

City of Newark
Department of Engineering
Division of Traffic and Signals
and
New Jersey Institute of Technology

Ras J. Baraka
Mayor
City of Newark

February 4, 2016

TABLE OF CONTENTS

EXECUTIVE SUMMARY

As New Jersey's largest city, the City of Newark functions as an employment, educational, social and cultural destination not only for Newark residents but for people throughout New Jersey's Gateway Region. Investment in ITS technologies, advanced detection and data collection protocols is needed to support Newark's continued redevelopment and keep the City economically competitive. The City of Newark's Smart City Challenge Application and corresponding vision will inform future land use and transportation infrastructure decisions. These decisions will support the City's transportation needs and promote improved quality of life for all network users; from residents and commuters to pedestrians, bicyclists and freight traffic.

The City of Newark's Smart City Vision is defined by five overarching goals: improve intermodal mobility and facilitate more efficient mode choice; promote responsible and sustainable environmentally sensitive development; provide more efficient municipal services; advance livable communities; and encourage economic growth.

The City of Newark and project partner the New Jersey Institute of Technology (NJIT) will work together to advance smart and innovative technologies throughout the City. A cornerstone of this collaborative effort is instrumentation of major arterial corridors throughout the City. These instruments will include Bluetooth, Wi-Fi and DSRC communication devices, air quality and emission sensors, intelligent LED lights, and video detection, all of which will be conducive to implementing vehicle-to-infrastructure communication and urban automation. In tandem with instrumentation, establishment of a communication protocol will allow public dissemination of collected data through a dedicated secure channel, which could be accessed by various City agencies, the general public, private sector service providers, as well as communication and computing devices on-board vehicles traveling through the City.

Formation of partnerships representing a variety of disciplines will be critical to advancing the goals of the project. Our strategic, regional partners in transportation system management include the New Jersey Department of Transportation, New Jersey Transit and the Port Authority of New York and New Jersey. Overlapping jurisdictions and organization missions may create challenges, but also create the potential to unlock many synergistic partnerships. Utility companies share many overlapping goals with Newark and much common ground may be available for developing relationships that benefit utilities, the City, and the public, involving advancement of smart technologies. Other City's agencies, such as the Parking Authority, the Newark Police Department, and Newark's Office of Information Technology would also participate by infusing smart features in their systems and integrating them in a holistic manner. Both the City and the ITS Resource Center at NJIT are also considering opportunities for partnering with technology providers from private sector who are interested in advancing smart transportation and smart city concepts.

VISION FOR SMART CITY OF NEWARK

Motivation

The City of Newark is in many ways perfectly positioned to take on the Smart City Challenge. Besides qualifying as a medium-sized city by population, Newark has a unique, mature and evolved inter-modal transportation system serving diverse needs of residents and the business community. The downtown area is being rejuvenated and is seeing a growing number of businesses looking to locate in the City. In response to growing traffic demand, the City's Division of Traffic and Signals has been investing in advanced traffic control systems over the past few years, including installation of video detection, actuated, and adaptive signal control in the downtown area. A fiber-optic network has also been expanded to interconnect 170 traffic signals and support deployment of advanced traffic control technologies. Over the past year the Division has been working with the ITS Resource Center at New Jersey Institute of Technology (NJIT) to develop and implement innovative traffic control and management systems through instrumentation of Newark's main arterials and deployment of vehicle-to-infrastructure communication and traffic data analytics technologies.

Despite a robust and well-connected transit network and dense walkable blocks, Newark is challenged by chronic congestion issues, particularly during peak hours in the downtown core and along major corridors. This congestion leads to lost productivity, degraded air quality and a reduced quality of life for commuters and residents alike. Additionally, Newark has been identified as a FHWA Pedestrian Safety Focus City, meaning that crash and fatality rates for pedestrians and bicyclists are higher than national averages. Both of these issues, while serious and significant, are not permanent conditions. The City of Newark believes, and has demonstrated through focused actions, that quality of life can be enhanced and safety improved for residents, commuters and visitors. Intelligent Transportation System (ITS) technology and other smart technologies and data management practices can be leveraged and applied to meet these challenges

Smart City Vision

To better serve the community, encourage development of the new travel-management technologies, and promote the efficient operation of associated municipal functions, the City of Newark will expand and improve connectivity and communication between the city's transportation infrastructure, traffic and transit system operating agencies, and the traveling public, regardless of the travel mode. These enhancements will optimize transportation decision making, thus supporting everyday activities of people who live, work, visit and travel through the City of Newark. The smart connectivity and communications will be achieved through the application of a robust data analytics and information delivery system supported by integrated and comprehensive instrumentation of Newark's roadways, public transit system, parking facilities, and public utility systems. These technologies will allow the system operators to monitor performance and make the adjustments in real time to optimize systems' operations. They will also enable the users ("connected citizens") to make transportation choices in response to current and predicted system status. The Smart City features will promote the efficient operation of Newark's facilities and infrastructure, improve level of service for the community,

and will encouraging private sector innovation, leading to more wide-ranging choices and designs for travelers.

Goals and Objectives

Application of "smart city" and "connected city" concepts in the City of Newark will support a broad regional development vision and objectives articulated in strategic documents adopted by the North Jersey Transportation Planning Authority (NJTPA), the Regional Transportation Plan (RTP), titled *Vision 2040*. Furthermore, it supports MAP-21 and FAST Act goals of improving reliability of the surface transportation system, improving the national freight network, and supporting regional economic development. Finally, Newark's Smart City Vision supports the advancement of the Newark Master Plan Mobility Element objectives of improving: local accessibility, including bike/pedestrian accessibility and mobility; regional connectivity; traffic circulation; safety; urban freight movement; and parking. Accordingly, Newark's Smart City program is developed around five core areas: **mobility**, **safety**, **efficiency**, **sustainability**, and **climate change**. The program strives to achieve the following measurable goals and objectives:

Goal #1. Improve Intermodal Mobility and Facilitate More Efficient Mode Choice

This goal entails improving the efficient movement of people and goods across transportation modes. There are three objectives which support the achievement of this goal, related to instrumentation of the built environment and providing citizens with the appropriate data to make informed mobility decisions.

Objective #1. Develop a robust network of instrumentation of City infrastructure to enable data collection on system performance. Instrumentation will entail installation of traffic sensors, parking occupancy detection systems, safety & security detection devices (cameras, Shotspotter), environmental sensors (air quality, weather sensors), pavement condition sensors, pavement temperature sensors installed on municipal vehicles, smart garbage containers (equipped with sensors, communication), and intelligent street lighting. This would also entail expansion of adaptive signal control and implementation of transit signal priority and other connected-transit applications.

Objective #2**.** Connected citizens: use the data to empower citizen to make more informed decisions affecting their mobility. This includes ensuring those citizens and the companies and platforms providing data have accurate and up to date information about travel times, roadway conditions, and environmental conditions. The pertinent data will be delivered to mobile devices as well as in-vehicle infotainment systems.

Objective #3. Facilitate mobility on demand and intermodal connectivity. This entails sharing economy and embracing travel modes such as ride sharing and car sharing. This objective also seeks to improve connections between modes to enhance first and last mile connectivity for users of transit.

Goal #2. Promote Sustainable and Environmentally Sensitive Development

This goal reflects the environmental considerations and the ramifications of climate change when making city-wide transportation decisions. Objectives that support the achievement of this goal involve travel choices that promote carbon free and active transportation.

> Objective #1. Increase viability of electric vehicles. This will be achieved through partnerships with public and private sector, including city's agencies, aimed at increasing the fleets of electric and hybrid vehicles and installing electric charging stations throughout the city. The use of autonomous electric transit vehicles will also help achieve this objective.
>
> Objective #2. Promote non-vehicular travel modes. Active, non-vehicular travel modes can be promoted by providing users with better information, such as travel time estimates, weather conditions, and health information. Additionally, sensing and monitoring technologies can relay information about problem areas, leading to increasing safety for bicycle use and pedestrians.

Goal #3. Provide More Efficient Municipal Services

This entails improved internal operations of various departments and divisions of the City of Newark, as well as the efficient distribution of information about their services to the citizens. Streamlining city's operations through urban automation is expected to significantly increase organizational efficiency.

> Objective #1. Implement communication network including data transfer, storage, processing, security and resiliency. This would require implementation of a secure and resilient information technology system to facilitate efficient data transfer, storage, processing, analytics, and sharing in real time. The municipal personnel also needs to be trained and equipped to monitor performance of the systems they are servicing and implement corrective measures to maximize the systems' level of service.

Goal #4. Advance Livable Communities

Goal #4 will utilize ITS, sensors and technology-based enhancement to improve the quality of life and livability of Newark's many neighborhoods.

> Objective #1. Improve traffic safety. Redesigning the roadway, signal equipment and the built environment is an engineering approach to improving traffic safety for vehicles, pedestrians and bicyclists. Newark will install systems to monitor vehicle movement and speed, video analysis will be used to determine near misses and high risk locations that need improvement and sensor technology will be used to identify pedestrians at intersections. Retrofitting the bus fleet that operates on city's streets to include collision avoidance and other safety solutions, and using V2I communication at intersections to mitigate traffic safety hazards will also help achieve this objective.
>
> Objective #2. Deploy Public Wi-Fi. Newark is home to several environmental justice communities and these communities experience greater difficulty in gaining access to personal computers and internet access. Providing public Wi-Fi free of charge or at

reduced rates would diminish this barrier for many residents seeking affordable internet access. Digital literacy is a cornerstone of providing modern education and employment opportunities; public internet access helps in this respect and facilitates economic development in disadvantaged communities.

Goal #5. Encourage Economic Growth

This goal can be achieved by supporting development and innovations of mobile and travel assistance technologies. These technologies the collection, analysis and distribution of large amounts of data and the development of strategic public-private partnerships which will support business development as well as provide more accurate travel data to citizens of Newark.

Objective #1. Develop data analytics (data integration/fusion, dissemination (sharing), visualization, decision support) and formulation of a communication network. Data collected from instruments placed throughout Newark will be collected, analyzed and packaged in a way that is safe and secure as well as relevant to the public users and private sector service providers. This data can be used to enhance City operations and provide Newark residents, commuters and visitors with timely and accurate information to aid in trip planning and modal choice decisions. Application of latest trends and innovations in data mining, big data storage and high-performance computing, as well as cyber-security solutions, will be critical in this respect. The other critical element will be implementation of a robust data communication network.

Objective #2. Foster public-private partnerships and induce entrepreneurship. The development of strategic public-private partnerships will allow the City of Newark to leverage existing wayfinding and in-vehicle technologies. Private companies that seek to provide this information to their customers need accurate, reliable and up to date traffic, travel and signal information. The City of Newark is in a position to collect and provide this information. The result of such partnerships will be improved information delivered to traveling public, in support of enhanced roadway safety and improved modal choice for citizens.

NEWARK'S CONTEXT

Location and Demographic Characteristics

The City of Newark is located in the heart of New Jersey's Gateway Region, and is one of the largest transportation hubs in the nation. With population of 277,140 (2010 U.S. Census) it is the largest city in the State of New Jersey, and the second largest city in the New York – Newark, NY-NJ-CT Urbanized Area. The city occupies a land area of 24.187 square miles, and has a population density of 11,458 persons per square mile. The location and key demographic indicators describing the City of Newark are shown in **Figure 1**.

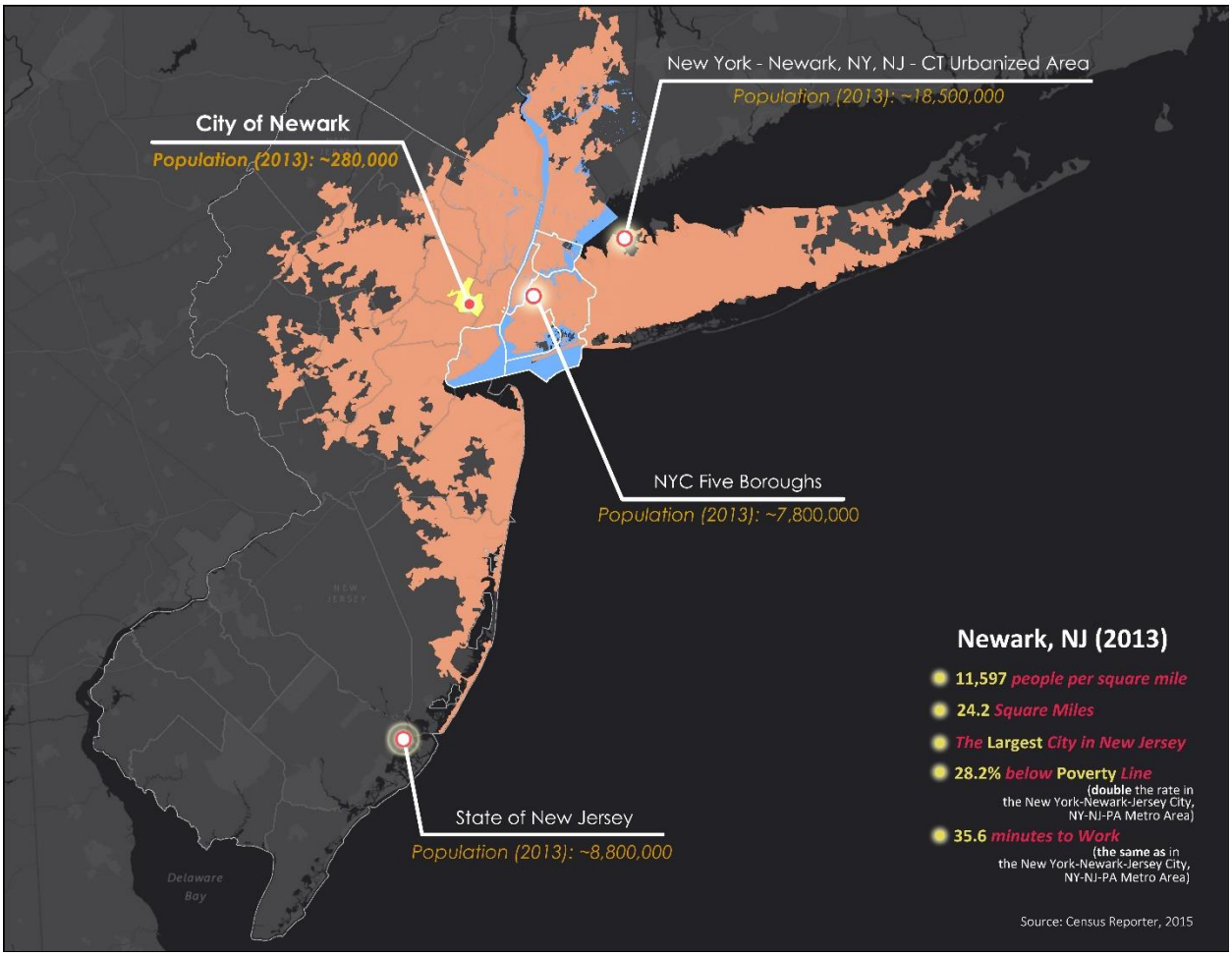

Figure 1. City of Newark in the context of NY-NJ-CT Urbanized Area

Newark accounts for about 1.51 percent of the overall population of the New York – Newark, NY-NJ-CT Urbanized Area, which falls short of the 15 percent threshold preferred by USDOT for 'ideal' candidate cities for the "Smart City Challenge". This statistic, however, should be viewed in the context of proximity to New York City, a known outlier when calculating many of regional metrics. To better understand Newark's regional context and significance, one should remove the New York City from the equation. Further, besides being the largest city in the State of New Jersey, Newark also serves as the seat for Essex County and accounts for 35 percent of its population. According to the 2009-2013 5-Year American Community Survey (ACS) Commuting Flows data, 93 percent of Essex County workers reside within New Jersey, and 52 percent reside within Essex County. Only 4.3 percent commute to work from New York State. This is illustrated in **Figure 2**. The data clearly shows that very few workers in Essex County, and by imputation in the City of Newark, come from outside of New Jersey, and fewer than half come from outside of the county itself. This confirms the position of Newark as the major regional employment center, independent of the skewing effect of New York City. Statistics aside, Newark also serves as a cultural, educational, and entertainment destination. It is home to Rutgers University, the New Jersey Institute of Technology, Seton Hall University's Law School, New Jersey Performing Arts Center, as well as Prudential Center, home NHL team New Jersey Devils.

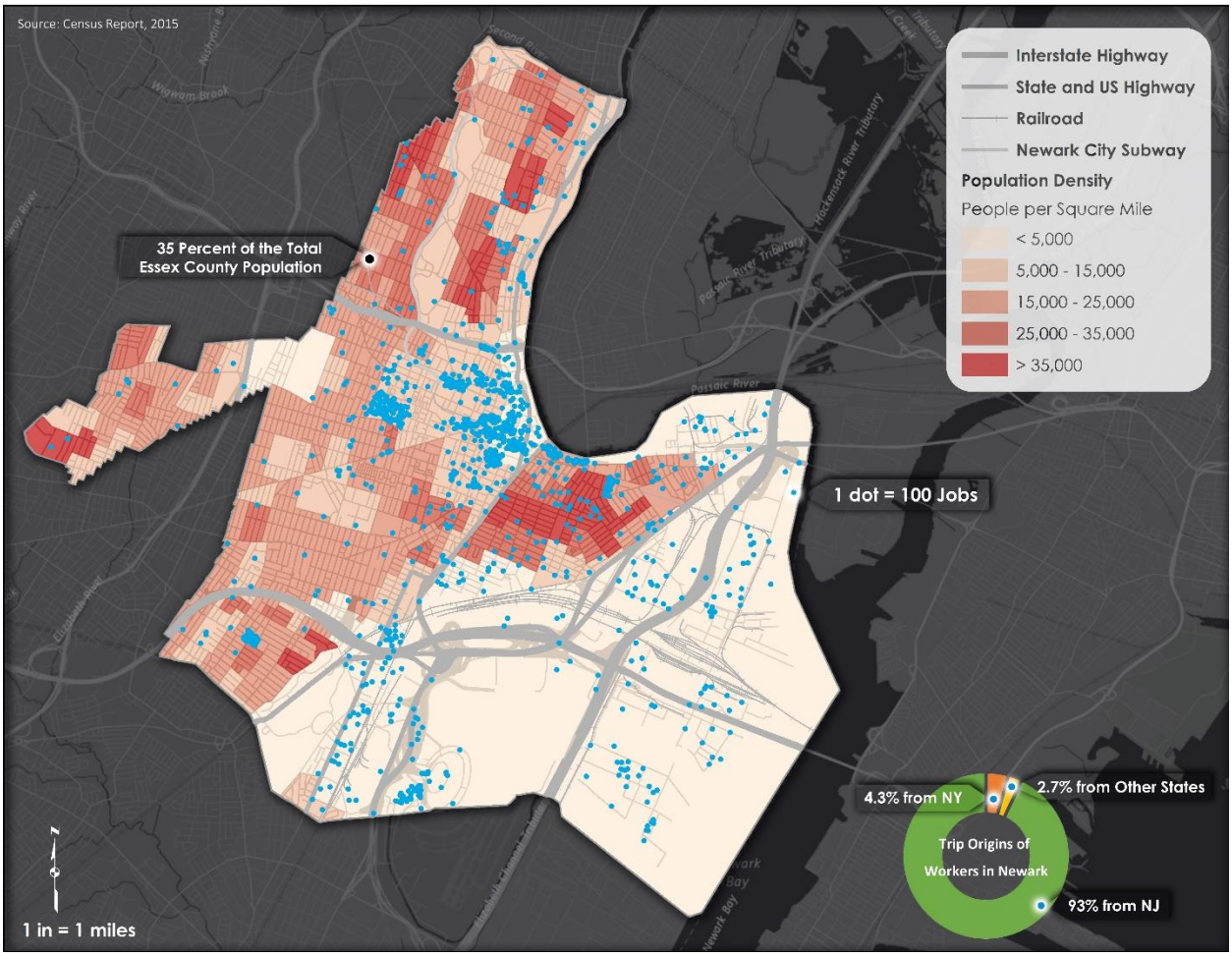

Figure 2. Population and Employment Density, Newark, New Jersey

Transportation System Profile

From a built environment perspective, Newark possesses one of the most diverse, multi-modal transportation profiles in the nation. The city is home to Port Newark, a major component of the Port of New York and New Jersey, the third largest port in the country. Newark Liberty International Airport is the nation's 16th busiest airport by number of passengers, and 10th busiest air cargo hub (according to Airports Council International). The abundance of highway and rail options benefits both the commuters and the freight industry: three interstate highways and five state highways, passenger and freight rail lines converge at Newark. Newark's intrinsically intermodal transportation infrastructure is illustrated in **Figure 3**.

Existing Highway and Street Network

The highway and street network serving the city consists of the following:

a. Municipal Streets system: 325 miles
b. Principal arterials: 16 routes, 27 miles.
c. County routes: 16 miles.

d. Freeways: 34 total miles. This includes Interstate highways I-280, I-78, and I-95 (the New Jersey Turnpike).

Existing Public Transportation System

Newark has two passenger rail stations: Newark Penn Station and Broad Street Station. With adjacent light rail and bus terminals and stations, as well as parking facilities, both train stations serve as intermodal commuter hubs. Together they serve six regional rail lines operated by New Jersey Transit (NJ Transit) that provide access to New York City and suburban New Jersey. Newark Penn Station also serves Amtrak's Northeast Corridor and PATH service to New York City. Local travel demand within the City is served by two light rail lines and over 40 bus routes with approximately 1,000 bus stops. Light rail and bus lines in the city are operated by NJ Transit, New Jersey's public transportation corporation. NJ Transit also operates the ADA paratransit service Access Link.

Shared-Use Mobility Services

EZ Ride is a transportation management association serving urban Essex County including the City of Newark. Rutgers University Newark operates a campus bus that serves Rutgers University, NJIT, Essex County Community College and the University of Medicine and Dentistry of New Jersey.

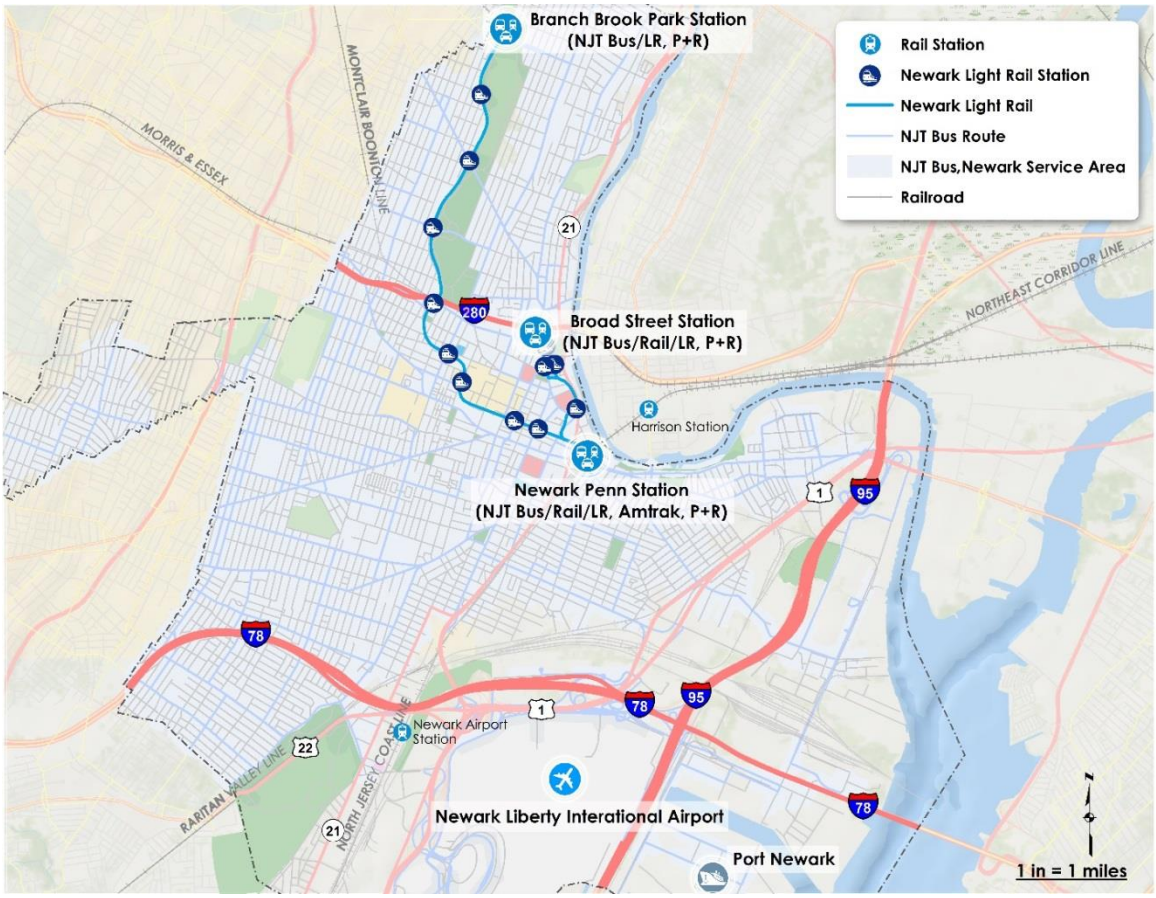

Figure 3. Newark's Intermodal Transportation System and Facilities

Intelligent Transportation Systems (ITS)

Newark's Division of Traffic and Signals hosts the City's centralized Traffic Management Center (TMC). Through the TMC traffic engineers are able to monitor and manage traffic using video feed from CCTV and traffic detection cameras, as well as Advanced Traffic Management System (ATMS). This center integrates video feed from over 40 cameras installed on traffic signal equipment throughout downtown Newark and along principal arterials. The Division is currently working with NJIT's ITS Resource Center to develop a more robust model for collecting, storing, and processing traffic data generated by the traffic detection cameras, to be used for performance monitoring and analysis. From the TMC the Division also manages adaptive traffic signals control (ATSC) system installed at seven intersections located around the City's major transit hub, Newark Penn Station, running Synchro Green system. This network will soon be expanded: design is underway for an ATSC system at 19 intersections along McCarter Highway (State Route 21). The communication between the traffic control infrastructure and the TMC is provided via extensive network of fiber and copper conduits installed along the city's major thoroughfares. The location and type of ITS infrastructure deployed throughout the city is shown further in the document in the Annotated Site Map.

Environment Conducive to Smart City Concepts

Newark's Division of Traffic and Signals has a proven track record of implementing demonstration projects including projects making use of new smart technologies. One such demonstration was Newark's Project Red Light, a red-light camera photo enforcement program. Nineteen cameras were installed as part of a New Jersey state-wide pilot program to evaluate the effectiveness of utilizing automated photo enforcement systems to monitor and fine red light violations. Initiated in 2009 the program ran until 2014. By the program's end intersections with the cameras saw a 100 percent reduction in right angle crashes, an 83 percent reduction in rear end crashes and an 83 percent reduction in total crashes. Additionally, the program resulted in 412,987 red light infraction tickets issued and paid, resulting in $35.9 million of total revenue generated for the City of Newark. Project Red Light demonstrates that Newark is both willing and able to undertake a large technology focused project that requires coordination across governmental agencies and collaboration with the private sector.

Newark's Division of Traffic and Signals has also completed a traffic signal interconnect project that has connected 170 of its 450 traffic signals through a fiber network to the City's Transportation Management Center (TMC). The City's signal system can monitor these signals in real time, and staff has the ability to adjust signal timings to respond to congestion and incidents when needed. Furthermore, video detection, sensors, radar and pan tilt cameras that provide data that is used to adjust traffic signal timings and make decisions about traffic circulation have all been installed at locations throughout the City. This system is currently being expanded to provide real time data on our website on traffic congestion, incidents and construction. Partnerships with the New Jersey Institute of Technology and various third party providers are enabling the City to provide real time data from our traffic signals to vehicles driving on Newark streets.

The City and Rutgers University have developed the "My Newark" app, providing a mechanism for residents, businesses and visitors to access information about Newark services such as garbage pickup, street cleaning and events. This app also allows users to report problems such as potholes, non-functioning street lights, missed garbage pickup, dead trees and any other safety or quality of life issue. This data is routed to the appropriate City agency who then responds and updates data within the app providing the user with real-time data regarding their complaint or request. Another app, "Newark One Stop", is a comprehensive resource linking our citizens to job opportunities. From searching for jobs to submitting a job application, the Newark One Stop app helps residents through the entire process of finding a new job.

Committed Leadership

In order for a demonstration project as large as the Smart City Challenge to succeed, support from the highest levels of city government is critical. Mayor Ras J. Baraka's dedication to providing citizens with technology they can use to improve their quality of life, spur economic growth and improve safety encapsulates his vision for the City of Newark. In addition to the Mayor, the Newark City Council shares in this vision of a Smart City. Leadership understands the importance of new technology in providing safe and consistent service to residents, commuters and the business community.

The City of Newark's leadership is fully committed to the success and expansion of the demonstration projects arising from participation in the US DOT's Smart City Challenge. The demonstration will be implemented by the City's Department of Engineering, Division of Traffic and Signals, the agency responsible for the City's transportation infrastructure. Jack M. Nata, Manager of the Division of Traffic and Signals, has served the City of Newark for 27 years. Throughout this time Mr. Nata has been a consistent advocate for exploring the bounds of what is possible in the realm of traffic and transportation planning and engineering. His leadership has been demonstrated in both the use of technology and in implementing cutting edge street geometry concepts. Under his leadership the City has created its first Transportation Management Center, fiber optic traffic signal interconnect network, a traffic signal adaptive signal system, electronic permit system for issuing construction permits and parking permits, and a sign and pavement management system. He created Newark's Complete Street Policy and implementation program, developed the City's Pedestrian and Bicycle Safety Action Plan, and adopted and successfully implemented NJTPA's Street Smart Pedestrian Education and Enforcement Campaign.

Sharing Economy

Newark recognizes that participating in the sharing economy can have positive impacts on City operations as well enabling individuals, corporations and non-profits to utilize City data in a way that optimizes resources and expands travel choice and decision making. Newark is currently working with researchers from NJIT's ITS Resource Center to collect, analyze and share existing signal timing and video data, initiatives that would be expanded under the Smart City Challenge program.

Open Data

Newark already makes a large portion of City data available for public view and use. This includes property information, restaurant health inspections, street flooding and trash schedule. All of this data is contained in interactive and easy to use maps. Through the Smart City Challenge program Newark would further develop the mechanisms by which data is collected and disseminated to the public. Specifically, the City will develop systems for collecting, packaging and distributing data based upon traffic monitoring sensors and cameras. Included also will be data related to signal timings. The addition of new sensors to track air quality, parking availability and road conditions will enable the City to share this data as well. Providing a platform for the sharing of open data will benefit third parties who will utilize the data to develop various applications and devices to monitor roadway conditions and anticipate signal timings, all of which provides benefits and services to members of the public who utilize Newark's roads and transportation network.

The City of Newark has demonstrated an ability to collect and manage large amounts of data generated via remote instrumentation deployed throughout the city. Notable projects include execution of Newark's Project Red Light, installation and operation of adaptive signal equipment data feeds using Adaptive System SynchroGreen, and installation and management of corridor monitoring Wi-Fi and Bluetooth sensors. The success of these programs indicates that City of Newark and NJIT staff has the knowledge and expertise to expand existing programs as well as undertake new data collection efforts.

Annotated Preliminary Site Map

The project sites, described in the annotated preliminary site map on the following page, are distributed across Newark's five wards and are oriented along principal arterial corridors and at key nodes of activity. Corridors to be instrumented include Broad St., Market St., Ferry St., University Ave., Irving Turner Blvd., Raymond Blvd., Central Ave., Bloomfield Ave., and McCarter Highway (Route 21). These corridors were selected as project sites due to significant access and volumes they carry, serving the CBD and providing connectivity to outer wards of the City and the regional network. These streets facilitate intermodal transportation choices, carrying high volumes of pedestrians, bicyclists and transit vehicles, and connect to Newark's intermodal passenger and cargo hubs – Newark Penn Station, Broad Street Station and Newark Liberty International Airport. The University Heights section, location of NJIT and Rutgers University Newark campuses is also included in the project site. The two adjacent campuses will be the location of initial deployment of electric and autonomous vehicle technology as part of this project, which would then expand to other appropriate sites in the downtown area.

Annotated Site Map
Newark, NJ

1 in = 2,000 feet

N

Smart City Deployment Site/Corridors

NEWARK
PENN STATION
AREA

Broad Street Station

Harrison Station

Newark Penn Station

Newark Airport
Station

Newark Liberty International Airport

Port Newark

280
21
1
78
95

Intermodal Transit Hub
Rail Station
Newark Light Rail Station
Newark Light Rail
Railroad
NJT Bus Route

Vehicular Video Detection
ATSC
CCTV
CTSS
EZ Pass Reader
Bluetooth
Cooper Lines
Fiber Lines

PROPOSED SMART CITY DEPLOYMENT

In order to achieve the goals and objectives of the Smart City program, a number of approaches and deployment initiatives are proposed involving advanced and connected technologies, innovative transportation improvements, and pertinent smart city elements. The proposed Smart City program aligns with all of the twelve US DOT vision elements outlined in the Smart City Challenge. The following identifies how this proposed program incorporates the Technology Elements, Innovative Approaches to Urban Transportation Elements, and Smart City Elements into a holistic approach to creating smart city infrastructure in Newark.

#1 Urban Automation

The Technology Elements of a Smart City solution help to address the need for real-time, practical management of existing traffic. This includes the flow of both automated and user-operated vehicles, traffic congestion and emergency needs. Newark has implemented several systems to improve traffic management operations. The current management model is comprised of three main components: Newark Traffic's Ethernet based Communication Network, Trafficware's ATMS.now Advanced Traffic Management System and Milestone's CCTV Surveillance Monitoring System.

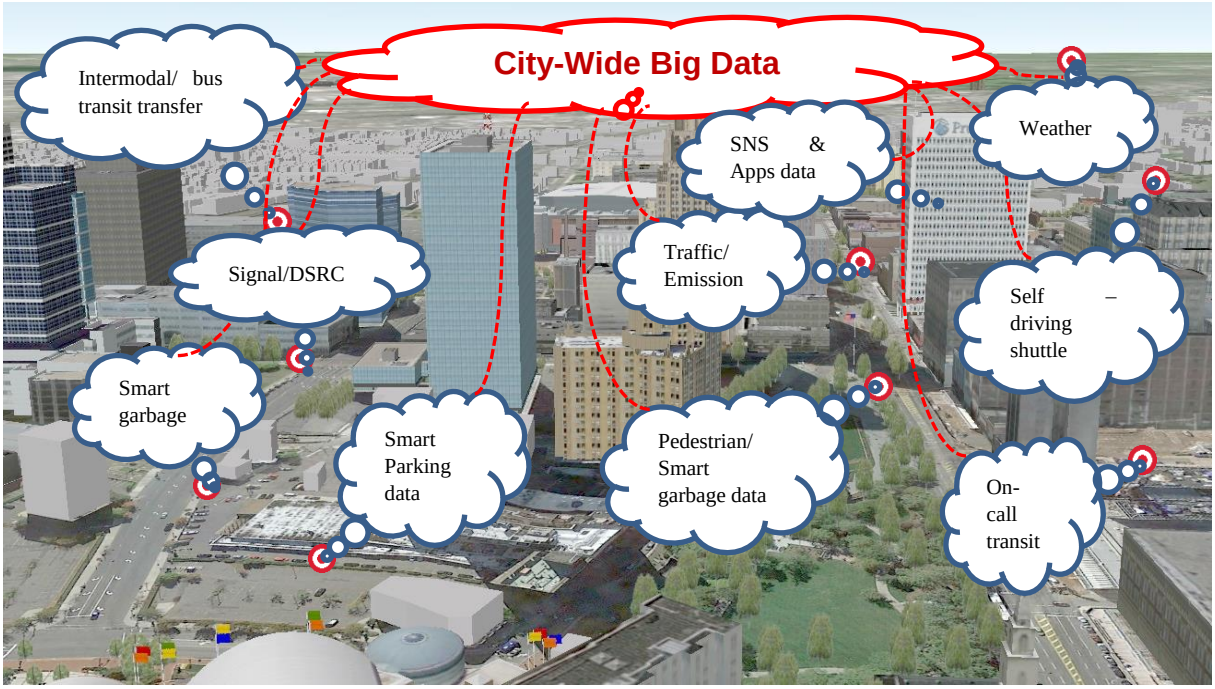

Figure 4. City-Wide Data Collection for Municipal Service

The first component used by the City is an Ethernet communication system, interconnected via fiber, twisted pair copper, wireless, and cellular with hundreds of switches connecting Ethernet based devices. The second component is Trafficware's ATMS.now, a centralized, advanced traffic management system, comprised of servers and workstations located at Newark's Transportation Management Center. These servers are communicating with 180 signalized intersections, located in the downtown area of the City and along major commercial corridors.

This system allows second by second data collection from the traffic controllers for analysis. The third component the City currently uses is Milestone's CCTV surveillance system, located at Newark's TMC, with servers, workstations and a video wall for over forty cameras placed throughout the City, communicating through the Ethernet network. This system allows visual confirmation of traffic flow as well as incidents management. Camera activity may also be viewed via smartphones and smart devices allowing TMC staff to monitor conditions remotely.

This Ethernet communication system is the backbone which connects devices to one another and to the central system for monitoring and analyzing data. It is imperative to expand the network across the entire City. By using additional physical connections between devices there is an advantage of larger bandwidth and better security. Wireless and cellular connections will also be utilized for a scalable infrastructure and interconnection to other cities. Many existing devices will be upgraded with higher bandwidth to accommodate an expanded network. The network will also need additional redundant loops to avoid downtime and a monitoring system to notify operators of potential problems. A long-term strategy to enhance communication will provide the means to transmit data between devices and the central infrastructure; making communication automation and connected vehicles possible.

The City of Newark will also expand on the use of Trafficware's ATMS.now, an advanced traffic management system that allows connection either directly to individual devices or integrates with other system software to provide one central platform for data collection and analysis. ATMS.now provides end users with an easy to use application in a tabular or GIS form. Additional detection devices will be added at intersections strategically throughout the City to get a more accurate depiction of traffic flow, patterns and incidents.

Utilizing a variety of sensors installed on City owned traffic signal equipment as well as leveraging partnerships to outfit third party infrastructure with sensors Newark has developing real time signal phasing will create automated corridors within the City. Instrumentation of these corridors will result in optimized travel times and reduced fuel consumption for motorists traveling throughout the City. Additional travel automation will come from technology such as the Mobileye Shield+TM which can be integrated into public transit services providing drivers with enhanced safety by avoiding and lessening roadway crashes.

By installing GPS and video in all snow plows the City's snow plow fleet would share data on visibility, temperature, road conditions, and treatment recommendation. This data could be layered on a map that would be posted on the City's website and the City's My Newark app to provide residents with real-time information on what roads have been plowed and when they were plowed. This technology will reduce snow removal time, result in more effective application of anti-icing agents, reduce fuel consumption and emissions of snow plows and decrease the number of crashes due to unplowed and icy roads. Finally ITS technology will be used to identify and classify pavement issues before they become critical without significant increases in operating costs. As part of the Smart City Challenge the City will install pavement monitoring sensors in all 1,000 City vehicles to report pavement conditions to the Traffic Control Center, remotely analyzing pavement on a daily basis.

#2 Connected Vehicles

Vehicle to infrastructure communication will be standardized with a system created to accommodate future expansions. Currently Newark has 170 signals that are directly connected to a centralized Transportation Management Center and the city plans to expand this to all 450 City traffic signals within the next five years. The information from these signals will be collected, packaged and securely distributed or made available to third party developers and companies as well as members of the public.

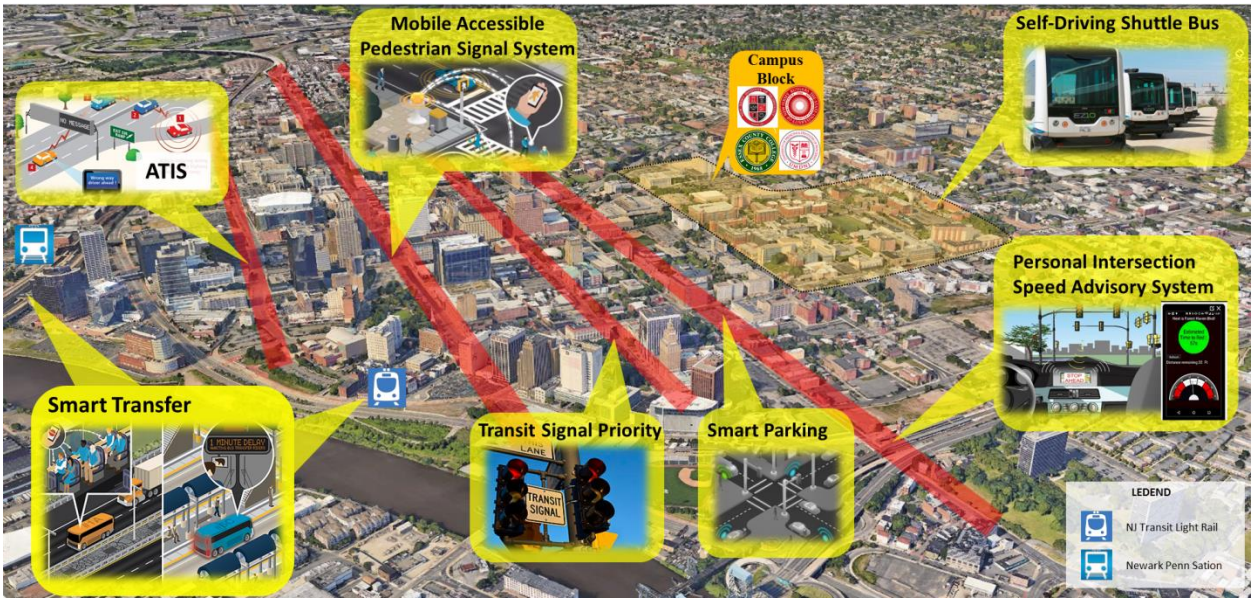

Figure 5. City-Wide Intermodal Connected Vehicle Applications

Access to City of Newark signal timing data will allow the private sector to develop and/ or sync current automated vehicle technologies to Newark's signal network. This will result in optimized travel times, reduced congestion and reduced fuel consumption and emissions reductions. Newark's role in the advancement of Connected Vehicles will be as a facilitator of data to support new and innovative technology developed and implemented by the private sector. Vehicle to infrastructure communications data shared responsibly provides the private sector with the incentive necessary to invest in automated technology. Expansion of the existing connected signal network is high priority as this will result in greater coverage and accuracy.

The data packets produced as a result of the proposed data collection and distribution system will also advance connected vehicle goals. The City will work closely with the state transit agency, New Jersey Transit (NJ Transit) and the Rutgers University shuttle system to develop Transit Signal Priority (TSP) applications. This will require vehicles to communicate directly with traffic signal equipment. This communication and priority will result in lower signal wait times for transit vehicles leading to more efficient service and predictable schedules. Signal information is also critical for autonomous vehicles as instrumentation moves out of the vehicle and into surrounding infrastructure. President Obama has proposed $4 billion to be spent over 10 years to continue this technology, and as companies such as Google have already logged millions of miles of test travel in autonomous vehicles it is imperative that Newark be prepared for this inevitable and major technological sea change.

#3 Intelligent, Sensor-Based Infrastructure

Integration of sensor-based infrastructure into various aspects of Newark's transportation network will enhance the City's infrastructure to vehicle communication network, providing additional information which can be distributed to the public. Many of these sensors can be located in ways that will help reduce congestion and provider travelers with data to aid in travel decision making. Newark's Smart City Vision includes work zone monitoring, smart on-street parking and sensors to detect parking lot inventories.

Sensors placed in street lights can be used to not only detect vehicle movements but also provide data on the location and availability of parking spaces. Current, an extension of GE, has developed intelligent LED fixtures that would be well suited to these applications. Coupling with Smart Grid and Smart Sensor Infrastructure, SSL performs lamp-level management, enabling smart dimming and autonomous ON/OFF switching of the street lighting. With the communications infrastructure in the City of Newark, SSL will be an easy-to-deploy technology crucial for building Smart City by producing seamless benefits from saving the City's energy costs and operation and maintenance costs for existing street lights.

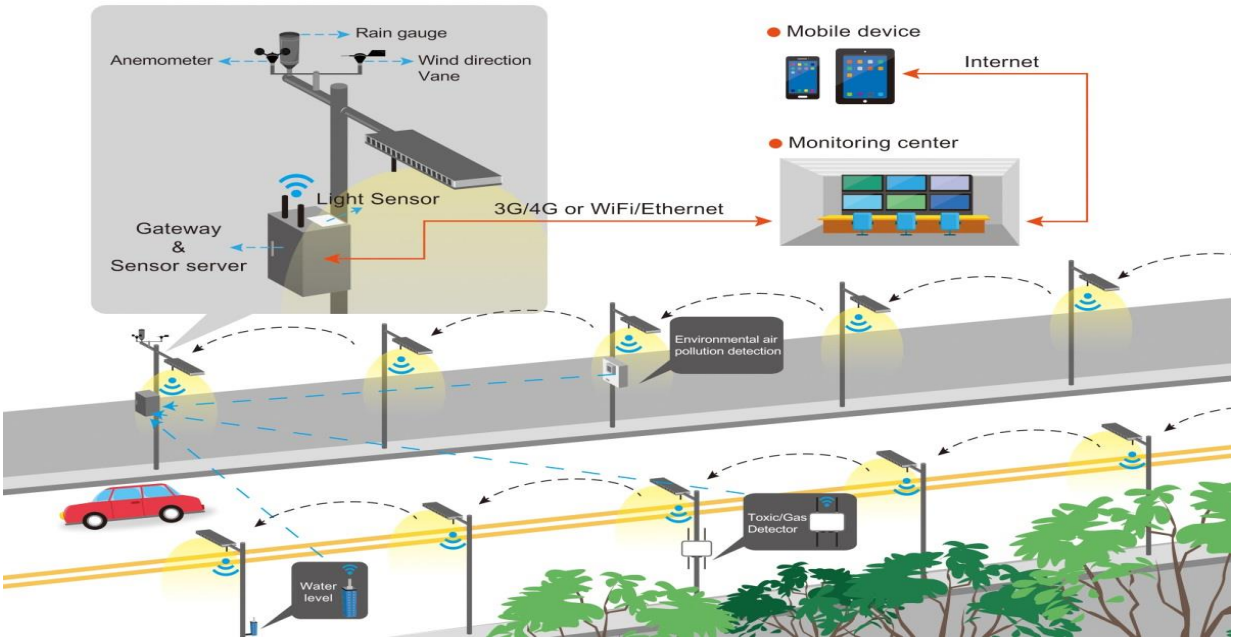

Figure 6. Smart Street Lighting

Work zone monitoring is a pilot program that the City is currently advancing in partnership with the NJIT, this program would be expanded through the Smart City Challenge program. Congestion and delays caused by construction in one area of the City can create ripple effects that expand to major roadways and highways, creating congestion issues within Newark and beyond its boundaries. The intent of the work zone monitoring program is to provide more accurate travel time and delay information to travelers in advance of their decision to take a particular route.

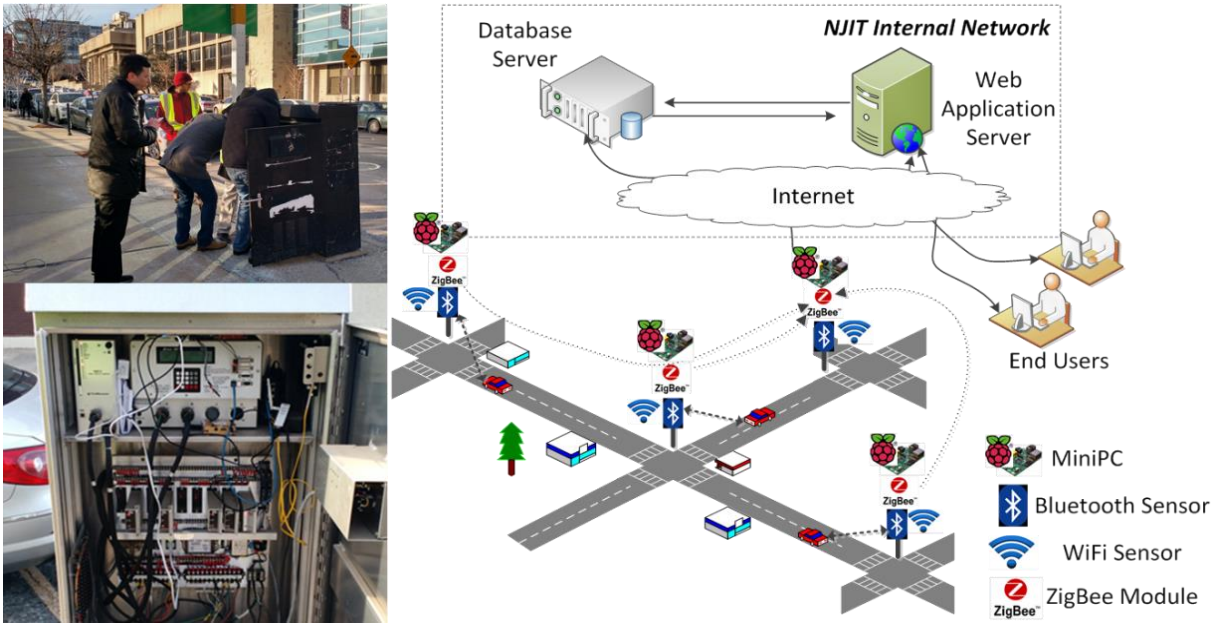

Figure 7. Newark – NJIT Corridor Instrumentation Pilot

Parking can be a source of unnecessary congestion and wasted fuel often because drivers have limited information about where parking is available and parking rates. Newark's Smart City Vision proposes sensors to monitor parking availability at both on street locations and within parking lots. Sensors installed via Intelligent LED's at on street parking spaces can be liked to an app such as the existing My Newark app. Similarly, sensors can be installed in parking bays at public and private lots. Data collected can be linked to an app or displayed on street facing information boards. These smart parking sensors will greatly improve the efficiency of drivers seeking parking. Benefits included reduced congestion, reduction of circling looking for parking, reduced emissions and improved services.

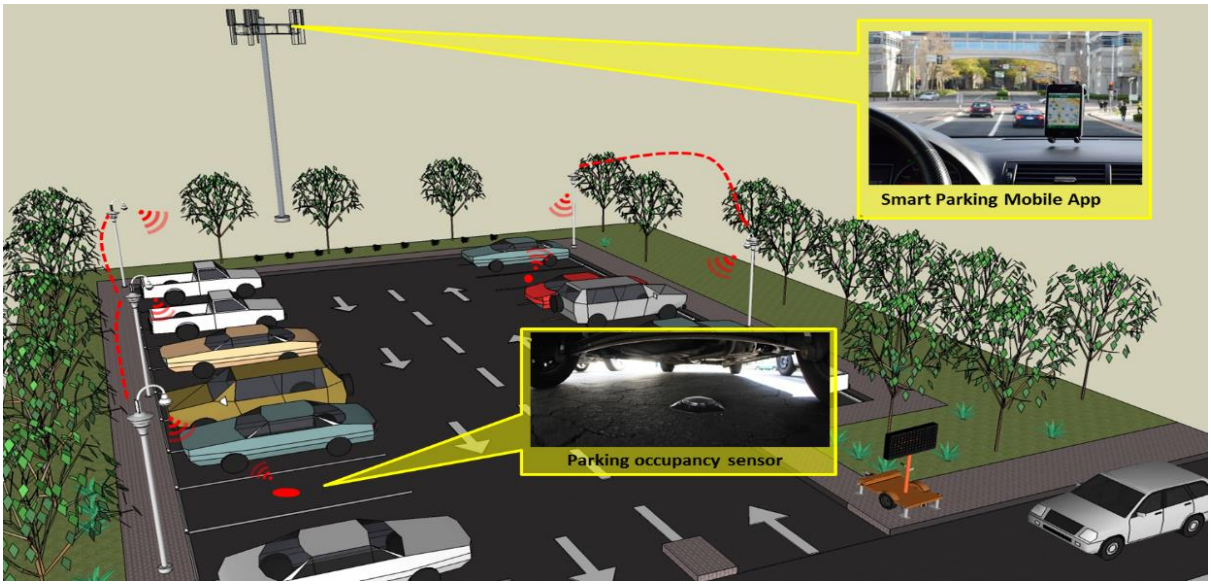

Figure 8. Smart Parking

Newark will upgrade all Route 21 signals to adaptive signals through NJTPA's Regional Local CMAQ Initiative Program, the goal of which is to reduce emissions and bring the NJTPA region into compliance with Federal air quality standards. By instrumenting those signals with emission sensors capturing carbon monoxide (CO), carbon dioxides (CO2), particulate matter (PM), and nitrogen oxides (NOx), the real-time emission information across the city can be collected and monitored in an automatic manner. The traffic signals of major corridors in the city can be automatically managed to improve the air quality of the city.

The City of Newark plans to expand its Shotspotter network to cover all 26 square miles of the City. This kind technology uses sensors to detect gunfire and collects data that helps communities define the scope of illegal gunfire. This system has been a vital tool for the Newark Police Department in fighting crime and keeping our City safe.

Instrumenting trash cans with a sensor unit, smart garbage collection (SGC) monitors the status of trash cans and transmits alert messages to a waste management center if they are full. SGC systems have been adopted into multiple cities all around the world, pursuing Smart City. Given the City's well-functioning infrastructure and communications, the City of Newark is well-positioned for the city-wide deployment of SGC. Automatically receiving the alert message, the City enables to monitor container fill-levels, forecast collection dates, and schedule the dispatch of garbage trucks, thereby increasing garbage collection efficiency.

Figure 9. Smart Garbage Collection

#4 Urban Analytics

A robust network of sensor-based infrastructure is dependent upon structured systems of collection and dissemination. The success of analyzing data in order to solve a problem depends upon the accuracy and completeness of the initial data. Urban Analytics will be supported by interconnected sensor and software networks. The City is currently using the Trafficware Synchro Green Server system at seven City intersections and is expanding it to another 19 intersections along McCarter Highway (Route21). This system is designed to collect traffic counts from presence detection units and relay those counts back to the central system. It evaluates traffic counts, analyzes traffic patterns and recommends the most efficient traffic pattern to run. It then sends this information to the signal controllers, cycle by cycle. This analysis allows maximum traffic flow through corridors, which in turn helps reduce congestion and car emissions. The City of Newark plans to extend the Synchro Green system to all major corridors to take advantage of existing technology.

Trafficware's Fleet.now module also supports Smart City Analytics. It is an (AVL) Automatic Vehicle Locator module that works with GPS vehicle tracking systems and allows vehicles to be tracked as they proceed through corridors. This could help Newark with retiming of lights for better traffic flow which ultimately helps reduce car emissions and improve the environment, two very critical goals of the Smart City challenge.

Newark's TMC receives real time video feed but currently this data is used only for real time traffic management. Traffic volumes collected from the video feeds, using Placemeter technology, can be used to conduct traffic counts, streamlining this process and saving valuable employee time, particularly if this process is automated. Counts of this nature are also more accurate as they can provide real-time, up to date and daily counts of intersections instead of a manual in the field count which only records one point in time.

There is great potential to share this data openly on a secured public platform, allowing companies, software developers and interested members of the public access to this data, spurring innovation of ITS software, vehicles and other products. Newark will expand its TMC to collect and analyze data in house and create real time XML "data packets" that can be disseminated through a secure server for public use. As part of this expansion of the control center would be the creation of an online portal linked to the City's website called "Connect Newark". Connect Newark would provide interested members of the public and third parties access real time data packets as well as a variety of other data gathered via the proposed sensors. Proper screening of the data will also be undertaken to ensure that any data shared openly with the public would not compromise the safety and security of critical City, state or federal assets as well as the safety of the members of the public. Newark will coordinate with the Newark Police Department and Newark's Office of Emergency Management to ensure compliance with all state and federal regulations concerning the sharing of data.

#5 User-Focused Mobility Services and Choices

Providing a platform for open data is critical to the success of increasing user-focused mobility services and choices. Private companies such as Google, Bing, Garmin or Waze provide navigation platforms to members of the public that the City of Newark cannot compete with. Similarly, auto manufacturers such as BMW or Audi are creating responsive in vehicle travel systems that can assist drivers in regulating speed and conserving fuel.

Newark seeks to leverage its position as a producer of a large amount of data, openly sharing the City's current and anticipated data about signal timing, traffic volumes, special events, weather events, construction and work zones, parking availability and air quality to interested third parties. Private companies are best positioned to provide direct mobility service to the public but this service is dependent upon up to date and accurate data. Allowing mobility service providers access to Newark's data will improve the accuracy of their products resulting in more accurate information being made available to consumers and the public. Better data for consumers means more informed choices resulting in enhanced mobility options and travel choices.

#6 Urban Delivery and Logistics

Trucking companies encounter several obstacles when delivering freight to congested Newark downtown area including a lack of accurate road traffic and route guidance information, and the availability of parking spaces and access points. The mobility and route choice platforms envisioned as a product of Vision Element #5, will assist truck drivers in selecting the shortest and fastest route as well as available parking location. Adaptive Urban Delivery and Logistics

will mitigate congestion and pollution by the rapid growth in light and heavy freight on Newark's roads through a combination of interventions to promote the efficient freight movement around the City: traffic monitoring, route guidance, smart parking, dynamic parking pricing, re-timing delivery, use of electric trucks and electric cargo bike.

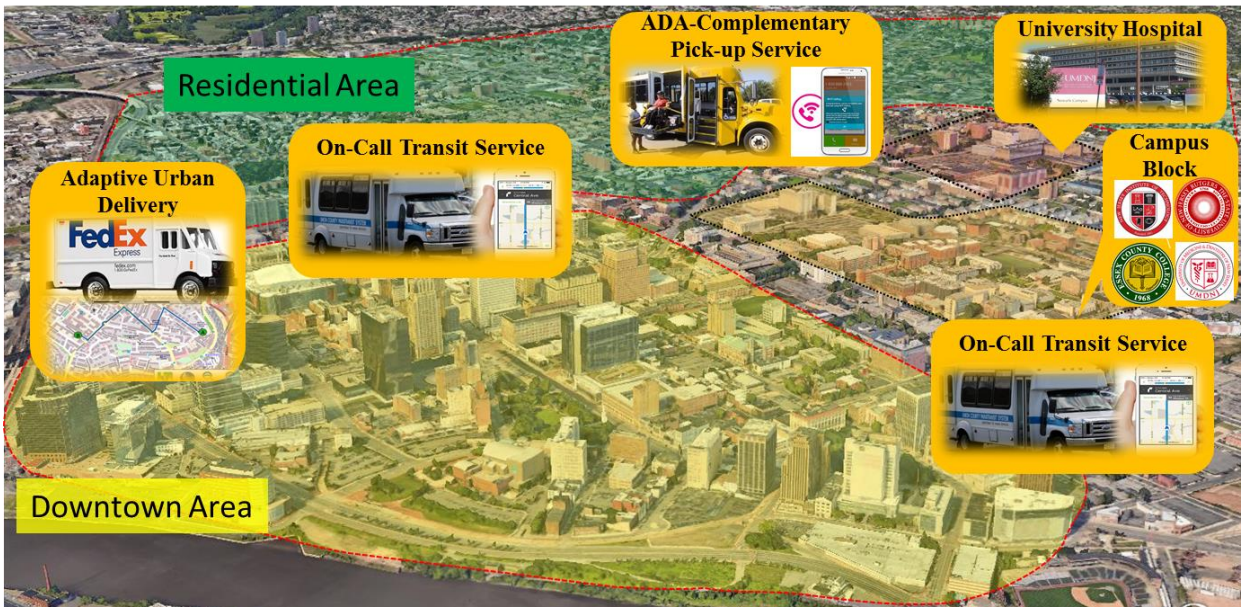

Figure 10. Urban Delivery, On-Call Transit Service, and ADA Complementary Pick Up Service

#7 Strategic Business Models and Partnering Opportunities

The City of Newark has built and maintains a strong working relationship with the New Jersey Institute of Technology (NJIT), a member of the UTC consortium. Through this collaboration city streets are transformed into a laboratory for learning and innovation. Newark and NJIT are already working towards the implementation of several ITS projects; these include instrumentation of work zones, instrumentation of major arterial corridors and experimentation with drone technology. These projects aim not only to evaluate the effectiveness of several types of sensors, but to equip the City's Transportation Management Center to receive, package and distribute the collected data. NJIT will be a necessary and critical partner in advancing Newark's Smart City vision.

Newark's utility providers are also important partners in advancing Newark's Smart City vision and goals. PSE&G is the regions primary gas and electricity provider and also owns the vast majority of street light poles throughout Newark. PSE&G light poles can host a wide array of sensing devices, including intelligent LED fixtures, poles can also accommodate remote or automated adaptive photo controls and programming of digital signage. Newark already works closely with PSE&G and further strengthening this partnership is the fact that PSE&G is exploring ways to incorporate dynamic sensors and technologies into their network.

Integrating transit buses and rail into an ITS network is provides equitable mobility choices and encourages greater use of transit and non-motorized modes of travel. ITS solutions such as transit signal priority, real time bus arrival and accurate schedule and delay data all require

collaboration with NJ Transit to ensure that Newark's infrastructure and collected data are being properly interpreted and incorporated into NJ Transit's rider services and operations. Additionally, partnership with Rutgers University Newark bus service for students will ensure that the University's bus system is integrated into Newark's larger transit network.

North Jersey Regional Transportation Planning Authority (NJTPA), the regions federally mandated metropolitan planning organization (MPO), oversees the distribution of federal transportation funding for 14 subregional entities, of which Newark is one. NJTPA has been a long standing partner assisting Newark with planning studies, safety efforts and numerous roadway projects. Partnership with NJTPA allows Newark to tap into a wealth of profession expertise as well as leverage additional funds to continue implementing the Smart City vision once the US DOT's Smart City Challenge project period has ended. As the primary driver of regional and local planning in the North Jersey region NJTPA's partnership and support has been and will continue to be essential as Newark continues to push the boundaries of what is possible for the City's roads, sidewalks and public spaces.

#8 Smart Grid, Roadway Electrification, and Electric Vehicles

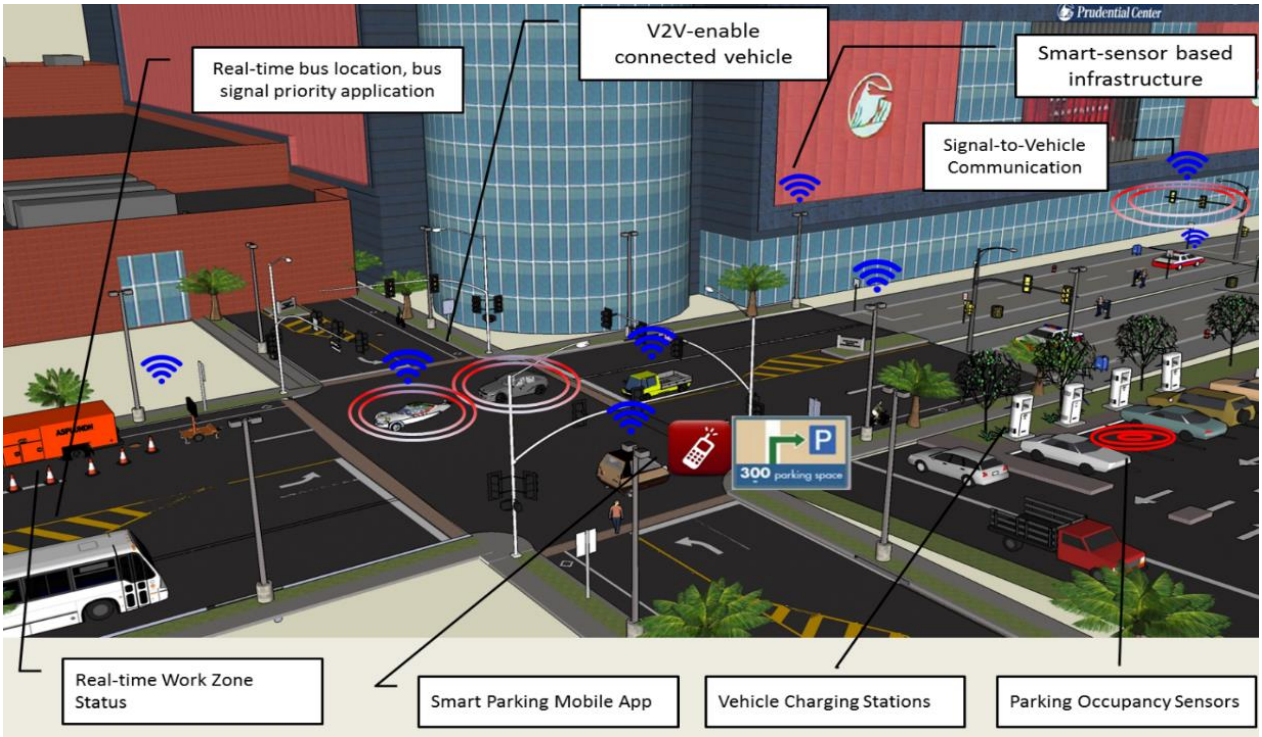

Figure 11. Smart Grid

Developing a more robust infrastructure to support electric and hybrid vehicles is vital as Newark seeks to reduce emissions. Electric vehicles are especially impactful in a state like New Jersey where more than 50% of electricity production comes from carbon free sources, particularly nuclear. Additionally, the NJTPA's planning region is largely out of compliance with federal clean air standards, with Newark being a non-compliant subregion. Combined with other efforts, encouraging electric vehicles can help Newark to work closer to compliance with federal standards, improving the quality of life for the millions of people who live in the metro

region. Newark's Smart City vision imagines two types of electric vehicle charging mechanisms. First are Rapid Charging Stations, initially these stations will be placed at institutional locations to take advantage of institutional vehicle fleets that travel short distances throughout the City and reliably return to the same location each night. The City of Newark and NJIT's vehicle fleets would be ideal starting points as each of these organizations is fully committed to the Smart City vision and can ensure reliable analysis and reporting of system performance. Second are wirelesses charging stations. These stations can be incorporated in city-wide infrastructure such as street light poles, traffic signal poles, parking meters as well as existing as stand along stations. Strategically placing wireless charging through Newark's core will encourage greater use of electric vehicles as many drivers have concerns over adequate facilities to recharge the vehicle when not at home.

#9 Connected, Involved Citizens

Traveler information comes in many forms and with the rise of smart phone technology and in-vehicle navigation systems it is easier than ever for consumers to monitor traffic conditions and adjust their travel routes, often in real time. Data collected and distributed through the process described in Vision Element #4 can be used by many of these third party apps to provide traveler with highly accurate and up to date roadway and transit information, allowing them to make better informed and more efficient travel decisions.

In addition to the many third party applications that exist to support travel decision making, Newark's own My Newark app is tailored to support the needs of Newark residents. Residents or visitors can make maintenance request, anonymously provide police with crime tips, check transit schedule and travel times, and view upcoming City events. This app would be expanded to incorporate new data provided by Newark's intelligent, sensor-based infrastructure.

#10: Architecture and Standards

Newark's Smart City Vision will utilize an interoperable regional ITS architecture that can extend beyond Newark's boarders to the larger region, state and country. This architecture is based upon the State of New Jersey ITS architecture guidelines contained within the "New Jersey Statewide ITS Architecture". New Jersey's standards, while tailored to the local New Jersey context, are also designed to meet all applicable federal ITS architecture standards. This insures that any ITS architecture design decisions that the City of Newark undertakes will have full compliance and integration with the ITS architecture that is being installed within the state and nationwide. Demonstration of ITS deployment in Newark's Smart City will be based on enhanced standards integrating Connected Vehicle Reference Implementation Architecture (CVRIA) and other existing standards into New Jersey's ITS standards and architecture. Development and integration of the standards and architecture will be documented.

#11: Low-Cost, Efficient, Secure, and Resilient Information and Communications Technology

Vision Element 10 provides the foundation of the Connected Vehicle Reference Implementation Architecture (CVRIA/SET-IT v2.0). However, certain aspects of the CVRIA/SET-IT must be

enhanced to meet the objectives of Vision Element 11. The availability of the DSRC wireless network is critical to maintaining continuous communication with all personal and commercial vehicles, as well as smart bicycles and pedestrian DSRC-enabled phones. If a DSRC node is taken out service due to maintenance, failure or traffic crash the RF footprint of the DSRC network is designed to recover the "out-of-service" node through network diversity. However, DSRC nodes will be deployed with "break away" fiber optic connectors, mounted in the base of the traffic cabinets or poles, which provides the capability to quickly restore the physical communication interface to DSRC radio node, once new equipment arrives on site. The IRIS (intelligent Release Inter-Connect System) is a multi-channel fiber optic connector system that mounts into the base on any traffic cabinet, camera pole or utility light pole, and inter-connects the fiber plant to electronic communication equipment within enclosure or utility pole. IRIS provides resilient design and integrates with common technology architectures and integrative policies.

Additionally, City's infrastructure and communications network will be protected by using advanced metering infrastructures (AMIs), public key infrastructure (PKI) or managed PKI to secure data integrity and service continuity. When information is transferred and managed over unsecured lines, between different operators, with heterogeneous systems, then data will be encrypted. By leveraging strong two factor authentication and one-time password entry, only trusted personnel can gain access to critical data and control systems. Digital certificates can also be used for authentication, signing and encryption. Designing and building encryption solutions into devices will ensure that they can only communicate with the required control center and communications can be authenticated.

#12: Smart Land Use

Newark is already advancing several initiatives that support the smart and equitable use of land and roadway space. Newark's Pedestrian and Bicycle Safety Action Plan identified problem corridors and intersections and developed clear action steps that will significantly improve safety. The Newark City Council adopted a Complete Streets Policy in 2012, included in this is a Complete Streets Design Guidelines handbook and Pedestrian, Bike and Transit Accommodations Checklist. These documents ensure that pedestrians, bicyclists and transit users are considered and provided for in all future roadway and streetscape projects. These planning and policy efforts will be further bolstered by the use of ITS technology. Pedestrian and bicyclist video detection and intrusion detection, provided by Placemeter, will allow planners to visualize how these modes travel through the City and better manage signals and traffic flows to accommodate them. Data collection based not on crashes but near misses can be used to prevent potential crashes and fatalities from happening, moving the City from a reactive policy and to a proactive approach.

COMMUNICATION AND DATA STANDARDS

Existing Standards, Architectures and Certification Processes

The City of Newark uses an Ethernet based communication network system that is interconnected via fiber, copper, microwave radios, and cellular modems. There are 170 intersections connected to this system that provide real-time traffic signal timings back to our ATMS Central Control System. All these intersections run Naztec manufactured controllers, models 980 and 2070, which are Ethernet enabled to communicate with Newark's current system. The City of Newark currently runs seven intersections on a Trafficware Synchro Green adaptive system in its downtown area, two intersections on McCarter Highway and the rest in the vicinity of Penn Station. In addition, Newark uses 40 Traffic Cameras that run on a Milestone camera system and are interconnected and viewable in Newark's ATMS Traffic System Bing Maps to monitor traffic and congestion along its major corridors including McCarter Highway, Broad Street and Raymond Boulevard.

The City of Newark strives to be at the forefront of the latest ITS. The City works in parallel with NJTPA's latest ITS strategic deployment plan known as "The Connected Corridor". This plan is in line with Newark's standards for ITS where the unified vision is to build a connected transportation system supported by innovative technology. NJTPA's "The Connected Corridor" does not recommend any specific technologies but does require that the technology used be the current state of the practice and conform to the National ITS Architecture. To incorporate "The Connected Corridor" integration is a key component and it is an attribute that the City of Newark has already been contributing to by working with institutions such as NJIT, Rutgers, Rutgers CAIT, PSEG, NJTPA, NJDOT and NJ Transit. The City of Newark with these standards for ITS and connected vehicles envisions a Smart City that will enhance and optimize our current transportation system through integration with other transportation agencies and jurisdictions within the region and state to achieve a seamless transportation network.

Infrastructure Readiness

Newark's Transportation Management Center is already connected to 170 video monitoring devices, making expansion and adaption of this system easily accomplishable. Further this center already receives a large amount of data, which in collaboration with NJIT will begin to be packaged and utilized in analysis and traffic control applications. Newark's experience managing remote sensing devices and the presence of a dedicated TMC means that the framework is already in place for expansion and enhancement of the network and monitoring system.

Further, Newark maintains active working relationships with local utilities, specifically PSE&G. This relationship is important because some infrastructure included in Newark's proposed Smart City vision will need to be placed on assets owned by a public utility company. As PSE&G's history of partnership indicates, placement of sensors and other ITS devices on poles owned by PSE&G is an attainable and realistic proposition.

Data Collection

Newark collects data via manual and automated methods. Data is collected manually three ways, utilizing Traffic Analyzers to collect vehicle volumes and speed, deploying Eco Counter TUBES system to collect bicycle volume and direction and utilizing staff to count vehicles, bicycles and pedestrians in the field. Automated data collection originates from two sources, vehicle volume

counts at all intersections running adaptive signal technology and corridor travel times measured along University Avenue using Wi-Fi and blue tooth sensors. These data, in conjunction with new data to be collected as outlined previously, will be used by the City of Newark, Division of Traffic and Signals and project partner NJIT ITS Resource Center to advance Goals #1, #3 and #5 of Newark's Smart City Vision.

This data has a variety of applicable uses. Data collected via Placemeter video technology can be used to count pedestrians and bicyclists, track crashes and near misses. This allows planners and engineers within the Division of Traffic and Signals to take a proactive approach to addressing public safety concerns. Data resulting from the monitoring of corridor speeds can be integrated with NJ Transit and Rutgers buses to provide riders with more accurate bus arrival time data. This data can be transmitted to riders' phones via an app and can also be displayed via digital signage installed at bus stops or nearby light poles. Newark's Public Works Department will also benefit from a more robust analysis of data. Sensor placed on municipal vehicles to detect pavement conditions can be utilized to prioritize road resurfacing and repair projects. This data, when shared with Public Works, can greatly improve interdepartmental efficiency, allowing subsurface repairs and replacements to be completed at the same time as new road surface treatments are being implemented.

There are several state and regional policies that guide implementation of projects and the resulting management of data. NJTPA's "The Connected Corridor" provides a strategic framework to guide ITS architecture and deployment plan decisions. New Jersey Statewide ITS Architecture lays the foundation for all ITS architectures designed to facilitate transportation systems integration throughout the state. Connected Vehicle Reference Implementation Architecture will be used for identifying key interfaces across Newark's connected vehicle environment. These interfaces will support further analysis to identify and prioritize standards development activities.

PRELIMINARY MANAGEMENT SUMMARY

Risks

Risks are inherent when undertaking any project that challenges the existing status quo. There are several risks related to the implementation of ITS infrastructure. Newark's Smart City vision includes distributing data in an open and free manner. A risk with this model of data sharing is that the data may be used for terroristic or other illegal purposes that could negatively impact infrastructure and residents. Exposure to this risk can be mitigated by controlling access to the data as well as the specific types of data available. Controlling access does not mean choosing to distribute to some groups over other but rather that to access the data users must create accounts with the Connect Newark website, these accounts may involve background checks conducted by Newark's Police Department, additionally, the type and amount of data that Newark shares will be carefully regulated, to safe guard critical infrastructure and utilities.

Infrastructure to vehicle communication systems also contain risk. Autonomous vehicles need continuous input from sensors within and without of the vehicle. Should a critical piece of communication infrastructure fail any vehicle may be left without direction posing a risk to

pedestrians and vehicles around it. Auto manufactures have built their own prevention protocols into the vehicles but City infrastructure will also contain levels of redundancy that can prevent against the loss of any one point of communication.

The political ramifications of exploring ITS solutions also carry with it a level of risk. Changing established ways of doing things can cause anger which is often directed at political leaders and policy makers. Education and outreach and a wealth of information can help to mitigate concerns from members of the public. When citizens are well informed and understand how changes can positively impact their lives they are more open to potential disruption that implementation of new systems may create.

Partnerships

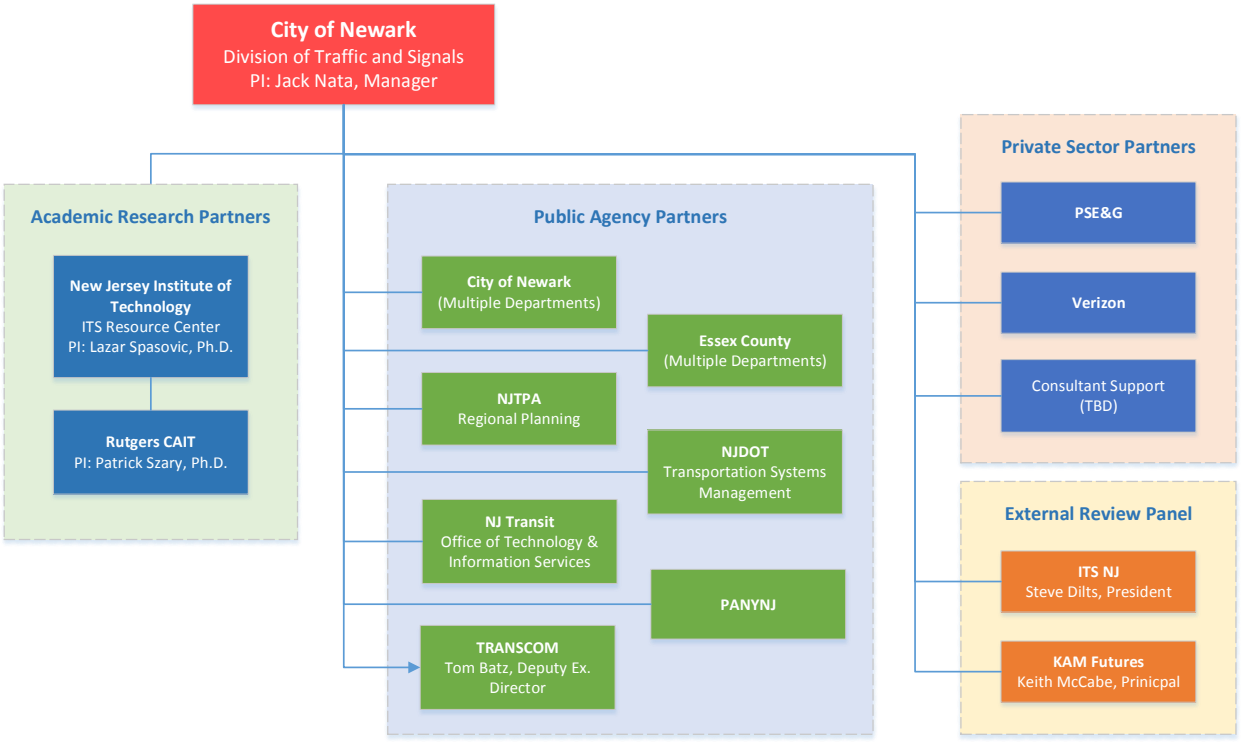

Figure 12. Organizational chart

New Jersey Institute of Technology (NJIT)

As encouraged in the USDOT's solicitation, "Beyond Traffic: The Smart City Challenge" the City has partnered with NJIT's University Transportation Center (UTC), a member of a UTC consortium, to leverage product and service development assets and develop the workforce. Given its involvement in cutting edge transportation research and as an integral part of Newark's community fabric, NJIT is uniquely positioned to contribute to the City of Newark Smart City vision.

Furthermore, Newark's Division of Traffic and Signals is already partnering with NJIT's ITS Resource Center on several exciting and related initiatives, described previously. This

partnership was a result of several factors; common interest in exploring innovative solutions for urban mobility problems; proximity of NJIT and access to its faculty, students, and researchers; and ongoing research at the ITS Resource Center that is compatible with ideas already discussed within the Division.

The Center for Advanced Infrastructure and Transportation's (CAIT), Rutgers University

The Center for Advanced Infrastructure and Transportation's (CAIT) research, education, and technology transfer initiatives address critical multimodal transportation issues such as mobility, congestion, bridge and road health monitoring and rehabilitation, asset management, safety, and national security. CAIT is based at Rutgers, The State University of New Jersey, and is one of only 5 National University Transportation Centers (UTC). The center partners with government, industry, and academia to solve mounting infrastructure challenges, advance state-of-the-art technologies, and prepare the next generation of transportation professionals. Across all transportation modes, CAIT is helping to keep our nation's infrastructure in a state of good repair and meet the need for safe, efficient, and environmentally sound ways to move people and goods in our nation and beyond.

The North Jersey Transportation Planning Authority (NJTPA)

The North Jersey Transportation Planning Authority (NJTPA) is a long standing partner of Newark. As the Metropolitan Planning Organization for Newark and the region NJTPA is a vital source of guidance, support and funding for many transportation projects in the City. NJTPA has provided support on past ITS projects, including the adaptive signal upgrade of McCarter Highway (Route 21). The NJTPA will be an important partner for this project as their staff can provide guidance and connect Newark to future funding opportunities.

The New Jersey Department of Transportation (NJDOT)

The New Jersey Department of Transportation (NJDOT) works closely with the City of Newark on a variety of projects, especially where jurisdiction overlaps or is shared by both the City and the NJDOT. Additionally, NJIT's ITS Resource Center is funded in part by the NJDOT as a research arm designed to explore new possibilities in highway and local roadway management. This close working relationship and direct financial support for ITS projects makes NJDOT's support of this project important to its success and for future funding once the program has ended.

New Jersey Transit

NJ Transit operates all mass transit vehicles in the state of New Jersey and its headquarters are based in Newark. The City of Newark's Smart City Vision outlines several ITS interventions that require collaboration with NJ Transit, this includes signal priority for buses and real time bus arrival and departure information at bus stops throughout the City as well as the Mobileye Shield+TM technology. Newark has partnered with NJ Transit on many past projects including the recent addition of adaptive signals surrounding NJ Transit's Newark Penn Station, the Penn Station Circulation Improvements Project, two BRT Projects and Newark Light Rail Project.

PSE&G

The Division of Traffic and Signals works closely with the region's largest energy supplier PSE&G and its headquarters are based in Newark. PSE&G also owns all the street lighting in the City making them a critical partner when poles are damaged or lights are out. PSE&G is independently exploring the use of intelligent LEDs as well as concealed placement speakers, alert indicators, blue button emergency call stations, digital signage, image sensors, cameras and environmental sensors to be used on light poles.

Essex County

Essex County is the City of Newark's home county and a close partner for many roadway projects. Essex maintains several county roadways that traverse Newark. As the City moves to integrate the entire signal network into one centralized Transportation Management Center it is imperative that Newark and Essex County work together to ensure that county signals are included in signal control and data management upgrades.

The Port Authority of New York and New Jersey

The Port Authority of New York and New Jersey operates and maintains the regions airports, the Port of New York and New Jersey, the PATH train system and a number of bridges and tunnels. Within Newark the Port Authority operates Port Newark, Newark Liberty International Airport and PATH train service from Newark Penn Station. These Port Authority operations are deeply imbedded within Newark's larger transportation network. Partnering with the Port Authority brings critical mass transit and large scale freight facilities in as part of Newark's Smart City Vision.

Verizon

Verizon has been an innovator in developing and implementing technologies and solutions that support smart city concepts, recognizing their potential to transform our lives and communities for the better. Verizon supports applications that range from intelligent street and ambient lighting, smart grid solutions, intelligent video and image processing, to intelligent traffic management with a communication network and cloud computing infrastructure to provide data storage, processing and analytics.

TRANSCOM

TRANSCOM is a coalition of the 16 major traffic, transit and public safety agencies in the New York/New Jersey/Connecticut metropolitan region. TRANSCOM implements ITS and TSMO concepts on a coordinated, regional basis and supports 24/7 coordinated, multi-agency response to major incidents, and provides facilitation, tools and resources for transportation information sharing among the member agencies and the public in real time. Partnership with TRANSCOM will utilize and leverage its regional, multi-modal transportation data collection and analytics resources.

External Review Partners

The City of Newark also intends to work with ITS New Jersey and an international expert on smart infrastructure and sustainable transportation Mr. Keith McCabe of KAM Futures (Manchester, UK) as external review board. They are expected to bring fresh perspectives, broad national, and international experience, and help the project team develop and implement a solid technology deployment plan as part of the Smart City program for the City of Newark.

Relevant Evidence of Organizational Capacity

The City of Newark is prepared to take on the US DOT's Smart City Challenge project due to a variety of supportive factors. Newark in partnership with NJIT is already working towards accomplishing pilot projects in many of the areas identified in this application, including data collection and analysis, instrumentation of corridors and work zones and using new technology such as drones to monitor traffic and events and provide real time updates to a centralized Transportation Management Center. As demonstrated through the attached support letters as well as demonstrated work history, Newark has the necessary leadership and partnerships in place to ensure a successful and highly impactful project is delivered.

Executive Commitment

Mayor Ras J. Baraka fully supports the implementation of this program as it supports many of his ongoing initiatives including economic development and providing equitable transportation choices to all residents of Newark. Philip Scott, Director of Engineering and Jack M. Nata, Manager of the Division of Traffic and Signals will be responsible for execution of the elements of this Smart City vision. Successful execution of past smart technology projects such as adaptive signals surrounding Newark Penn Station, creation of the Division of Traffic and Signal's TMC with 170 interconnected traffic signals, installation and upkeep of over 40 video cameras for traffic monitoring and the great success of the City's Red light Running Camera Program demonstrate that not only are these leaders committed to USDOT's Smart City Challenge program but have experience and a proven track record of implementing these types of projects.

Workforce Capacity

The knowledge, skills, abilities, and competencies of Newark's engineering, planning and maintenance staff with support from the engineering researchers, professors and students of NJTI ensure that each aspect of project implementation will have a qualified professional involved. Newark's traffic planners and engineers and civil engineers have extensive experience designing, managing and implementing ITS and signal projects.

The Division of Traffic and Signals designs all upgrades to its transportation infrastructure, manages all new projects and oversees construction. All maintenance activities are done by the Division's staff or by private contractors, of whom the City has developed long standing working relationships with and who understand Newark's needs and unique context.

In recent years researchers from the New Jersey Institute of Technology, recognizing close proximity and shared interests, have begun working with the City on a variety of ITS projects. These researchers, housed in the NJ DOT supported ITS Resource Center, have approached Newark as a living laboratory, developing and testing concepts that not only further their research but advance City goals.

Performance Management Capabilities

Newark's performance management capabilities fall into three major categories as illustrated by **Figure 13**, Infrastructure and Instrumentation, Data Management, and Partnerships. These processes are based on identification of a relevant factor and corresponding actions to achieve an end product.

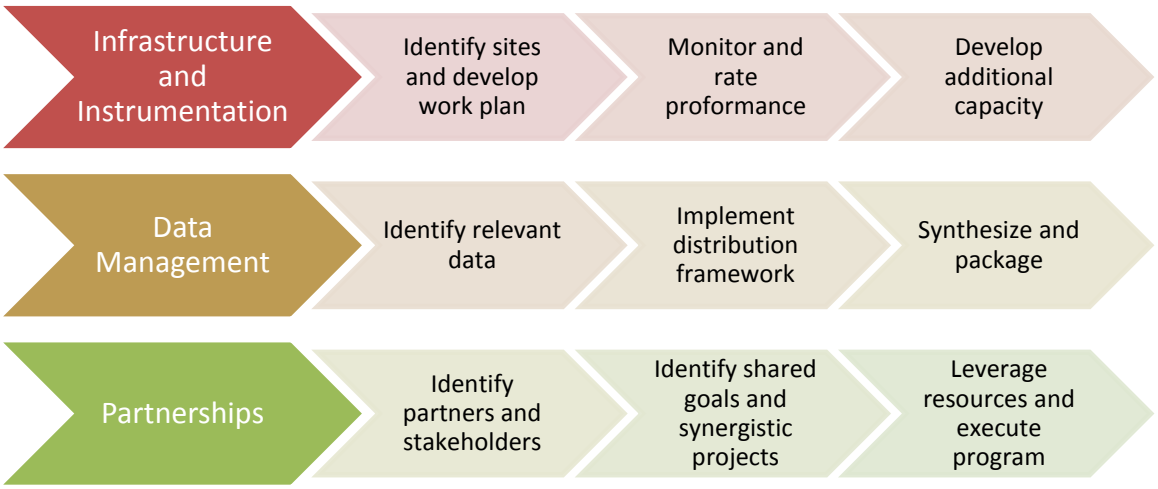

Figure 13. Newark's Smart City Vision performance management process

Opportunities for Additional Funding

It is anticipated that through the City of Newark's partnership with PSE&G the City of Newark would be able to leverage PSE&G's light poles to install various sensors. This type of collaboration can be considered an in kind donation by PSE&G, making available existing infrastructure for installing on new sensors means that Newark does not need to install new poles, which can be costly. Additionally, as PSE&G maintains their infrastructure they can work with Newark to identify when a sensor may need maintenance or replacement.

As North Jersey's MPO the NJTPA is tasked by the federal government to allocate federal transportation funding to address regional needs. Newark has and will continue to leverage this support to advance ITS technology, sensor implementation and data management projects. As described earlier Newark frequently works with the NJTPA on regional planning projects, many of which address various Smart City Vision Elements, this is a symbiotic relationship whereby Newark assists the NJTPA in advancing regional planning goals while the NJTPA contributes to Newark's success in advancing local planning initiatives.