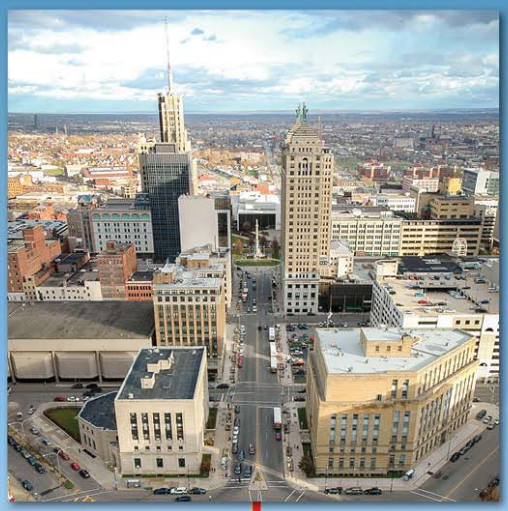
Part 1 – VISION NARRATIVE

"Beyond Traffic: The Smart City Challenge"

Niagara International Transportation Technology Coalition (NITTEC) for Buffalo, NY



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U.S. Department of Transportation (USDOT)
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1. Application Overview and Roadmap

The City of Buffalo (**Figure 1.1**) and the Buffalo Niagara region are writing a new story—a story about how a "rust belt" region is retooling itself in the 21st century to meet the real challenge of how to live more sustainably in an era of economic and demographic change and environmental uncertainty. It is a story of old places with new people, fresh ideas, and new ways for working together to use our land more wisely, move more efficiently, create great places to live, ensure healthy and equitable communities, and meet the challenges of climate change and a transforming energy economy. Through the use of connectivity between vehicles, infrastructure, and people, combined with effective regional partnerships, Buffalo is well on its way to becoming a Smart City.

Figure 1.1. City of Buffalo: Our Proposed Location for the Smart City Challenge

Today, Buffalo is moving toward a sustainable future at all levels of society, incorporating actions in the community, government, and private entities in the area, making it an ideal location for a scalable and replicable implementation of the Smart City vision elements. **The case for Buffalo is made in Section 2.**

The Smart City Challenge is an opportunity for the **Niagara International Transportation Technology Coalition (NITTEC), with support from the Niagara Frontier Transportation Authority (NFTA)**, to continue and accelerate the growth of Buffalo into an ***instrumented, interconnected, and intelligent city*** (**Figure 1.2**). **Driven by our specific needs and desired outcomes identified in Section 3**, the city and region, in partnership with the state, will deploy the "Internet of Things" (IoT) successfully to transportation. IoT is the result of the combination of devices (sensors/actuators), connectivity (broadband wireless/fiber optics), and people and information (big data). This interaction is creating new types of smart applications and services for transportation and beyond. To accomplish this mission, NITTEC and partners will instrument, interconnect, and integrate vehicles, infrastructure, centers, and communications through a system architecture that is resilient and scalable. **Our holistic and integrated vision is presented in Section 4.**

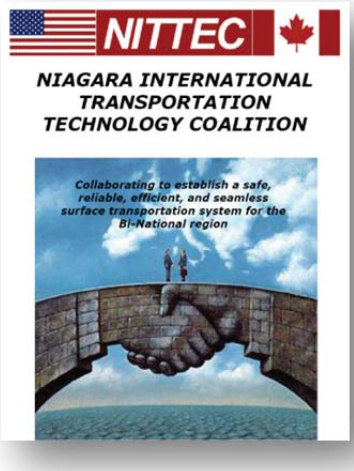
Our approach to support a low-risk and high-payoff implementation of Smart City vision and concepts is presented in Section 5. This section of the document describes a partnership-driven open and interoperable framework that supports a digital revolution in how the city supports personal and shared mobility and that collaborates with local and state government for efficient services across jurisdictions. The identified vision and specific implementation approach develops the operational integration across government agencies to reduce costs, improve service delivery, and stimulate public-private partnerships that create platforms for entrepreneurship, job creation, and improved transportation options and connectivity to employment opportunities for all Buffalonians.

Our vision is implemented at three levels – regional, downtown sub-area and at a corridor level.

- A regional level, integration between vehicles, infrastructure, and centers through a resilient network architecture creates opportunities for synergies between different operating agencies in the region and results in new modes of public-private partnerships for traveler information. NITTEC (our grant applicant), as an operating coalition is perfectly suited to the regional integration of the IoT required for the Smart City.
- At a downtown sub-area, we bring a natural incubation lab in the Buffalo Niagara Medical Campus (BNMC). Combined with the booming central business district (CBD) and other employment zones, the sub-area provides an excellent opportunity to create equitable and multimodal transportation options that spur economic growth in an inclusive manner. In this area, the Smart City application elements are geared towards supporting new and emerging models of transportation, using connected and automated technology to improve safety and reliability and supporting energy-efficient transportation.
- Lastly, at the corridor-level, connected and automated technology help enable travelers and freight traffic in a critical bi-national corridor (I-190) travel safely and reliably especially in periods of adverse weather.

Figure 1.2. The City of Buffalo's Vision of an Instrumented, Interconnected, and Intelligent Smart City

NITTEC will execute the vision with support from the partners on the Smart City team. NITTEC is an organization of transportation and international border-crossing agencies in Western New York and Southern Ontario, working together to coordinate transportation facilities and operations, taking advantage of new technologies as appropriate, and sharing information with each other and with the traveling public. NITTEC acts as a Transportation Management Center for the binational region, and the coordination of intelligent transportation systems (ITS) services provided by NITTEC to agencies, jurisdictions, and the general public in the region has been recognized as a model for metropolitan areas in New York State.



Recognizing the value of partnerships, NITTEC brings together public, private, and academic partners who will play a vital role in accomplishing the vision laid out for the region. **Each of the partners identified for this effort brings strong local connections and nationally recognized expertise in Smart Cities (Figure 1.3)**. **Detailed roles of the partners, management, and governance structure are described in Section 6 of the document.**

In addition to dedicated partners, NITTEC brings a strong and committed stakeholder group to the application. Our application is strongly supported at the highest levels of state and local governments, and it leverages past experiences in these areas by our public and private partners. **Letters of support from various stakeholders and partners are provided in Appendix A.**

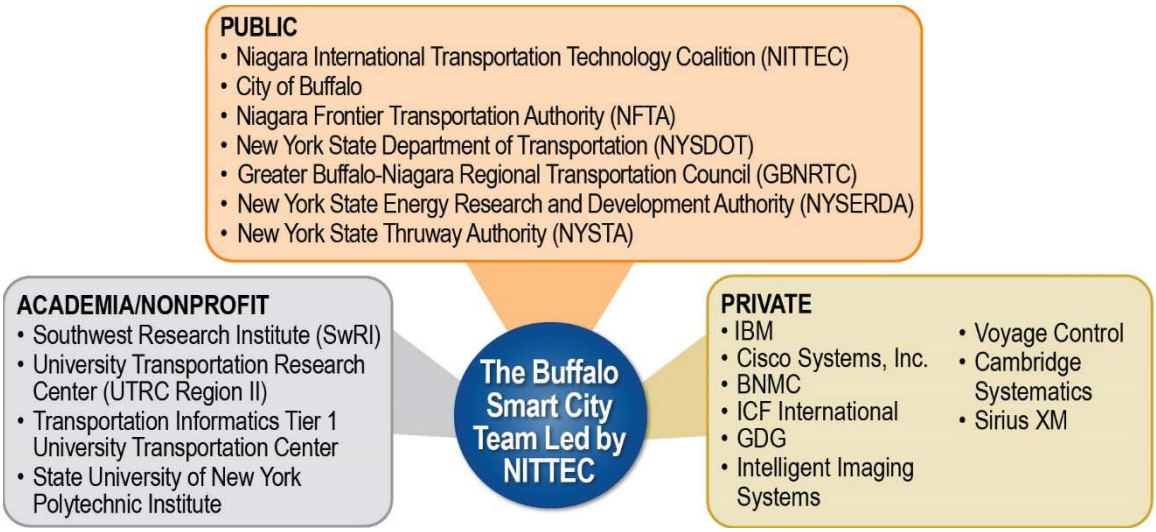


Figure 1.3. The Smart City Challenge team for Buffalo brings strong local champions and technology leaders.

2. Buffalo's Alignment with USDOT's Desired City Characteristics

The City of Buffalo and the proposed project area offer a scalable and replicable model for Smart City development for the United States. The region lies at the confluence of two Great Lakes, linked by one of the wonders of the natural world, the Niagara River and Niagara Falls. The region occupies a **strategic position on the U.S.-Canadian border**[1] and on the southern edge of a binational region of nearly 9 million people **(the third largest urban concentration in North America)**, **and it is within 500 miles of 41% of the U.S. population.** The population and city characteristics not only meet the criteria, but are strongly geared toward adoption of the Smart City vision identified in this section.

The following eight characteristics (**Figure 2.1**) create a unique combination of factors that provide the foundation for the vision elements proposed in this application, and they align perfectly with USDOT's desired characteristics identified in the Notice of Funding Availability. These characteristics create a low-risk and high-payoff location for a Smart City implementation that builds from the current levels of successes in regional collaboration and operations. Evidence for each of these characteristics is provided in this section.

[1] In 2013, 86% of the land mode trade that occurs between the United States and Ontario crossed at either the Niagara crossings in the megaregion or to Michigan at the Windsor or Sarnia crossings.

Figure 2.1. Buffalo's characteristics make it an ideal fit for Smart City deployment.

Characteristic #1—A changing population *with a demographic profile suited to adoption of new technologies and services*

Buffalo has experienced a downward trend in its number of residents in the last decades:

- The population in 2010 was 292,648, roughly 11% less than in 2000 (U.S. Census Bureau, 2010).

However, affordable cost of living, reasonable real estate prices, a thriving university system and medical research facility, and the region's proximity to New York City and Toronto are drawing young entrepreneurs.

- **The number of residents between the ages of 20 and 34—the millennials—has increased by more than 10% since 2005.**

Forecasts in the metropolitan transportation plan show significant growth from 2010 to 2040, especially in the area proposed for the Smart City vision elements (**Figure 2.2**). With this growth has come an increased demand for housing in the downtown area. This demand and increase in urban density is illustrated by the 1,200 new residential units added in recent years and by the city's goal to have 2,000 more units online by 2018.

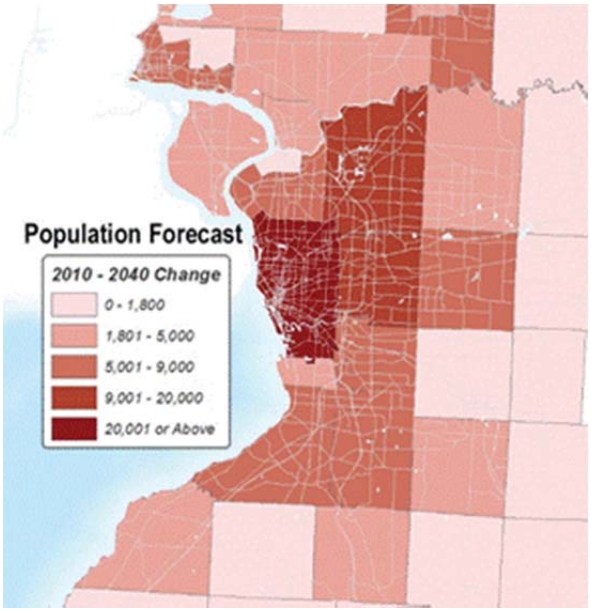


Figure 2.2. Population Growth in the Core Urban Area

The current and expected high percentage of young adults[2] indicates a potentially high presence of a new, technologically savvy generation known as "millennials." This generation is motivated by a need for constant information sharing, a key characteristic of a Smart City population—one that enables real-time data transfer between the system and its users.

Characteristic #2—An evolving economy *that is creating new jobs and new needs for sustainable transportation*

In 1970, 1 of every 3 jobs in the Buffalo Niagara region was in manufacturing; today, it is only 1 in 10. Meanwhile, **the share of jobs in health care, education, finance, and professional services has more than doubled.** With **more than 20 colleges and universities in the region**, there is a strong backbone for quality education and skills development. **One of our partners, the** BNMC is a self-sustaining social enterprise successfully combining innovation, job creation, and urban revitalization. It serves as the umbrella organization of the anchor institutions that make up the quickly growing BNMC, located within the 120-acre campus bordering the Allentown and Fruit Belt Neighborhoods and Buffalo's CBD (Figure 2.3). **The city is also home to emerging biomedical research and high-tech manufacturing industries,** providing a booming economic backbone and associated job growth (**Table 2.1**).

Figure 2.3. Buffalo Niagara Medical Campus, a key sub-area in our Smart City implementation approach is home to a growing employment base and innovations in transportation.

Table 2.1. Contributing Factors to Buffalo's Evolving Economy

Factor	Characteristic	Contribution
BNMC	A consortium of nine health care, research, and educational institutions.	Located on 120 acres in downtown Buffalo, NY, it hosts 12,000 people working and studying today, with **17,000 people projected by the end of 2016.**
SolarCity	The nation's largest seller of residential solar power.	Building a plant in Buffalo, NY—**adding up to 5,000 jobs within the next 10 years**.
Tourism/ Sports	An industry bringing in nearly **12 million people on an annual basis.** Buffalo is part of the National Football League (NFL) and the National Hockey League (NHL).	**Brings in more than $2.2 billion to the economy each year.** Buffalo will host the NHL Draft in 2016, the National Collegiate Athletic Association Men's Basketball Tournament Games in 2017, and the World Junior Hockey Championships in 2018.

Characteristic #3—A multimodal city with a growing shared economy *that is on the cusp of making a meaningful impact on single-occupancy car use*

Buffalo has good history in urban planning with intrinsic support for walkable and transit-friendly communities. From the original radial street grid laid out by Pierre L'Enfant's surveyor, Joseph Ellicott, to the park and parkway system designed by Frederick Law Olmsted, a solid

[2] In 2010, approximately 20% of the city's population are less than 15 years old, 33% between 15 and 35 years old, 31% between 35 and 60 years old, and only 16% are 60 years of age or older.

urban framework has survived mostly intact. The numbers presented here highlight the opportunity to increase the market share of other modes of transportation, such as public transportation and non-motorized modes, if the proper investment is made to provide more efficient and dynamic multimodal services.

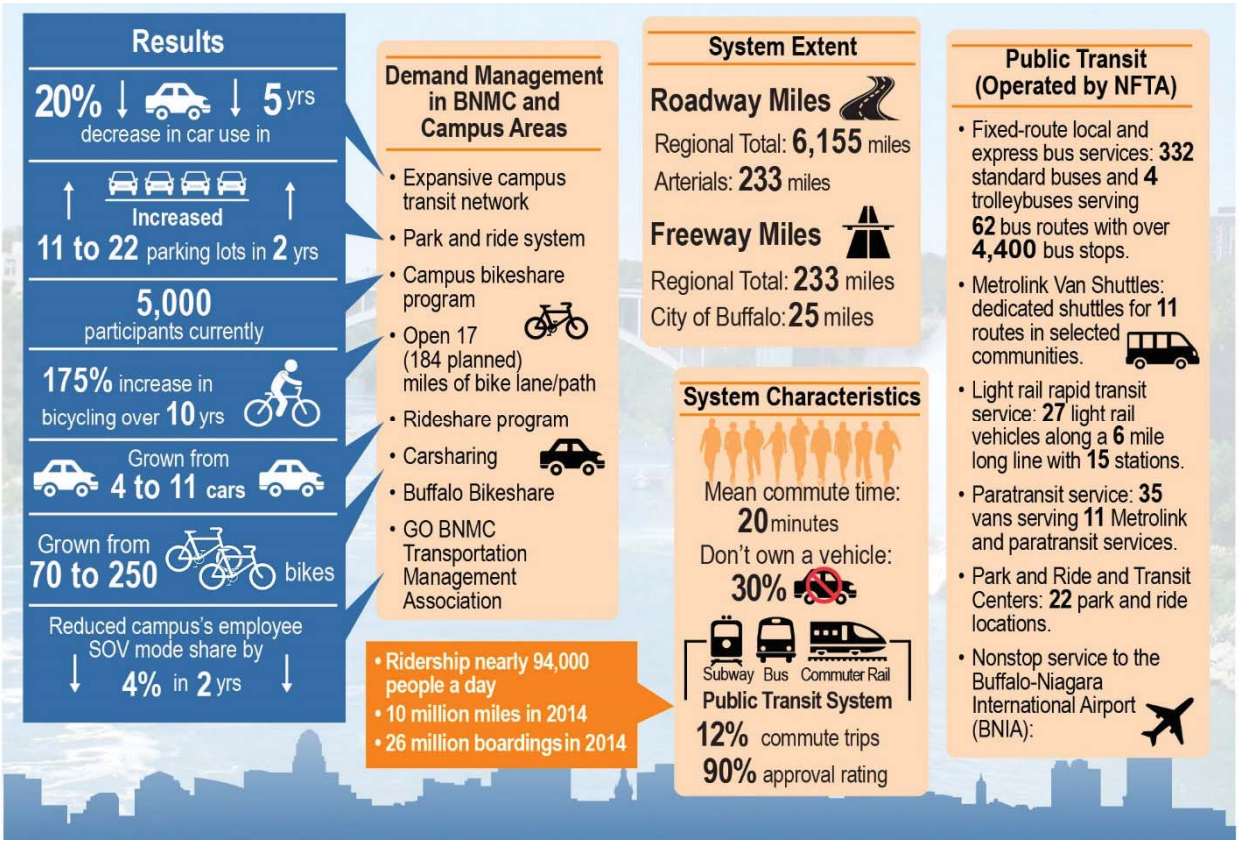


Figure 2.4. System Extent and Features in Buffalo

While the mean commute time is only 20 minutes, **30% of households do not own a vehicle. The public transportation system sustains 12% of commute trips, with an approval rating of around 90% (NFTA-Metro, 2013)**. Ridership on public transit is estimated at nearly 94,000 people a day, which translated into 10 million miles in 2014, with 26 million boardings.

In addition to its public transportation services, the City of Buffalo supports strategies and other modes of transportation that seek a shift from private vehicle usage. For instance, the **expansive campus transit network has resulted in a 20% decrease** in car use in 5 years. Other strategies that have received significant support are its **park and ride system**, which has **increased from 11 lots to 22 lots in 2 years**, and the **campus bikeshare program**. The City of Buffalo is a supporter of the Active Living by Design program, linking transportation to public health. In this sense, the city has opened **17 bike lane/path miles and has 184 miles planned**, for approximately **73 miles of designated bikeways (on-road) and 135 of multi-use trails (off-road)** in the Buffalo Niagara region (GBNRTC, 2010), **which has resulted in a 175% increase in bicycling in the City of Buffalo over the past decade**. The city has also strengthened its commitment to bicycle transportation through its partnership with GObike Buffalo to complete a new bicycle facilities master plan in 2015 funded in part by NYSDOT and the NYS Energy Research and Development Authority.

The **rideshare program** has around 5,000 participants already. **Carsharing** has grown from 4 to 11 cars, **and Buffalo Bikeshare** will grow from 70 to 250 bikes operating in the system by the summer of 2016, showing that such types of programs can work with the right type of marketing tailored to small urban communities. **Legislation is under consideration to allow transportation network companies to operate beyond New York City.**

Buffalo Niagara Medical Campus (BNMC), Inc., established the GO BNMC Transportation Management Association (TMA) in late 2012 to ensure that the BNMC campus employees are served by a robust multimodal transportation system. These programs and partnerships have led to BNMC's ability to help facilitate, manage, and implement more than $2,000,000 in transportation projects over the last 3 years and have served to improve access to alternative transportation options and **reduce the campus's employee single-occupant vehicle (SOV) mode share by 4% in 2 years.**

The Buffalo area already has over 100 public and workplace charging stations within 50 miles. A group led by Clean Communities of Western NY is developing and implementing an electric vehicle (EV) charging infrastructure plan to enable greater electric mobility in the region and between Buffalo and other parts of New York State.

Characteristic #4—National leadership in transportation operations *that demonstrates a proactive and regional approach to transportation*

NITTEC acts as a Transportation Management Center for the binational region, and the coordination of ITS services provided by NITTEC to agencies, jurisdictions, and the general public in the region has been recognized as a model for metropolitan areas in New York State.

Table 2.2. Buffalo's Regional Transportation Management and Operations

NITTEC and partners are leaders in proactive Transportation Systems Management and Operations, providing national examples in effective regional collaboration.	
Freeways	Actively managed and heavily instrumented with ITS devices including closed-circuit television, Dynamic Message Signs, and the TRANSMIT System. NITTEC is one of the FHWA grantees for developing an Integrated Corridor Management (ICM) system on the I-190 corridor.
Border Crossings	Equipped with queue warning systems and cameras to assist travelers.
Traveler Information System	Contains website and mobile app with more than 140,000 website users in 2014.
Transit	Prioritizes transit signal along Niagara Street (installation); trip planning tools; real-time updates; bus arrival systems; and the introduction of smart media, replacement of fareboxes, and installation of fare gates at underground rail stations.

Characteristic #5—A rich data environment *that offers untapped potential for urban analytics centered on Smart City Technology*

Through the work of NITTEC, there already exists a good flow of real-time operations data from ITS sensors on the region's freeways to the Traffic Management Center for managing the daily operation of the region's transportation system. The new fare collection system will also present a wealth of data pertaining to the trip patterns of riders, which will allow us to better plan for the public's needs. In 2014, **researchers from the University at Buffalo began working to create an integrated data warehouse, which would resolve the issues resulting from independent and incongruent data collection.** The result was a prototype warehouse that serves to combine these datasets in an assessable and straightforward way. This provides great potential for an open

data environment that allows for innovative public and private partnerships. All urban analytic and transportation simulation tools could be greatly improved by advancing Smart City technologies. **Figure 2.5** shows some of the data related initiatives that are underway in the region.

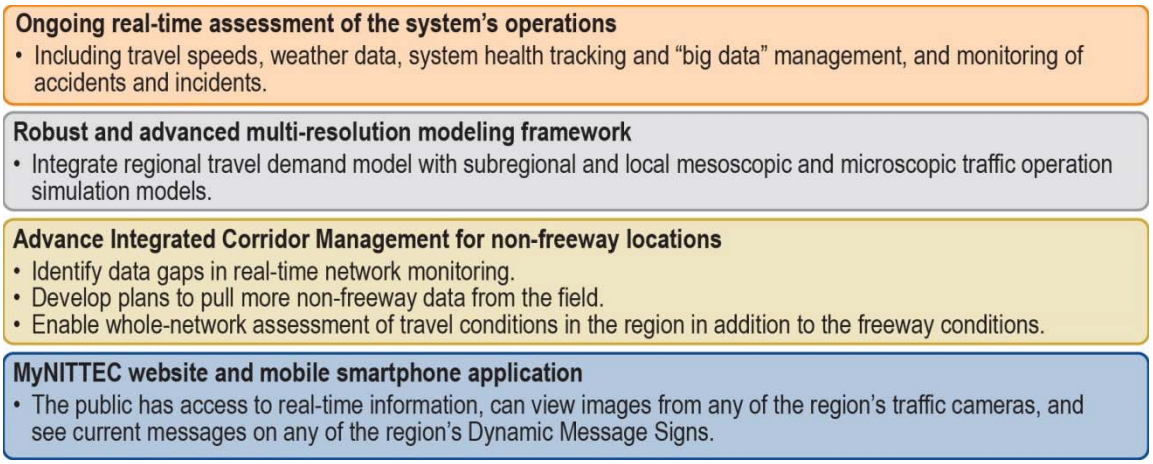


Figure 2.5. Sources of Data for Mobility Analytics

Characteristic #6—A proven history of operational collaboration *that showcases institutional capacity to undertake multi-agency projects*

Buffalo today benefits from strong working relationships between the public and the private entities in the region. In fact, the importance of building off of the collaborations is clearly illustrated by **One Region Forward,**[3] a broad-based collaborative effort to promote more sustainable forms of development in the Buffalo Niagara region—in land use, transportation, housing, energy, climate change, access to food, and more. The effort has recently completed a federally recognized regional plan for sustainable development.

Existing partnerships in the region enable the transformation of Buffalo to a Smart City:

Greater Buffalo Niagara Regional Transportation Council (GBNRTC), Niagara Frontier Transportation Authority (NFTA), New York State Department of Transportation (NYSDOT); Erie County, Niagara County, City of Buffalo, City of Niagara Falls, Association of Erie County Governments, Niagara County Supervisors Association, University at Buffalo Regional Institute and Urban Design Project (UBRI/UDP), Daemen College Center for Sustainable Communities and Civic Engagement (CSCCE), VOICE Buffalo, Local Initiatives Support Corporation Buffalo (LISC), Western New York Environmental Alliance (WNYEA), Buffalo Niagara Riverkeeper, the John R. Oishei Foundation, Buffalo Niagara Medical Campus (BNMC), Belmont Housing Resources for WNY, Inc. (Belmont), Buffalo Niagara Partnership (BNP), Empire State Development, New York Department of State, Division of Smart Growth, Niagara County Department of Social Services, and the Seneca Nation of Indians.

The Buffalo region is one of the nation's leaders in transportation systems management and operations, operating a robust ITS system that supports the entire region. The Buffalo Niagara Binational Regional ITS Architecture is a roadmap for transportation systems integration for the metropolitan area of Buffalo, Niagara Falls, the surrounding municipalities in New York, and the Region of Niagara in Ontario, Canada, over the next 15 years. In 2014, NITTEC completed their update of the Regional ITS Architecture for Western New York and Southern Ontario. The

[3] http://www.oneregionforward.org/about/

Regional ITS Architecture has been used as a planning tool for Regional ITS Projects involving multiple agencies and stakeholders, including the Peace Bridge Gateway Project and Niagara Street Corridor Project.

Lastly, active participants of the Smart City Market Alignment for Roadway Technologies (SMART) Consortium—a partnership of representatives from industry, government, and academia focused on accelerating the deployment of connected and automated technologies—have all provided letters of support for this proposal including Erie County, NYSDOT, New York State Thruway, New York State Energy Research and Development Authority (NYSERDA), SUNY Polytechnic Institute (Poly), University Transportation Research Center (UTRC), Southwest Research Institute (SwRI), Global Dynamic Group, SiriusXM, Cisco, and IBM. In addition, several other stakeholders have provided support letters for this application, including Buffalo Bikeshare, Erie County, GObike, BikeShare, New York State Motor Truck Association, the Peace Bridge Authority, One Region Forward (a regional collaborative), and Shared Mobility, Inc.

Characteristic #7—A strong and engaged partnership with the research community *that creates an opportunity for innovation, especially in the area of Connected and Automated Vehicles*

NITTEC, NYSDOT, NFTA, and key public sector partners are closely aligned with the research community, including several of them as partners in this application, as can be seen in **Section 6.2**. UTRC Region II, one of the 10 funded regional research centers, is a leader in connected vehicle/autonomous vehicle (CV/AV) technology and has strong connections to Buffalo through one of the active members of the UTRC, University at Buffalo. NYSDOT is one of the leading states in research and development of CV technology going back to the initial deployment of the Manhattan and Long Island Test Beds for the 2008 ITS World Congress demonstrations in New York City. Since then, members of the team have been involved in the Affiliated Test Bed program. This includes managing efforts in partnership with FHWA and the ITS Joint Program Office.

Furthermore, NYSERDA promotes sustainability, clean transportation, energy efficiency, and the use of renewable energy resources. Over the past decade, NYSDOT and NYSERDA have jointly funded a wide range of transportation research projects to demonstrate transportation innovations that both reduce energy use and enhance transportation system operations. The program invests $3 million per year and has funded innovative ideas in Buffalo such as carsharing and bikesharing services, Complete Streets education, comprehensive Travel Demand Management programs at BNMC, integrated corridor management planning, and the development of a regional transportation management association, among others. These projects have served as models for further deployment statewide and nationwide.

Characteristic #8—A binational megaregion and freight corridor *that creates new opportunities and challenges for freight and economic activity*

Sixteen percent of all U.S.-Canada trade crosses at the Niagara border. The Peace Bridge experiences heavy truck traffic as shown in **Figure 2.6**, many of these trucks using interstates like I-190 and I-90.

With more than 9 million people, the binational megaregion is the third largest urban concentration in North America. Supporting the U.S.-Canada trade and the economic activity of the megaregion are a variety of freight facilities that span the gamut of modes (**Table 2.3**).

While recurring congestion is not generally a problem for freight in the area, non-recurring delays due to weather, incidents, and construction are significant. Similarly, freight optimization between modes and ensuring reliable border-crossing times remain a priority for the region, especially with forecasted freight growth.

Figure 2.6. Peace Bridge Border Crossing is a significant freight gateway in the region.

Table 2.3. Freight Facilities in the Region

Niagara Frontier Binational Freight Characteristics	
Facilities	• 4 motor vehicle bridges • Queen Elizabeth Way and I-90 (major connectors) • 3 railway bridges (1 no longer operating) • 4 major railways (CP, CN, CSX, Norfolk Southern) • 4 major airports • Welland Canal (St. Lawrence Seaway)
Traffic	• 3.0 million trucks per year ($80 billion goods) • Rail ($25 billion goods) • Truck traffic via Buffalo to rise 90% from 2010 to 2035

3. Needs and Performance Measures for Our Smart City Application

Our grant application for Smart Cities is needs-driven (i.e., the vision elements are being proposed to solve critical needs identified by NITTEC and our partners). In discussion with our partners and stakeholders, the following 10 needs were identified as imperatives for the grant application (**Table 3.1**). These needs guide the design of our vision and our implementation approach and provide the roadmap to success by defining the expected levels of performance in each need.

Table 3.1. Our needs drive our Smart City vision.

Core Needs	Why is this a continuing need for Buffalo?
Improving safety of traveling public, transit users, bicycle and pedestrians, freight, and public fleets in the City of Buffalo	• 1,158 incidents were observed during 2014, 67% of which were on the three major freeways I-190, I-290, and I-90; 44 of them were major incidents involving durations of more than 2 hours • In a 3-year period, 2009–2012, a Tri-State Transportation Campaign report noted 3,648 motor vehicle collisions with pedestrians and bicycles in Erie County alone, resulting in 38 pedestrian and 5 bicyclist deaths

Table 3.1. Our needs drive our Smart City vision.

Core Needs	Why is this a continuing need for Buffalo?
Increasing travel options for the general public and reducing car dependency in the region	• 82% of the population commutes to work by driving alone; despite recent gains, use of public transportation for commuting dropped significantly from 10% to 4% in the region between 1970 and 2010
Improving access to destinations and jobs to select population groups (youths, disabilities, seniors)	• Only 26% of Buffalo Niagara's population lives within easy access to public transportation • Only 31% of Buffalo Niagara's jobs are located within easy access of transit
Reducing energy impacts of transportation and moving toward a clean energy future	• Major source of energy use and environmental impacts in Buffalo is largely driven by vehicle miles of travel growth, which has grown per capita from 8 miles (1970) to 18 miles (2010) a day
Accelerating economic growth and job growth in the Buffalo Niagara region	• Identified the need for continued entrepreneurship and human capital to develop new industries and capabilities and transition to a new economy • The influence of visitors to the Buffalo region is still critical to the region's economy
Improving freight operations from the border, within and out of the city	• While recurring congestion is not a factor, non-recurring delay, freight optimization, and border crossings are critical needs of freight stakeholders
Improving regional decision-making between county, city, state, and Canada	• As a binational megaregion with the third largest urban concentration, operational collaboration, regional planning, and resource sharing are priorities for the region
Improving citizen engagement and satisfaction in the City of Buffalo	• Improving the accountability of the public sector to citizens is a continuing need and ongoing effort by the City of Buffalo's CitiStat program, which is entering into its 10th year of operation
Reducing total agency cost of managing the system	• Cost of winter maintenance including fuel, materials, and labor is particularly acute in a winter weather location like Buffalo • Aging infrastructure including bridges creates additional costs for operating agencies in the region
Improving city cohesion and equity	• With significant variations in socioeconomic characteristics in the city and the makeup of the urban area in Buffalo, there is a need to create solutions that lead to better integration of services, urban locations, and access to employment opportunities

3.1 Key Performance Measures

The following performance measures have been identified by the stakeholders and partners as the leading indicators of successful deployment:

1. Increase in center-to-center communication and use of common incident-reporting formats
2. Increased efficiency of commercial vehicle operations and enforcement activities
3. Reductions in non-recurring delay (incidents, weather, construction) to truck operations
4. Improvements in fleet management regional efficiencies due to optimization of public sector regulation and oversight
5. Assessment of citizen engagement (intensity, satisfaction, influence) in system management, maintenance, and planning
6. Reductions in agency cost of operations and maintenance attributed to Smart City elements
7. Reductions in frequency, severity, and type of vehicle-related and bike-ped–related incidents

8. Reduction in regional mode share for SOVs city-wide and corresponding reduction in vehicle miles traveled from SOV usage
9. Increase in the range, urban frequency distribution, and quality of transportation options and service providers available (to current and new customers) including Americans with Disabilities Act (ADA) complementary paratransit
10. Increase in level of deployment of EVs and alternatively fueled vehicles being used in Buffalo
11. Number of new firms and startups working in areas related to Smart City vision elements
12. Growth in visitors and visitor spending in Buffalo
13. Improvement in community well-being indicators in Buffalo

Prior to the implementation, NITTEC and the team will establish a baseline for these performance indicators for a pre–Smart City scenario. In the implementation phase, NITTEC and partners will track their performance for these indicators and provide support to the independent evaluators identified by USDOT. Our university partners, UTRC and TransInfo, will be critical in developing a performance management and evaluation plan in Phase II of the application.

4. A Holistic, Integrated Vision for a Smart City Implementation in Buffalo

NITTEC sees the size and the scope of the Smart City application as an opportunity to make a transformational impact by developing an integrated "system of systems" that tackle the identified needs in a cohesive manner involving multiple agencies, private sector, and academia, as opposed to a piecemeal or siloed approach. Rather than focusing on one need, considering the Smart City concepts as a holistic framework allows the region to make meaningful progress on meeting the multiple needs of the citizens of Buffalo. Together, NITTEC sees the following outcomes for people, agencies, and the overall economy. (**Figure 4.1**)

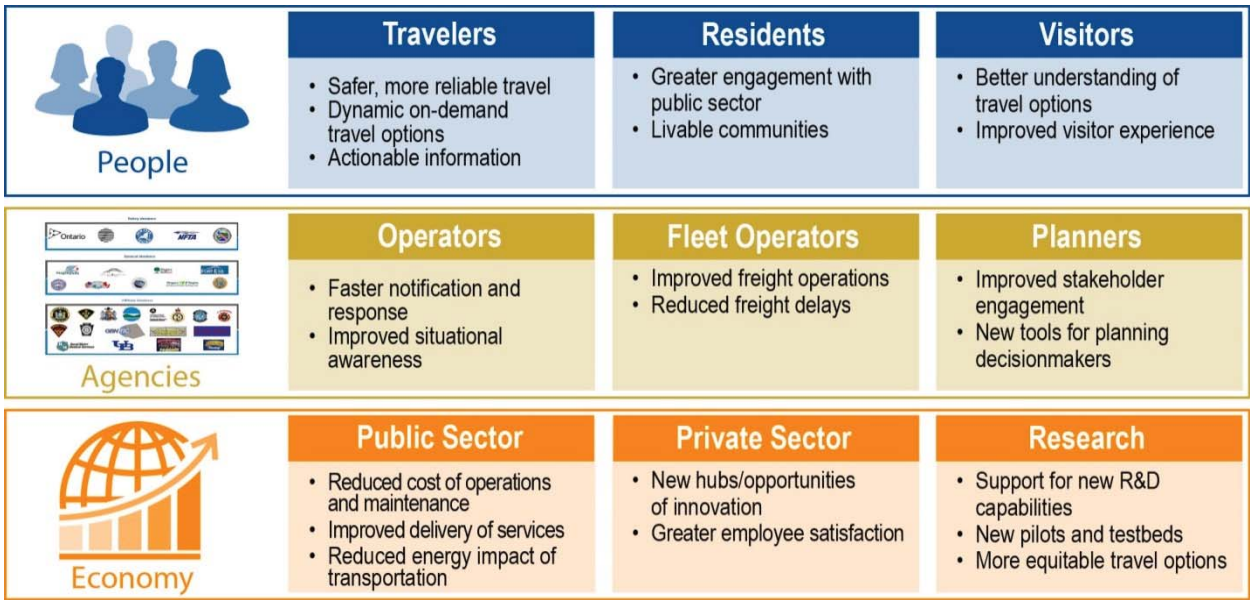


Figure 4.1. Our Desired Outcomes for People, Agencies, and the Economy

Building on the robust ITS infrastructure, to build out the physical devices in the IoT architecture, the team will:

- **Connect public fleet vehicles (snow plows, highway patrol, fire, ambulances, and transit buses) with onboard equipment that has both 5.9 Ghz Dedicated Short Range Communications (DSRC) as well as cellular capabilities in the project area.**
- **Build out roadside equipment along key arterials/intersections at downtown area and along key freeways to collect CV data as well as support various Vehicle to Infrastructure (V2I) applications using both DSRC and cellular communications.**
- **Add condition monitoring sensors to bridges and key facilities along corridors.**
- **Add parking sensors and availability systems in the downtown area.**
- **Develop citizen reporting tools that use smartphone connectivity to directly engage with the public.**

The instrumentation of maintenance vehicles and buses with hybrid onboard devices capable of DSRC and cellular communications will drive the added benefits of providing greater optionality in data communication as technology continues to rapidly evolve.

While physical devices are critical, center-to-center connectivity between various operating agencies enables regional data sharing and collaborative decision-making. NITTEC, as a multi-agency operational entity, is perfectly suited to creating a common center-to-center operating framework that brings in traffic, transit, emergency response, tollways, and maintenance. For example, planned integration with the NYS Department of Homeland Security's Early Warning Weather Detection System is illustrative of how agencies can use common systems to become situationally aware of conditions earlier. The centerpiece of this system is the New York State Mesonet, a network of 125 weather stations across the state, with at least one site in every county. Integration with the mesonet will better help NYSDOT, cities, and counties prepare for various weather conditions. This fusion of weather data for improvements to safety, mobility, and agency efficiency has the potential to be the most powerful in the nation.

Critical to ensuring the connectivity of these physical devices as well as center-to-center integration is a high-speed, high-capacity communications network that is IPv6 compatible with appropriate information technology support. Many of these expected improvements will be achieved based on the integration of certain Cisco infrastructure. Leveraging its cutting-edge "fog platform" that enables certain CV applications to potentially be stored on the network, Cisco will offer its Connected Roadways solution to support an end-to-end infrastructure that helps enable vehicle-to-vehicle (V2V) and V2I applications contemplated in this application. The network architecture defined for the region will factor in a security operating concept using tools like the Security Credentialing Management System.

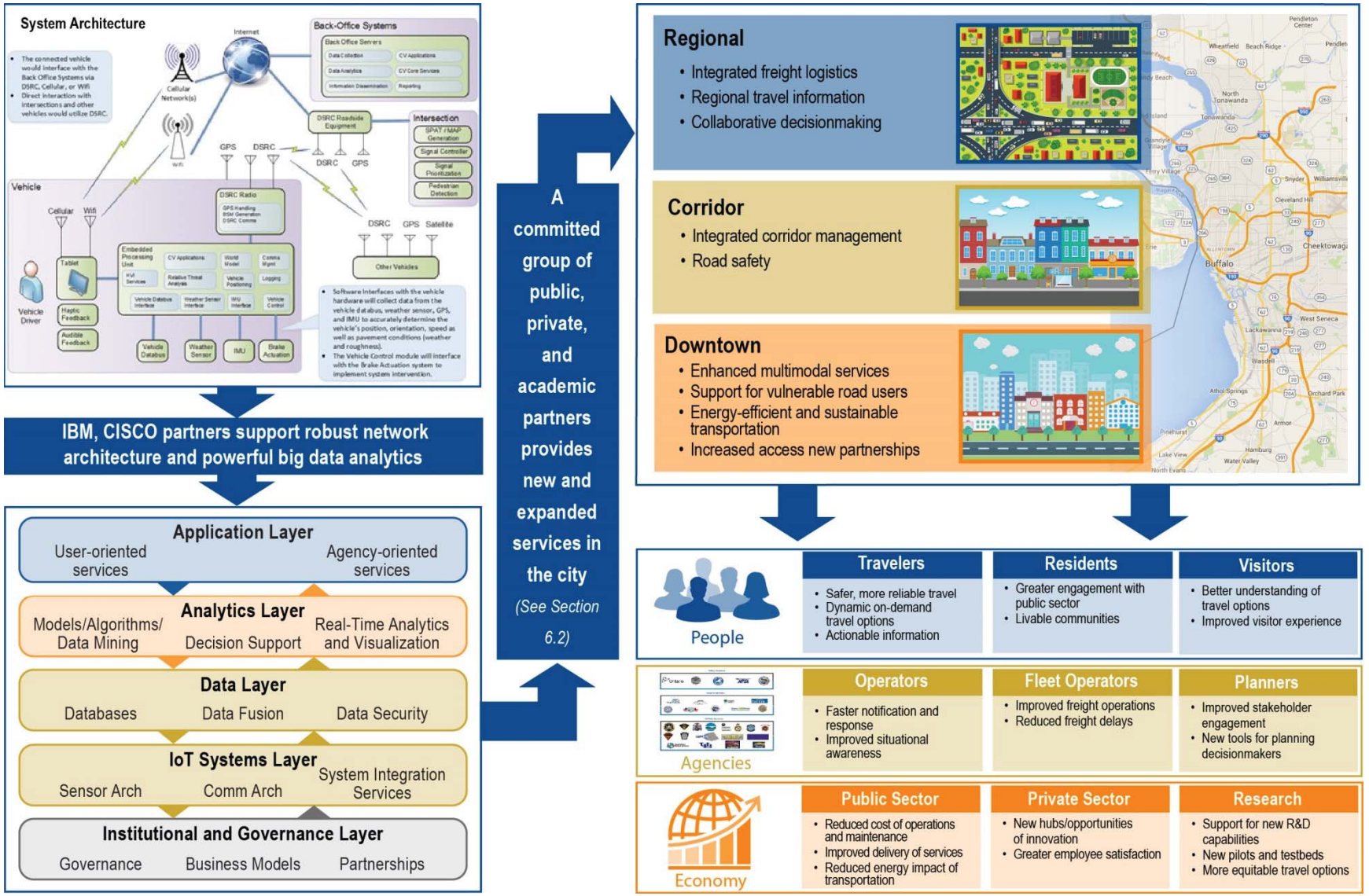
IBM and our university partners (UTRC Region II and TransInfo) bring national expertise in managing the data and developing meaningful analytics from the "big data" world that will emerge from the IoT. **Figure 4.2** illustrates the overall vision for the Smart City proposal.

Perhaps the most exciting synergy is real-time traveler information via DSRC, cellular, or satellite by both our public agency partners as well as our private sector partners. For example, our partner SiriusXM has a penetration rate of approximately 15% of all vehicles (and much higher in new vehicles), and this is expected to increase over the life of this program. This

represents one of the most robust direct vehicle communication networks available in the market. NYSDOT has its statewide 511 traveler information system, and partnership through the Smart City Challenge offers increased functionality and improvements to better use the vitally important data. Not only does this partnership offer the opportunity for greater real-time traveler information, it also offers the critically important opportunity to deploy real-time routing information, basic safety messaging, and (after proper testing) three levels of sophistication of informing drivers of hazards such as stop signs, grade crossings, and pending bridge collisions. On the freight side, our partner Intelligent Imaging Systems brings a system with 850,000 trucks to deliver our content. The region and New York State will build off its open data/open format based on the lessons learned from 511 deployment. New York State is currently completing an integrated statewide geographic information system (GIS) as an asset for all levels of government.

With this robust sensor and communications infrastructure in place, coupled with a "big data analytical" framework, the team will then begin developing the applications that meet the region's needs defined in Section 3. These may be led by individual agencies. The next section shows how specific applications will be implemented at different levels within the City of Buffalo leveraging the IoT.

Figure 4.2. The IoT connects vehicles, infrastructure, people, and centers building on the existing ITS infrastructure.



5. Implementing Our Vision: High-Level Approach

Translating the vision into a meaningful reality for Buffalo requires a carefully planned implementation approach. With the expansive scope of the 12 vision elements and the multiple partners and agencies involved, the following section provides our high-level approach to realize early successes and build regional support and interest in the Smart City program.

5.1 Implementation Elements and Levels

It is important to determine how the various elements fit together as part of a holistic implementation effort. For Buffalo, three levels of implementation are defined: regional, downtown sub-area, and a corridor (I-190). Each of these levels and the vision elements included are described in the following subsections. A crosswalk is provided in **Table 5-1** showing how the activities in each of the three levels support each other.

Table 5.1. Crosswalk of Vision Elements with Implementation Areas

Vision Elements	Proposed Implementation Strategies	R	C	D
1. Urban Automation	Pilot deployment of low-speed automated shuttles within the BNMC campus			X
	Driver assist technologies for snow plows and transit vehicles on I-190 corridor		X	
2. Connected Vehicles	Connected and Cooperative Bicycle and pedestrian safety applications supported by a situational awareness system.			X
	Advanced crash avoidance systems for transit		X	X
	Telematics data collection for road condition reporting system.	X		
	Road weather 5.9 GHz DSRC application to provide in-vehicle advisories		X	
	Situational awareness for work zones.		X	
	Wrong-way driving and over-height warnings.		X	
3. Intelligent Sensor-Based Infrastructure	Bridge and other asset monitoring sensors for asset management using both fixed and mobile systems	X		
	Transit signal priority along key arterials.		X	X
	Active parking management in BNMC.		X	
4. Urban Analytics	Maintenance performance measurement and snow plow route optimization.	X		
	Evacuation and diversion modeling.	X		
	Real-time multimodal performance dashboards for the region.	X		
5. User-Focused Mobility Services and Choices	Electronic integration of snow and ice removal systems between agencies	X		
	Early warning systems and wide-area traveler dissemination using Sirius XM and other 3rd parties	X		
	Human Service transportation (HST) coordination based on travel management coordination center concept in region.	X		
	Integrated trip planning and traveler information services.	X		
	Grow Shared–use mobility options in BNMC			X
	Integrated Transportation Fare System.	X		
	BNMC Parking System Development.			X
	Accessible Transportation Technology Implementation for Transit			X
	Full suite of ICM technology on I-190 corridor		X	
6. Urban Delivery and Logistics	Expedited clearance programs and systems for freight	X		
	Local supply-chain logistics optimization using online brokerage	X		
	Smart Roadside Solutions for trucks	X		

Table 5.1. Crosswalk of Vision Elements with Implementation Areas

Vision Elements	Proposed Implementation Strategies	R	C	D
7. Strategic Business Models and Partnering Opportunities	Completion of BNMC Mobility Hub			X
	Development of a BNMC "Change Lab"	X		X
	Cold-weather CV/AV research testbed with UB	X		
8. Smart Grid, Roadway Electrification, and Electric Vehicles	Meet Green Garage Certification standards and add Electric Vehicles charging stations.			X
	Microgrid technology to combine grid-based electricity with solar power and an on-site combined heat and power (CHP) system to increase efficiency			X
	Develop a Smart Grid Network Operations Center platform to optimize energy flexibility while actively coordinating collective distributed energy resources.			X
	Fruit Belt Neighborhood Solar Project that seeks to engage and benefit the neighborhood through the installation of (100) residential PV systems			X
9. Connected, Involved Citizens	Citizen engagement tools practices for winter weather management, work-zone management to supplement existing services	X		
10. Architecture and Standards	Standardization of GIS maps, incident reporting systems, and center to center communication.	X		
	Open data sets for use by other agencies and third party developers.	X		
11. Low-Cost, Efficient, Secure, and Resilient (ICT).	New network architecture for the region that includes modern communication protocols, like IPv6, and support resources to keep the network running.	X		
	Uniform emergency reporting software.	X		
12. Smart Land Use	Urban analytics data, citizen engagement will be used to support land-use planning	X		

R = Regional C= Corridor D= Downtown

5.1.1 Smart City—Regional Elements

While many of the vision elements have regional applications and the Smart City architecture will apply to the larger Buffalo Niagara region, the first wave of applications and field infrastructure implementation is expected to occur in a focused area that is shown in the annotated site map. The project boundary can broadly be described by the following (see **Figure 5.1**):

- The area encircled by I-290, I-90, and I-190
- The border crossing at the Peace Bridge
- An extension in the northeast to include University at Buffalo North Campus
- An extension in the east to include the Buffalo Niagara International Airport
- Roadways just south of I-190 to include the Solar City project

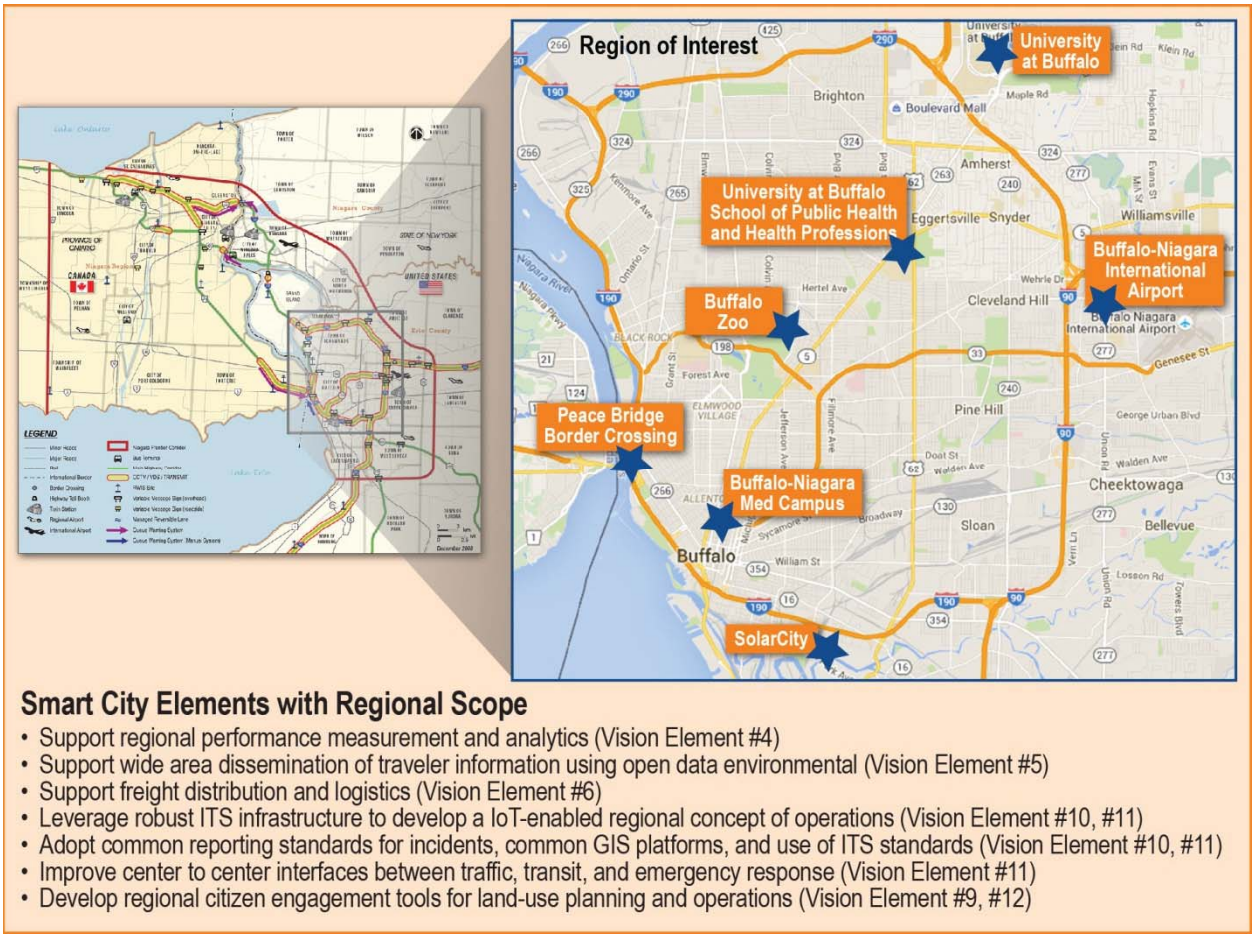


Figure 5.1. Annotated Map Smart City—Regional Elements

At this geographic scope, led by NITTEC, the foundational system architecture is developed and standardized across the region **(Vision Element #10)**. Building from the ITS architecture, these include standardization of GIS maps, incident reporting systems, and center-to-center communication necessary for a regional operating concept defined by safe, reliable, efficient, and seamless surface transportation system. This also includes developing open datasets for use by other agencies and third-party developers.

The Smart City Buffalo team includes members who are active within the Connected Vehicle standards development (e.g., IEEE Tiger Team, IEEE 1609, SAE J2735, and SAE J2945).

Secondly, the region is readied for an IoT world where a suite of validated solutions that securely connect disparate transportation systems to increase safety and reduce roadside incidents, improve traffic flow, and provide a centralized view of highway systems. This will support both our corridor and downtown area deployments as well. This includes consideration of modern communication protocols like IPv6 and supports resources to keep the network running **(Vision Element #11).**Included in the region is a uniform emergency reporting software that will be used by all counties in New York State as part of NYResponds. NYResponds Mutualink, a new technology solution, integrates telephone, radio, video, and file sharing into one interoperable application. This enables local emergency staff to share seamless, real-time

information with the state and other counties. This is another example of consolidating and integrating services across and between jurisdictions—an inherent requirement for the IoT **(Vision Element #11).**

In addition, regional approaches can leverage individual agency resources to achieve shared outcomes for several vision elements:

- An increase in the adoption of expedited clearance programs and systems (such as single oversize and overweight systems, border clearance) by the entire region can create efficiencies not only for the agencies but also for fleet operators (Vision Element #6).
- Electronic integration of snow and ice removal systems to coordinate NITTEC Traffic and Operations, City of Buffalo Department of Public Works (DPW), Erie County DPW, New York State Thruway, and NYSDOT winter response is a strategy supported at the regional level (Vision Element #5).
- Optimization of freight travel including drayage is possible at the regional level between various intermodal facilities by sharing data feeds with freight-relevant information. Our partners include the New York State Thruway Authority, NYSDOT, Intelligent Imaging Systems, and Voyage Control, who will play a major role in defining the applications at this level (Vision Element #6).
- Shared monitoring of regional assets such as bridges, pavement, and ITS equipment using real-time sensors (both fixed and mobile) across the region will lead to efficiencies in asset management practices and decision-making **(Vision Element #3).**

Some user-focused mobility services also exist at this level for regional traveler information needs, especially through open data and partnerships that bring regional partners together:

- Early warning systems and wide-area traveler dissemination through partners like SiriusXM and others. Such wide-area dissemination may be used by travelers in the region to alter trip decisions and actively manage demand, including balancing the load at the various border crossings and also during emergencies **(Vision Element #5).**
- Human service transportation coordination based on travel management coordination center concept for one-stop shop for disabled and senior transportation services **(Vision Element #5).**
- Support for enabling integrated trip planning and traveler information services between different services in the area **(Vision Element #5).**
- Joint purchasing of infrastructure in the region.

Summary

Proposed regional elements create the foundational tools necessary for resilient, low-cost, secure architecture that is interoperable across the region. By leveraging these elements, new regional applications for travelers and agencies are proposed that improve incident and emergency response, improve notification to travelers, and support efficient freight movement.

Urban analytics and performance measurement at this level provide input to regional planning and performance management. Supported by our partners in TransInfo and IBM, several analytic tools will be added to the region to take advantage of the new data capabilities in the region. Such tools may include winter maintenance performance measurement and route optimization, evacuation and diversion modeling, and real-time multimodal performance dashboards for the region **(Vision Element #4)**.

NYSERDA's efforts to expand the market for EVs are tied closely with the state's efforts to roll out a smart electric grid. National Grid, the main utility in Buffalo, is a strong partner and is very interested in both vehicle electrification and ways to integrate vehicle charging, grid communications, and grid controls. Through this application, there is an opportunity for Buffalo and National Grid **(Vision Element #8)** to lead in:

- Implementation of new options for on-bill payments for public charging stations, innovative methods for encouraging cars to charge at hours when electric grid use is low, battery-backed charging stations that reduce demand spikes, and innovative business models for deploying public charging stations.
- Continued growth in EV integration in the carsharing fleet, providing low- and moderate-income communities with access to clean cars.
- New partnerships between charging station network owners and carsharing companies, and more (Vision Element #8).

Lastly, at a regional level, the City of Buffalo will continue its award-winning citizen engagement programs[4] and enhance existing tools to support innovative engagement practices for winter weather management and work zone management **(Vision Element #9).**

5.1.2 Smart City—Downtown Sub-area Elements

A core downtown area has been identified for the implementation of several of the vision elements with a focus on developing a multimodal, shared, and highly energy-efficient sub-area within Buffalo. The Smart Sub-area focuses on BNMC, Buffalo's Innovation Commercialization Hub in the Central Business District (CBD) where IBM is located, and also includes some of the most economically vulnerable neighborhoods on Buffalo's East Side. In many of these neighborhoods, the census tracts close to half the families live in poverty and, of the 23,100+ higher-paying jobs existing in the community, only a small fraction—1 out of 10—are held by residents in Buffalo (east of Main Street).

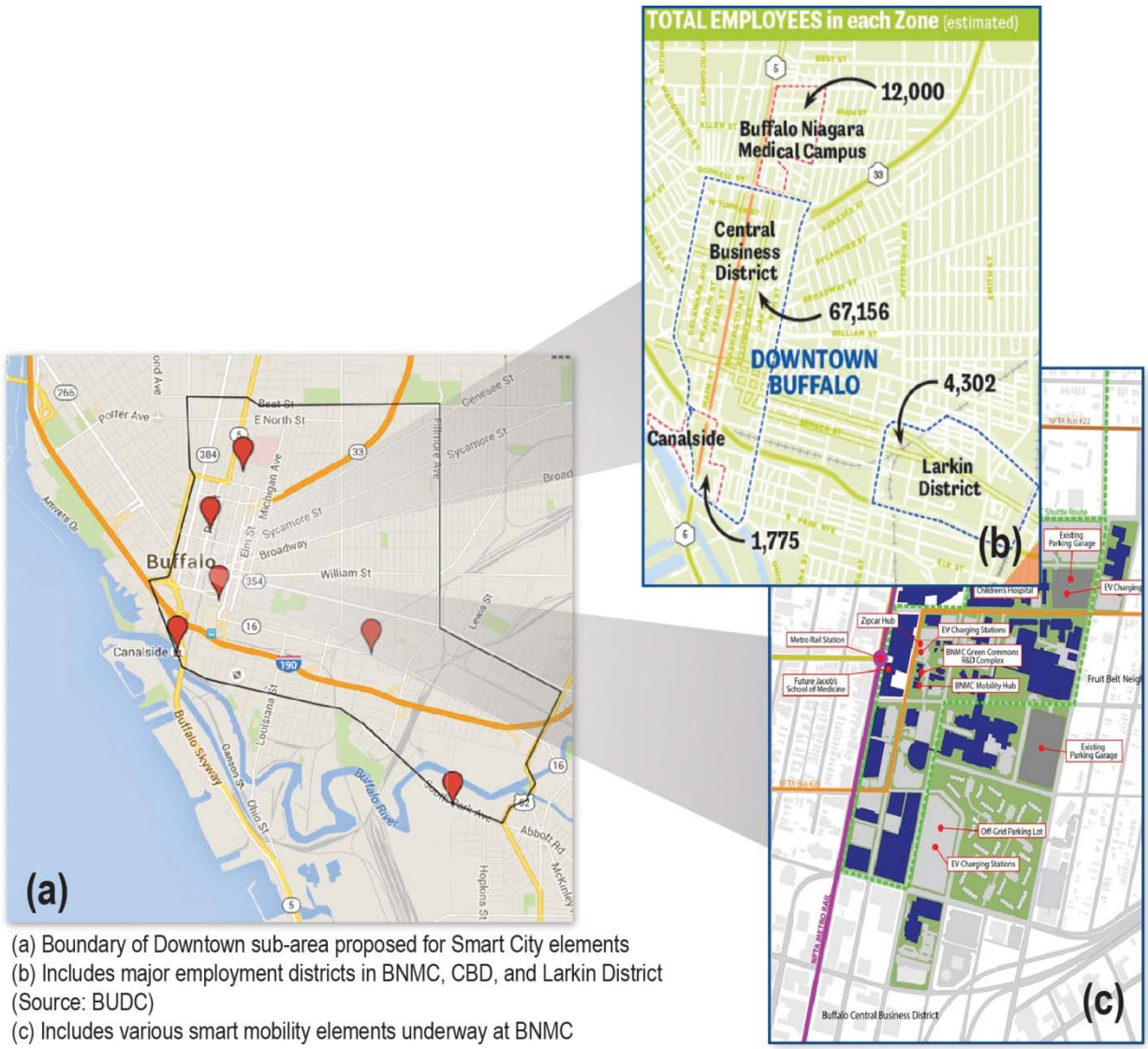
Toward the eastern boundary of the map lies the Larkin District employment hub and the Solar City employment complex to the south. The additional neighborhood geography and the important employment centers to the east and south of the CBD are included to promote greater equity and job access opportunities for residents through Buffalo's Smart City initiative.

At this implementation level, **connected and automated technology** elements in our framework are deployed including **(Vision Element #1 and Vision Element #2)**:

- A cooperative vehicle-infrastructure DSRC-based situational awareness system, to be developed at key intersections to support bicycle and pedestrian safety applications as shown in the adjoining figure.
- NFTA buses operating in this corridor, to include advanced crash avoidance systems using Mobileye's Shield +TM driver assistance safety technology.
- Transit signal priority along key arterials in the downtown area for NFTA buses.

[4] The Public Technology Institute (PTI) recognized Mayor Brown and the City of Buffalo Citizen's Participation Academy, 311 mobile app, and other innovative channels offered at the Division of Citizen Services as a means to effectively engage residents in citizen participation. This is Buffalo's third PTI designation award.

- Pilot deployment of low-speed automated shuttles that operate within the BNMC campus area to provide first- and last-mile connectivity to transit.



(a) Boundary of Downtown sub-area proposed for Smart City elements
(b) Includes major employment districts in BNMC, CBD, and Larkin District (Source: BUDC)
(c) Includes various smart mobility elements underway at BNMC

Figure 5.2. Downtown Sub-area for Smart City Implementation

Supported both by real-time data on conditions and historical data on travel demand and preferences, at this level, the emphasis on mobility services and innovative travel options will be led by our partners BNMC and the City of Buffalo.

BNMC is a natural incubator of Smart City concepts. The BNMC fosters conversation and collaboration among its nine member institutions, its partners, and the community to address critical issues impacting them, including energy, transportation and parking, workforce development, and healthy communities, with the overarching goal of increasing economic development and building a stronger community within and outside its campus. BNMC is undergoing rapid growth over the next 5–20 years, and sustainable planning, energy efficiency, and mobility management are critical to managing this growth.

Specific vision elements implemented at this level include:

- **Completion of BNMC Mobility Hub to support shared-use mobility and alternate transit options:** This will serve as the TMA headquarters and transportation resource center where employees and nearby residents can come to learn about and sign up for various services and programs (including carsharing and bikesharing) at a centralized location **(Vision Element #5 and #7).**
- **Development of a BNMC "Change Lab":** This will be an outlet for partnership, implementation, and monitoring/evaluation of innovative transportation solutions in an urban environment, such as those being researched and developed by the UB Institute for Sustainable Transportation and Logistics, including autonomous and connected vehicles **(Vision Element #7).**

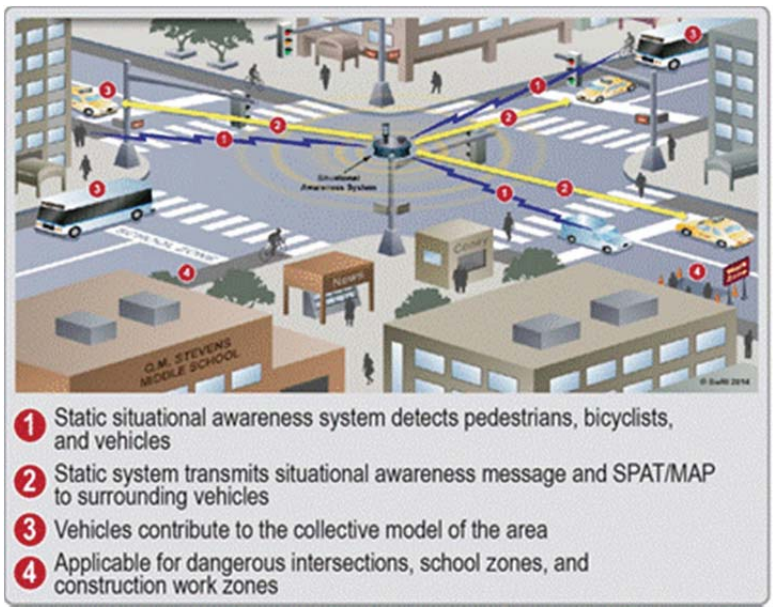


Figure 5.3. Schematic Showing a Cooperative Vehicle-Infrastructure Situational Awareness System for Bike-Ped Safety in Downtown

- **Integrated Transportation Fare System (Smart Card):** BNMC and partners will integrate various fare collection and access control systems among transportation and parking services on the BNMC. The program will serve as a step toward the creation of a more efficient and user-friendly multimodal transportation and parking network, while also providing new data resources for use in analyzing, planning, and implementing future transportation services, policies, and programs **(Vision Element #5).**
- **BNMC Parking System Development:** The BNMC TMA is also responsible for the management of the BNMC Parking System, currently composed of more than 4,700 parking spaces, with construction of a new 1,800-space garage soon underway. BNMC will work with the city and local leaders to explore the use of active parking management strategies for better management of on-street parking spaces in the area, including residential permit programs, parking sensors, and the use of mobile technologies **(Vision Element #3 and #5).**
- **Accessible Transportation Technology Implementation:** To ensure that the benefits of technology are equitably available, NFTA and partners will develop advanced wayfinding

Summary

At the downtown level, the emphasis will be on making multimodal travel safe, fun, and efficient. By using connected vehicle technology to prevent bike-ped crashes, using automated shuttles, and enabling public and private partnerships for travel options including parking, the outcome of Smart City elements at this level will be an increased mode share for non-SOV modes and improvements in safety and energy use.

All of these elements contribute to the enhancement of downtown as a business and residential hub, and they increase connectivity between different neighborhoods in this area, leading to a spurt in economic investments.

technology that enables persons with disabilities to effectively hail and use transit **(Vision Element #5).**

- **Intelligent Streetlighting:** Upgrading to LED streetlighting is becoming a statewide priority in New York cities. A series of NYS-supported programs and regulations are making this easier to accomplish starting in 2016. While these upgrades are being completed, they provide a great opportunity to enhance Buffalo's smart infrastructure by installing one of the many new LED streetlighting products that incorporate a range of sensing and communication technologies. This could be a great avenue to more affordably implement a smart parking system **(Vision Element #8).**

In addition, initiatives in this sub area championed by BNMC includes a strong energy-efficiency focus. Specific vision elements that can be supported by the Smart City application include:

- **Fruit Belt Neighborhood Solar Project**. a National Grid REV Demonstration supported by the BNMC, Inc. that seeks to engage and benefit the neighborhood through the installation of (100) residential PV systems on a sub-set of homes, which would be screened through both a combined structural/roofing and solar viability assessment and comprehensive home energy audit conducted by local contractors.
- **BNMC Community Micro-Grid**. The BNMC Inc., its member institutions develop an *Energy Innovation Plan* that supports economic development and growth in the greater Buffalo Niagara Region. The plan integrates demand management, energy efficiency, grid modernization, alternative transportation and renewable energy to develop the campus and surrounding areas as a self-sustainable energy hub (Community Micro-Grid) able to offset utility outages or natural disasters enhancing reliability and resiliency.
- **Smart Grid Network Operations Center (NOC)**. Provide a platform for BNMC member institutions and adjoining community members to optimize their energy flexibility based on individual priorities with respect to reliability, cost, and sustainability while actively coordinating their collective distributed energy resources (DERs) in a market that compensates them for providing such system benefits.
- **Energy Efficiency**. The goal for construction of the new garage is to meet Green Garage Certification standards, including but not limited to accommodating additional EV charging stations on the campus (currently there are 22), additional secure bicycle parking, and use of light-emitting diode (LED) lighting. **(Vision Element #6)**.
- **Integration of EV charging into parking management**. Tying EV charging networks like ChargePoint into broader smart parking systems would help EV drivers plan their trips better and feel more confident in their ability to get a charge when needed. Smart parking system deployment could also provide an opportunity for lower-cost EV charging station rollout if there is a conduit being laid or solar photovoltaic installed to bring electricity to infrastructure in parking lots or on-street **(Vision Element #8)**.

5.1.3 Smart City—I-190 Corridor Elements

NITTEC and partners are currently working on an ICM plan for major facilities in the Buffalo Niagara region. The corridor includes all the major freeways in the region and encompasses the City of Buffalo. For the Smart City implementation, a portion of this larger network, the I-190 corridor, will be identified as a priority.

The I-190 corridor includes a major interstate that leads to an international border, has adjoining arterials with transit service, and is heavily instrumented with fixed ITS detection. All of these characteristics make it an ideal starting location for implementing Smart City elements. When successful, these elements can be easily transitioned to other corridors like I-290 and I-90.

In this corridor, NITTEC and partners plan to deploy a complementary set of CV communications capabilities to the downtown area. This will include the necessary number of DSRC Roadside Units and vehicle instrumentation to support a variety of CV functions. The architecture would allow the vehicles to communicate with other vehicles, intersection components, and back office systems using a variety of communication mechanisms (DSRC, cellular, and satellite). Safety-critical applications (e.g., V2V collision avoidance and intersection status) would occur over 5.9 GHz DSRC. Other applications that are less time-critical would use Wi-Fi and cellular.

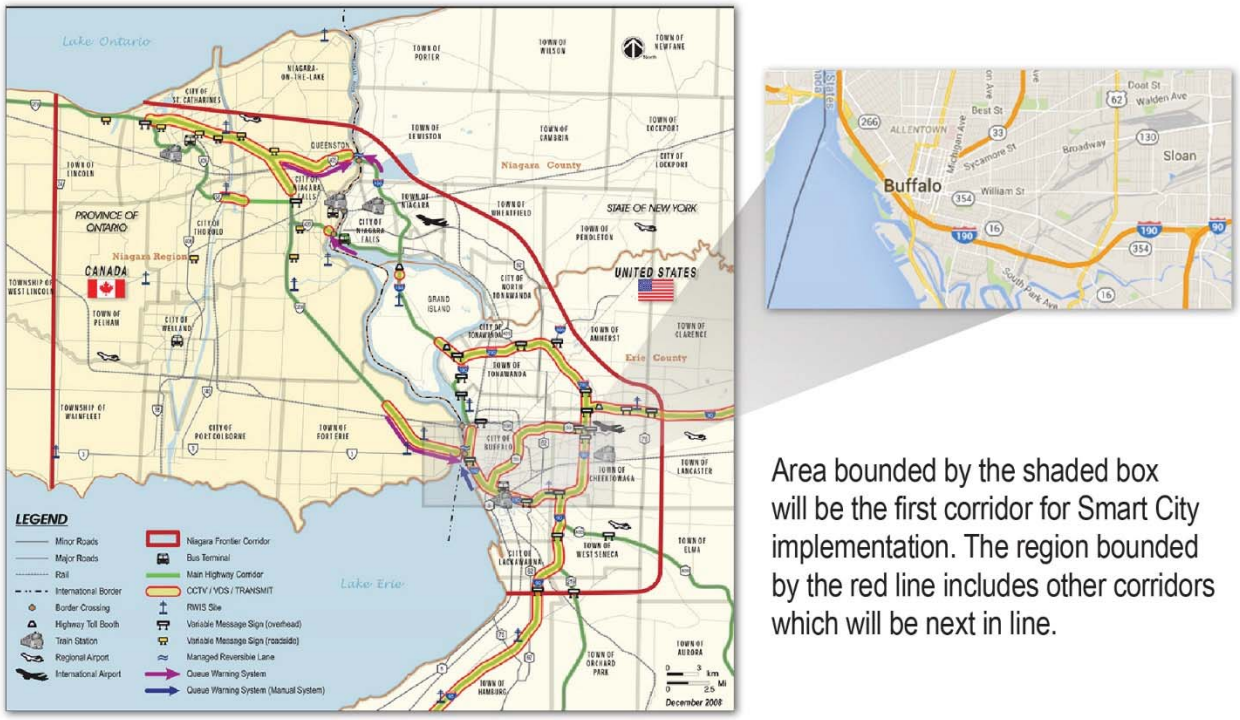


Figure 5.4. I-190 Corridor for Smart City Implementation

Using the flexible CV architecture, NITTEC and partners will develop the following priority applications to start the program **(Vision Element #2):**

- Connected vehicle telematics data collection for road condition reporting system on the corridor, which can be shared as part of regional traveler information and third-party applications.
- Use of existing deployable road weather 5.9 GHz DSRC application to provide in-vehicle alerts and advisories for adverse road conditions.
- Connected vehicle enabled situational awareness for work zones and school zones.

Summary:

At our corridor level, connected and automated technology is widely used to improve the situational awareness of both the traveler and the agency. By using connected vehicle data and road weather management, work zone management can be improved, which are two critical areas for Buffalo.

- V2I applications for wrong-way driving and over-height warnings for trucks approaching bridges.

In addition, snow plows operating on this corridor will be equipped with driver assist technologies that use a combination of sensors and Global Positioning System technology to provide feedback and displays to help operators keep on track with their snow plow operations even when they cannot see the road **(Vision Element #1).**

Lastly, this corridor will benefit from the full suite of ICM technology including a corridor-based decision support tool that allows for coordinated incident response, route diversions, and other control strategies. ICM is jointly funded by USDOT/NYSERDA and includes a simulation component that provides NITTEC a determination of near-term traffic impacts for their use in management of the incident **(Vision Element #5).**

5.2 Sustainability and Scalability of Vision

NITTEC as the lead agency for the program is responsible for the continued capability maturity of the Smart City framework. NITTEC and partners believe that implementing the plan as described in Section 4.3 would take us from an opportunistic level, where there are multi-agency partnerships emerging, to a managed level, where technology and data-enabled dynamic services deliver tangible improvements.

As a regional agency, NITTEC is able to work across agency and jurisdictional boundaries, enabling the scalability of the applications and the Smart City infrastructure to other corridors (I-290 or I-90) fairly easily. NITTEC and partners through its governance structure and the committee membership will continue to build on success toward an optimized level, growing from the downtown sub-area to a city-wide open "system of systems" that continually adapts and grows to meet changing citizen expectations and is resilient to economic changes and to disasters.

5.3 Managing Technical, Institutional, and Programmatic Risk

NITTEC's strong oversight through the management structure described in Section 6 mitigates a lot of the programmatic risk. As a complex program with many moving parts, the role of the Smart City working committee to establish a yearly work plan greatly improves program management of this effort.

Secondly, the team's realistic approach to vision elements and context-sensitive application of solutions to corridors, sub-areas, and regions allow us to manage the technical risks to the Smart City program by decomposition of the program elements into manageable implementation activities. By focusing on the base layers of the technology at a regional level, interoperability and scalability across corridors and sub-areas are maintained. By keeping the focus on the corridors and sub-areas, applications can be developed to target highly local conditions such as employer mix, weather, and land-use patterns.

Lastly, the working coalitions and history of collaboration between agencies and partners in this application coupled with the support from highest levels of agency leadership allow us to mitigate the institutional risks.

6. Technical Capability to Successfully Implement Our Approach

The Smart City grant application and the subsequent implementation will be carried out by a committed group of public, private, and academic partners with clearly defined roles and responsibilities. The following sections highlight the governance, roles and responsibilities, commitment, and local resources available for this project.

6.1 Clear Management, Governance and Decision-making Approach

NITTEC as the grant applicant will be responsible for setting up a management, governance, and decision-making approach to the Smart City Challenge. This role is well suited to NITTEC, a coalition agency that works together with the member agencies to coordinate transportation facilities and operations, taking advantage of new technologies as appropriate, and sharing information with each other and with the traveling public.

NFTA acts as a host agency to NITTEC. This arrangement was formalized in an agreement between NYSDOT and NFTA for supporting coalition activities and the operation of the Traffic Operations Center. In addition to providing office space, NFTA provides administrative services to NITTEC.

NITTEC's governing structure consists of a Board of Directors and eight committees. The Board of Directors can establish additional standing or ad hoc committees and/or project teams for specific tasks. For the Smart City Challenge, NITTEC will set up a Smart City committee that includes representatives from all existing committees as well others necessary for the governance of the program. The Smart City committee will be responsible for the program development and implementation oversight of the Smart City program elements as shown in **Figure 6.1**. NITTEC would structure the Smart City committee following the existing NITTEC committee model, which has been in place for more than 20 years. The committee would develop a mandate and a yearly work plan; meet on a regular schedule and develop a plan to progress on the initiatives that were defined at the startup of the committee; and build consensus from the members on the initiatives.

The program development activity will create a phased approach to implementing the framework described in Sections 3 and 4. Program element implementation activities will be undertaken under the leadership of the public and private partners. The Smart City committee will be responsible for ensuring that all program element implementations are sequenced correctly and implemented in line with the Smart City vision.

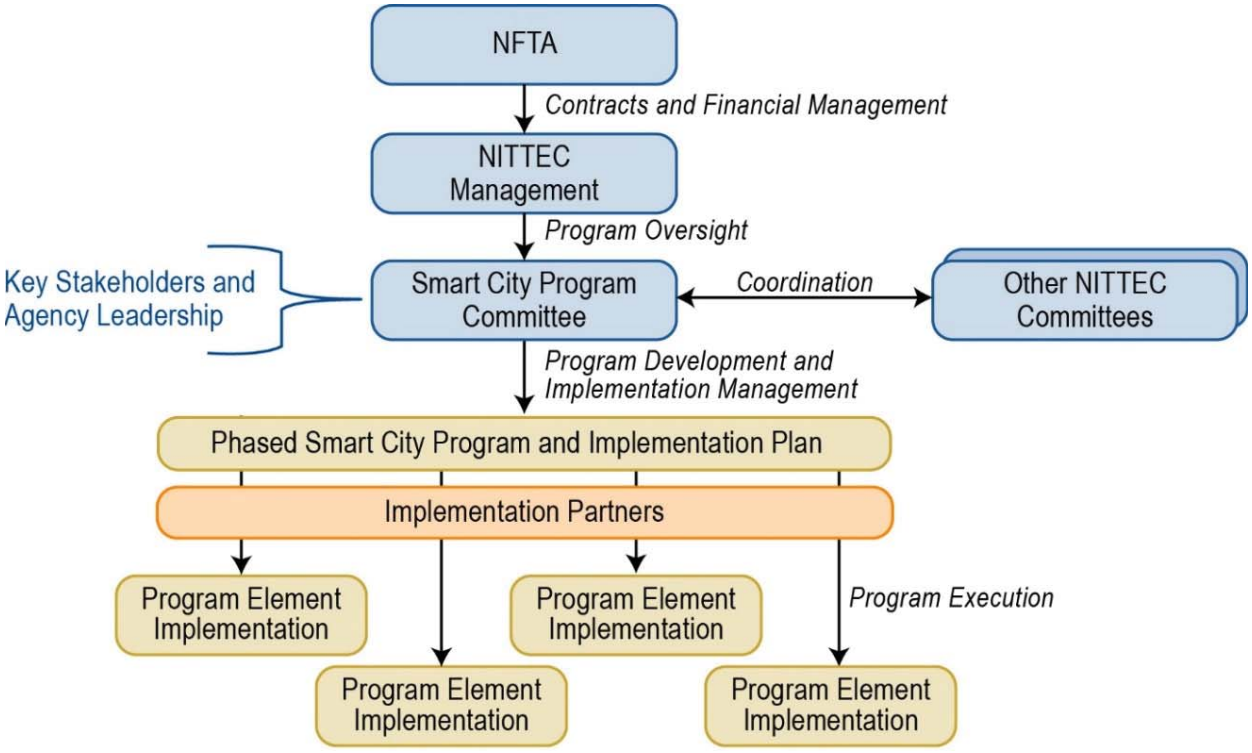


Figure 6.1. Our program management approach takes advantage of the multi-agency committee structure already in place at NITTEC.

6.2 Committed Partners with Clear Roles and Extensive Stakeholder Involvement

For the Smart City application, NITTEC has pulled together a public, private, and academic team to help with the planning and implementation of the vision elements proposed in our approach. In addition to partners identified below, there are several stakeholders who will be directly impacted by the Smart City implementation. The following sections identify specific roles for partners and list the primary stakeholders of interest.

6.2.1 Implementation Partners and Roles

The planning phase of the Smart City challenge will further define the roles of partners and stakeholders in the project, but we have begun the process of establishing roles and responsibilities to partners already. The following table provides a quick summary of the primary stakeholders in the Smart City project and their roles.

Table 6.1. Committed partners from public, private, and academic institutions comprise the team lead by NITTEC.

Partner	Roles
Public Sector Partners	
NITTEC	• Serve as lead for Smart City implementation • Manage Smart City committee and program implementation
NFTA	• Serve as contract and fiscal agent for NITTEC • Lead transit-related vision elements
NYSDOT	• Lead CV/AV infrastructure deployment and application development in freeway corridors
NYSERDA	• Support vision elements relating to sustainability, shared-use, and clean transportation

Table 6.1. Committed partners from public, private, and academic institutions comprise the team lead by NITTEC.

Partner	Roles
City of Buffalo	• Lead deployment of connected sensor infrastructure on city streets and on city fleets • Support transit and shared-use–related elements
Thruway Authority	• Support connected and automated infrastructure deployments • Support freight-related vision elements
GBNRTC	• Lead land-use planning vision elements • Provide overall planning support to the implementation
Private Sector Partners	
BNMC	• Lead development of more efficient, multimodal, and sustainable transportation and parking system on the target area
IBM	• Lead data analytics, cloud storage, and computing program elements as part of implementation
CISCO	• Lead the design and management of the network architecture as part of implementation
SiriusXM	• Support wide-area dissemination of travel condition data generated by various applications
Intelligent Imaging Systems	• Support freight optimization and dynamic freight-specific travel guidance for freight-related program elements • Support compliance review efficiency improvements
Voyage Control	• Support freight optimization and dynamic freight-specific travel guidance for freight-related program elements
GDG	• Support outreach and partnering for planning and implementation
Cambridge	• Support analysis, modeling, and simulation for urban analytics
ICF International	• Support integrated corridor management, transportation systems management, and operations and EV readiness-related program elements
Academic Partners/Not-for-Profit	
SwRI	• Support system engineering, design, and testing of automated and connected vehicles
UTRC Region II	• Support research and development of autonomous and connected vehicles applications
SUNY Polytechnic Institute	• Lead public-private partnerships with industry leaders to innovate and commercialize smart devices, integrated system tailored for broad array of IoT applications
TransInfo	• Implement performance measurement of autonomous and connected vehicles with special focus on human behavior

6.2.2 Stakeholders

An array of regional stakeholders will be engaged through the NITTEC membership. Currently, NITTEC consists of 14 member agencies: Erie County, Ministry of Transportation Ontario, NYSDOT, NYS Thruway Authority, NFTA, Buffalo and Fort Erie Public Bridge Authority, City of Buffalo, City of Niagara Falls (New York), City of Niagara Falls (Ontario), Niagara County, Niagara Falls Bridge Commission, Niagara Parks Commission, Niagara Region, and the Town of Fort Erie.

NITTEC also currently has 17 affiliate members who are not voting members of NITTEC but may send representatives to participate in committees. Current affiliate members of NITTEC include New York State Police, Ontario Provincial Police, GBNRTC, Federal Highway Administration, the Town of Amherst, the Town of Tonawanda, the Town of Niagara-on-the-Lake, NYS Department of Environmental Conservation, John's Towing, Rusiniak's Towing, U.S. Customs and Border Protection, Canada Border Services Agency, University at Buffalo, Rural Metro, City of St. Catharines, Montgomery Services, and Twin City Ambulance.

6.3 Demonstrated Commitment from City, State, Private leadership

As noted in the introduction, the grant application and the Smart City vision elements described in Section 4 have the commitment of the state, city, county, and NFTA. Committed partners include private sector representatives who have been actively involved in putting together this grant application. Letters of support are provided in Appendix A.

6.4 Additional Available Local Resources to Support Smart City Implementation

Our application elements as described in Sections 4 and 5 are highly local. Our private and academic partners are currently active in the City of Buffalo carrying out several Smart City–related initiatives already. Their roles are described in Section 6.2. In addition, there are a few emerging initiatives with great promise to be leveraged for our Smart City program. These include the following:

- The $5 billion Clean Energy Fund, to be administered by NYSERDA, builds on the progress the state is already making in developing a robust clean-tech sector. Of the $5 billion, $717 million is allocated to innovation and research. The fund will help spur innovations through research and technology development that will drive clean-tech business growth and job creation while providing more energy choices to residential and business customers. This is of direct relevance to **Vision Element #8.**
- NITTEC manages a Revolving Loan Fund (RLF) established to support and enhance innovation and development of solutions to improve mobility in the region. There is approximately $4,958,000 in available monies for regional ITS, operations, and mobility projects for loan through the NITTEC RLF. Based on the established guidelines, loans are available for member agency sponsored organizations that wish to pursue project funding in the region in accordance with the established Project Selection Criteria and could potentially support Smart City program elements.
- Through the leadership of the UTRC Region 2 and SUNY Poly, the SMART Consortium strategy was launched in 2014 and now serves as one of the premier platforms to align leading industry experts, university researchers, and government officials to support the sustainable development and deployment of connected and autonomous vehicles.
- NYSDOT/NYSERDA is funding a truck platooning planning study. Upon the study's completion and feasibility assessment, there may be potential interest in testing concepts at a deployment site in New York State, adding to the automated technology elements proposed in the application.
- NITTEC and ITS elements are included in the MPO Metropolitan Transportation Plan and Transportation Improvement Program (TIP). Annual operating costs for NITTEC as well as capital projects are financed through the TIP process.

7. Summary

NITTEC sees the size and the scope of Smart Cities as an opportunity to tackle multiple needs simultaneously and holistically. Through our vision described in Section 4 and our approach described in Section 5, we are ready to take on the Smart City Challenge. Recognizing that transportation is the lifeline that opens up nearly every opportunity from attending school to

getting to work or receiving life-saving medical care, NITTEC and partners view the Smart City application as a catalyst to create a stronger, more equitable Buffalo economy through a connected and engaged citizenry.

Buffalo's merits as an ideal Smart City location derive from not only the demographic characteristics, but also from the successful history of regional collaboration. As one of the nation's leaders in regional systems management and operations, NITTEC is an ideal grantee to support the Smart City program, which is intrinsically a multi-agency framework of action.

Figure 7.1. Multiple Benefits from Smart City Implementation

Our carefully selected team of partners brings local champions; public, private, and academic expertise; and a passion for the digital revolution promised by the implementation of the Smart City elements. NITTEC and its partners recognize the wide range of benefits that come from realizing the vision for an instrumented, interconnected, and intelligent city for local agencies, citizens, and the overall economy, and our application is strongly supported by all levels of government in the region as evidenced by letters of support in Appendix A.

Our approach described in Section 5 is driven by a strong sense of practicality and clear focus on the desired outcomes and performance. Our emerging governance and management approach clearly shows how a multi-agency implementation will be managed.

All these factors make Buffalo a low-risk and high-payoff location. As a location for Smart Cities, our successful implementation in Buffalo will serve as a model for how using the power of technology and connectivity starts a digital revolution that changes the way we understand our systems, and how they work and interface with each other. By unleashing the power of connectivity, automation, and integration, Buffalo seeks a future of shared prosperity by all residents through regaining its leadership position in innovation not seen since the turn of the 20th century when iron, coal, and hydro-electricity turned the region into an industrial giant.