

B'SMART

Beyond Traffic: USDOT Smart City Challenge

Connecting Communities to Opportunities in Baltimore for a Safe, Efficient, Sustainable, Equitable and Economically Competitive Smart City



A Proposal Submitted to the
U.S. Department of Transportation
Notice of Funding Opportunity DTFH6116RA00002
By the City of Baltimore, Maryland

Transform Baltimore

Transforming distressed neighborhoods through...

Leadership

Smart City Technologies

Community Support

Partnership

Economic Development

Education

Job Training

...into economically vibrant communities



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Executive Summary

The disconnected community, separated from vital ladders of opportunity for growth and development, is a chronic issue that has plagued the American city. While rapid growth in personal automobile sales over the last century gave Americans the freedom to travel at a moment's notice, and the construction of high-speed expressways connected previously disconnected rural and suburban communities, urban areas suffered the consequences. Highways were constructed through previously vibrant urban communities, displacing families and destroying property along the way. Those with the necessary means relocated to the suburbs. Those remaining were left disconnected from economic opportunity and upward mobility, and were forced to depend increasingly on limited public transit options. This vicious cycle continued to accelerate over time, concentrating poverty in neighborhoods with poor transportation connections, fewer jobs, higher crime, and inadequate access to important services including healthcare, food, and more recently, broadband Internet access.

Though much promise exists for smart city technologies to lead a revitalization of urban communities across the nation, issues in making this vision a reality remain. The Baltimore Vision for Smart City (**B'Smart**) is a bold step forward that connects communities to opportunities, starting with historically underserved neighborhoods in West Baltimore that bore the brunt of displacement and disconnection through the construction of the "highway to nowhere" in the 1960's and 1970's. To transform Baltimore into a city of greater economic prosperity and social equity, it is vital to successfully demonstrate how smart city technologies can better connect low-income communities, often with limited access to Internet and smartphones, to economic opportunities, and how these technologies integrate with the existing infrastructure and create new prospects within these communities.

The City of Baltimore and its partners have developed a comprehensive approach toward this goal. At its core are the Smart Community Hubs, where traditional transit services meet smart mobility services, enabled by connected/automated/electric vehicles and the sharing economy, to provide low-cost options to connect users to transit hubs and final destinations. These hubs will also house electric vehicle and smart grid infrastructure, public Internet/Wi-Fi/Smart phone portals, next-generation city logistics operations, on-site job training opportunities and additional features that will attract new businesses and spur economic development.

Baltimore proudly includes a series of innovative smart city solutions in this proposal specifically designed for low-income communities, such as connected V2V/V2X-enabled mesh networks offering free Wi-Fi access to the West Baltimore community, low-cost automated mobility service for hub connection and accessibility, wayfinding tools for elderly and disabled citizens, low-income credits in sharing economy ecosystems, new jobs from technology implementation, and many more. Another strength of the proposal stems from the connected and automated port concept, supported by crowd-sourced freight solutions at the Port of Baltimore and Smart Community Hubs.

Baltimore is the ideal candidate for the USDOT Smart City Challenge. Following the civil unrest that took place in West Baltimore this past spring, city, regional, state, federal and private-sector leaders have publicly stated their commitment to revitalizing underserved communities in Baltimore. In 2015 alone, USDOT chose West Baltimore as one of the seven cities to receive technical assistance for economic development related to transportation projects through its LadderStep pilot. The State announced a \$700 million plan to eliminate blight in West Baltimore and a \$135 million plan to improve transit service.

While Baltimore's struggles have been highlighted over the past few months, it is by no mean alone. Many American cities, especially cities that developed around heavy industry, are facing similar challenges. The **B'Smart** vision can be easily replicated and shared elsewhere. At the heart of the Baltimore team are more than 50 committed city, regional and state agencies, leading universities, locally invested non-profits, and Fortune 500 corporate partners. The assets, expertise and commitment these partners bring, coupled with the **B'Smart** vision and the USDOT Smart City Challenge investment, will generate the biggest, most progressive, and most transferable impact with the highest chance of a truly transformative success.

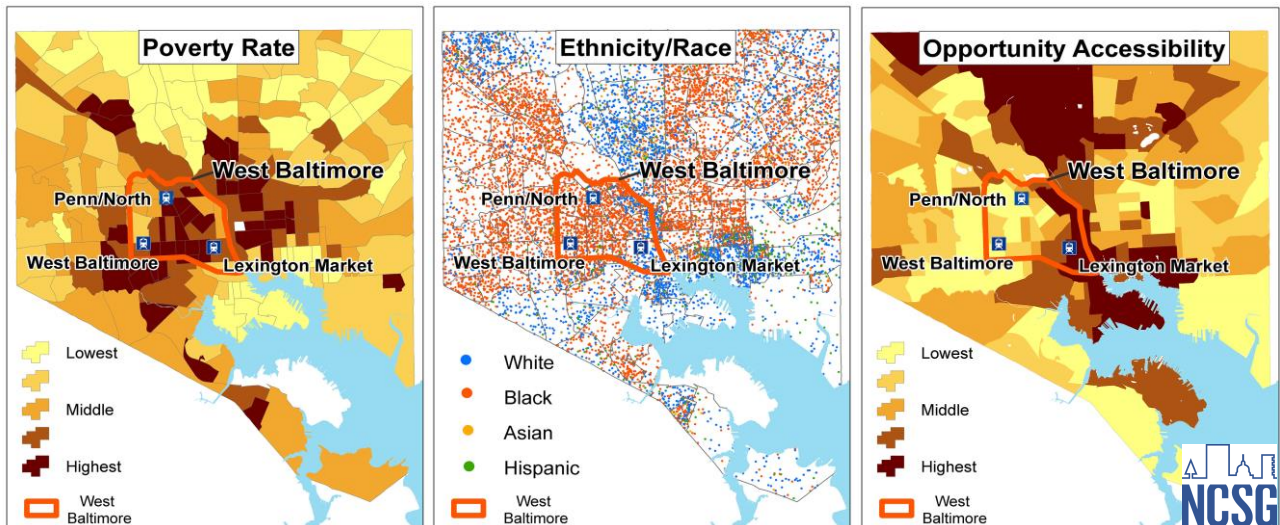
1 Baltimore Smart City Vision & Goals

| 1.1 Transform Baltimore: Connecting Communities to Opportunities

The City of Baltimore, Maryland is home to some of the best hospitals and medical schools in the world, a vibrant job and culture center at the Inner Harbor, and an extensive multimodal transportation system including the Port of Baltimore, the 13th largest port in the nation and the top importer of automobiles in the country. The new transportation vision for Baltimore is one of sustaining economic vitality and improving quality of life by attracting and supporting state-of-the-art technological developments and innovation.

The **Baltimore Smart City Vision** focuses on *transforming* disconnected communities with smart city solutions throughout the city, and the action starts with connecting low-income communities in West Baltimore to economic opportunities while attracting businesses and jobs back to this community.

The city, regional and state leaders are eager to employ smart city technologies to address top transportation issues in Baltimore: transit accessibility, travel reliability, urban congestion, vehicle and pedestrian safety, energy and emissions, freight mobility, and first/last-mile access.



The **primary urban challenge** in Baltimore is socially and economically disconnected communities with poor transportation accessibility to jobs and opportunities. A recent [Harvard study](#) reveals that a person born in a low-income community in Baltimore has the least chance of ascending out of that income group in the entire nation. Historically underserved communities with mostly minority residents in West Baltimore have some of the highest poverty rates and poorest access to opportunities (see graphs above; see proposal back cover for all image sources and credits). In 2015, West Baltimore became the face of struggles with poverty and urban decay with the civil unrest following the death of Freddy Gray. The systemic connectivity issue facing West Baltimore was further highlighted when the long-awaited Red Line light rail transit project in the community was recently cancelled.

The Baltimore Smart City Vision (B'Smart) aims to transform Baltimore, immediately connecting West Baltimore to economic opportunities through integrated smart transportation and economic development solutions, and gradually expanding the focus to the rest of the city and transferring the model to cities and states across the nation.

This vision is supported by four interrelated smart city strategies:

- (1) **Connect West Baltimore to existing opportunities** with affordable, safer, more efficient, sustainable smart mobility options integrated with transit;
- (2) **Attract developments and jobs** back to low-income communities with smart city technology deployment;
- (3) **Create smart city ecosystems** for passenger and freight travel through sharing economy and open data; &
- (4) **Innovate port & city logistics** to improve freight efficiency, reliability and safety, and reduce costs and emissions.



| 1.2 Smart Community Hub

With resources from this USDOT grant and commitments from the city and its partners, Baltimore will demonstrate the **Smart Community Hub** concept at three existing multimodal transit stations: West Baltimore Marc, Lexington Market, and Penn-North (**Hub Creation**).

An evolutionary approach for implementing revolutionary technologies in Baltimore by transforming existing transit stations to multifunctional Smart Community Hubs with smart mobility, safety & sustainability.

Various smart city technologies, such as automation and connected vehicle, will also diversify and enhance the efficiency, safety, and sustainability of mobility services connecting Community Hubs (**Hub Connection**) and first/last mile linkages between Community Hubs and trip origins/destinations (**Hub Accessibility**). Smart city technologies for freight will be implemented at and around Smart Community Hubs and the Port of Baltimore for connected, automated and crowd-sourced city logistics hubs of the future (**Hub Logistics**).

Multi-Functional Smart Community Hub: Here's How it Works

1 Multimodal Transportation Hub where traditional and smart mobility services connect to each other for seamless transfers

2 EV & Smart Grid Hub EV charging/rental/sharing and smart-grid hub integrating power & transportation sectors

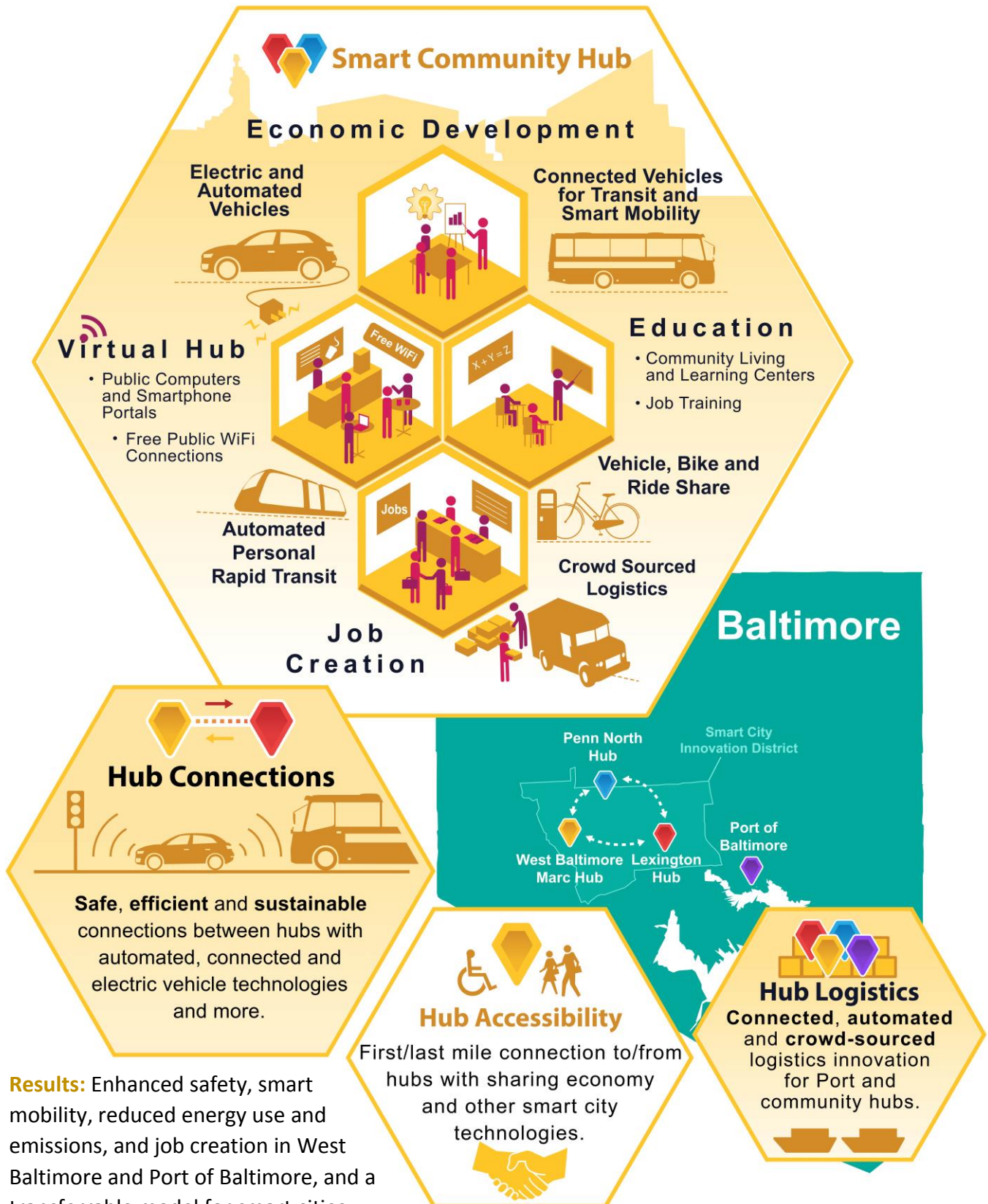
3 Community Job and Living Hub where job training, economic development, health care & ICT access congregate in&around hubs

4 Hub Connection EV-based rapid transit, automated transit, personal rapid transit, CV-enabled safety&mobility solutions, and smart bike/pedestrian greenways supplement existing signalized arterials, bus transit, metro rail, and commuter rail to connect the community hubs.

5 Hub Accessibility Sharing economy ecosystem proving dynamic shuttle, ride sharing/bike sharing/EV rental/ADA on-demand services for traveling to and from hubs, complete with e-payment with low-income household.

6 Hub Logistics Connected logistics automating and tracking each freight movement at the Port and crowd-sourced urban delivery hubs, with dynamic freight operations and sharing economy freight ecosystem for shippers, carriers, businesses and citizens.

Improve Safety, Mobility, and Sustainability with the Smart Community Hub Implementation Framework



Results: Enhanced safety, smart mobility, reduced energy use and emissions, and job creation in West Baltimore and Port of Baltimore, and a transferrable model for smart cities.

| 1.3 B'Smart Goals and Performance Measures

The five primary goals supporting the B'Smart vision of connecting communities to opportunities, key performance metrics, and B'Smart 2020 objectives are summarized below.

Goals	Description	Performance Metrics	B'Smart 2020 Objectives
Safety	Life and property of citizens must be protected as they access opportunities.	Crash rate/severity, Pedestrian, bicycle, transit, and freight crashes and fatalities, Citizen rating of community safety/security	Move toward zero deaths, Reduce crashes across all modes by 20%, Increase citizen rating of safety and security in WB by 50%
Mobility	Smart City offers more reliable and efficient trips for travelers and freight on all modes. It also provides more non-auto travel options to citizens through mobility-on-demand and sharing economy.	Congestion delay, Travel time index, Planning time Index, Bottlenecks, Speeds, Transit service time and on-time arrival, Transit ridership, Cost and time on mobility-on-demand and sharing economy modes, Population coverage of new mobility modes, Urban delivery delay, Freight congestion cost, Area coverage of sharing economy urban delivery modes	10% improvement across all efficiency metrics, 20% improvement across all reliability metrics, Population and area coverage of new mobility modes and sharing economy modes reaches 80% of the WB community
Sustainability	Smart City promotes environmentally friendly and energy efficient urban solutions with renewable resources	Emissions and fuel use per person mile, Air quality index, Electric Vehicle share, Non-auto mode share, Walkability score, Renewable energy source for power grid, EV sharing economy mode ridership	10% reduction in fuel use and emissions for trips from/to the WB community, More EV, sharing economy, and other non-auto trips than auto trips
Equity	Access to affordable and reliable transportation broadens opportunities and is vital for addressing poverty, unemployment and access to health care and education.	Average commute time for all city residents, and especially WB residents, Average cost per urban trip for WB residents, Access/egress travel time to/from the Smart Community Hubs, Coverage of public Wi-Fi in WB, Number of computer and smart phone portals in Smart Community Hubs	20% reduction of commute time and costs for WB residents, 50% reduction of hub access/egress time, Low/no-cost Wi-Fi coverage to 50% of WB residents, 1,000 public computer and smart phone portals in Community Hubs
Job Creation	Smart City promotes economic growth and job creation in existing and new business sectors.	Jobs created in WB, Jobs created at the Port, Jobs created in the City, Unemployment rate, Household income, Number of WB residents trained for job skills and entrepreneurship	3,000 new jobs with >2/3 of them in WB and Port, 10% reduction in unemployment rate, 10% increase in income, Job training to 1,000 WB residents each year

| 1.4 Why Baltimore?



Biggest Impact

- > On urban congestion
- > Transit service quality
- > Disconnected communities
- > Economic inequality

B'Smart addresses a community with the most urgent needs for revitalization through technology and innovation. Smart city technologies improving hub connection and accessibility with connected and automated vehicle and sharing economy modes can significantly decrease auto mode share, reduce accidents, and reduce recurrent and non-recurrent congestion delay. Aggressive technology

deployment plans for EV and smart grid will further reduce energy use and emissions. All

proposed technology deployments are strategically located inside a Smart City Innovation District (later extended to the entire city and beyond), which will allow for maximum benefits and for these technologies to multiply. The Baltimore proposal also leverages more than one billion of on-going investments (see Section 9), enabling the USDOT grant to maximize impact.

Most Transferrable

- > Universally applicable concepts
- > Data and performance sharing
- > Removal of tech. adoption barrier
- > Platform with 50+ member cities

Baltimore faces population, transportation, and community challenges representative of many U.S. cities that are struggling to revitalize their urban centers and to connect communities. The Baltimore approach of converting existing transit stations to Smart Community Hubs is applicable and transferrable to all American cities with existing

transit centers, new urbanism neighborhoods, or job hubs. A truly multimodal transportation infrastructure in Baltimore, including all forms of transit services, sharing economy modes, and a major water port and airport, allows for comprehensive deployment of smart city technologies and maximizes the opportunity for other cities to transfer technologies of their interests for specific types of infrastructure. A major barrier to new technology adoption for city governments is inequity because low-income and minority population groups are often the last to adopt and benefit from emerging technologies. By focusing on improving equity and assisting low-income communities, a success in Baltimore will remove this key technology adoption barrier for other cities. Existing platforms for data/analytics/technology/experience sharing are already in place, led by Baltimore and its university partners, that can immediately transfer smart city technologies to more than 100 cities and universities (see Section 7).

Most Progressive

- > Revitalization & transformation of low-income communities
- > Job training and job creation
- > Technologies for lowering cost and accessing opportunities
- > Best demo site in the nation

B'Smart will directly benefit more than 50,000 low-income and minority residents in West Baltimore by improving their transportation access to opportunities, lowering their transportation costs, providing new jobs near their existing homes, offering job training at easily accessible locations, expanding access to free public Wi-Fi and smart phones, and re-connecting the communities with sharing economy tools and new community hubs. West Baltimore, a community

devastated by the 2015 protests, hungry for innovation and ready for a transformation, has been at the center of a national dialogue on issues and solutions in disconnected communities.

Highest Chance of Success

- > Full partner support
- > Effective risk management
- > Carefully staged implementation plan
- > Strong track record of tech-demo execution

Baltimore has established a strong track record of successfully launching and executing technology innovation initiatives. Most recently, by promoting innovations in the bio, health care and cybersecurity technology sectors and by working through public-private-

philanthropic partnerships, the City has created 22,572 new jobs and reversed the half-century

trend of population decline. **B'Smart** is strongly supported by leaders of city, regional and state governments, ports, community organizations, and more than 50 committed and capable academic, non-profit and private-sector partners (see Appendix A for support letters). The proposed evolutionary approach focuses on compatibility and complementarity between futuristic smart city technologies and the existing multimodal transportation hubs, which mitigates technology, institutional, and policy risks. The implementation plan (see Section 5) is also carefully staged with low-risk projects completed first to ensure success, strength program support, and avoid program-halting incidents. All these qualifications, combined with hundreds of millions of dollars of committed investments in Baltimore transit stations, transit links, and [Innovation Village](#) in West Baltimore pave a solid foundation toward a transformative success.

2 Baltimore City Characteristics

| 2.1 Population and Density

Baltimore meets the specified attributes for an ideal Smart City in terms of population (200K – 850K), density and having a significant portion of the overall Urban Area population (>15%):

> **Population Size**

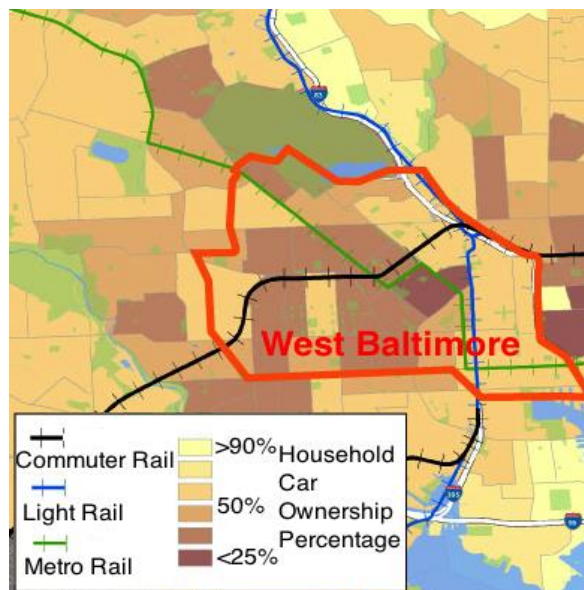
666,271 (Baltimore City)
 2,753,396 (Baltimore MSA)
 23% (City/MSA)

> **Population Density**

7,687 people/sq. mi. (Baltimore City)
 1,058 people/ sq. mi. (Baltimore MSA)
 7 times denser in Baltimore City

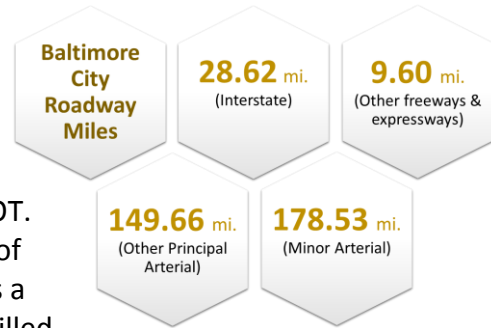
| 2.2 Multimodal Transportation Infrastructure System

Transit The Baltimore metro area has a comprehensive public transportation system including Metrorail, light rail, commuter rail, regular bus, rapid bus, and mobility/paratransit services, 1,509 service vehicles, 563 rail transit track miles, and 2,056 bus route miles. While extensive in scope, the Baltimore transit system requires major improvements. A typical Baltimore resident can only get to 11% of the jobs in the region within an hour using public transportation, with an average transit commute time of 55 minutes. The existing rail transit system in and around West Baltimore is illustrated in the map, which also shows low car ownership and transit dependency of this community. Poor accessibility to and from the rail transit stations has been a key factor for the lack of opportunities and the lack of business and economic development in West Baltimore.



Baltimore used to be a city connected by streetcars. The current bus routes essentially replaced the streetcar lines. The residential and job centers of the city have significantly changed since the time of the streetcars; but the bus routes have not. Additionally, increased ridership on the Light Rail and Heavy Rail Metro subway have led to poor performance. In Fall 2015, Maryland Governor Larry Hogan announced a plan to improve the transit system in Baltimore and committed \$135 million to this effort.

Highway The City of Baltimore has authority over the operations of all roadways within the city boundary, except tolled facilities and Interstate highways. Major issues with the highway system are congestion and safety. Baltimore has an average commute time of 31 minutes, the worst of all mid-sized cities identified by USDOT. In 2013, the City of Baltimore experienced 20,933 crashes, of which 1,243 involved at least one pedestrian or bicyclist. As a result of these crashes, 6,815 people were injured and 28 killed.



Port of Baltimore

The Port of Baltimore remains a strong economic engine, generating 108,000 jobs in the region. However, the aging vehicular and freight infrastructure in Baltimore create major bottlenecks for freight movements along the East Coast. Port of Baltimore is ranked 14th in the nation for truck freight delay (over 6 million hours annually). The expansion of the Panama Canal will bring new economic opportunities to Baltimore and along with the expected major increase in freight shipments, creates an increased urgency to address freight mobility/reliability and urban logistics issues in and around the Port of Baltimore.



Sharing Economy Modes The concept of a sharing economy, e.g., vehicle sharing and ride sharing, has been ongoing in Baltimore for more than 40 years (including the first [Commuter Connections](#) ride share program). The City has also approved a bike-sharing program that will be launched in Fall 2016. Baltimore, in partnership with the University of Maryland, received \$4.5 million from the US DOE in 2015 to develop a sharing economy ecosystem to incentivize residents and businesses to make sustainable travel decisions that minimize energy use. The private sector has also started sharing economy transportation and logistics services in the region, including dynamic mobility-on-demand transit services and urban delivery services.





Smart Grid & EV Infrastructure Electric vehicle usage in Baltimore is prevalent and staged for significant growth. Maryland is one of the country's first eight states participating in the Zero Emission Vehicle Memorandum of Understanding (ZEV MOU). Baltimore City was one of the first federal and state award recipients of EV funding to install public EV charging stations in 2010. The city and partners did so along the 13-State I-95 corridor, known as the transportation "backbone" of the East Coast. Baltimore has grown its EV presence since the earliest development of EV production models in 2010-2012, placing EVs into its own municipal fleet with state funding support. Baltimore is also the headquarter location for the Maryland Department of the Environment (MDE) and Maryland Transit Administration (MTA), both of which are working aggressively to promote EVs, renewable energy and smart grid developments. The Port of Baltimore has introduced EV into port operations. The city and state work very cooperatively with the local utility, Baltimore Gas & Electric (BGE) on smart grid applications to assure the strongest grid operations, resilience and security, while also encouraging EV usage. Among several incentive programs in Baltimore, BGE initiated an EV pilot program to encourage the use of EVs in 2014.



ICT, ITS & TMC Infrastructure: Baltimore has an extensive existing Information and Communications Technology (ICT) infrastructure including fiber optics, Wi-Fi and cellular connections. Baltimore City Traffic Management Center (TMC) and the Emergency Operations Center, in collaboration with the Maryland State Highway Administration (SHA) and Maryland Transit Administration (MTA), maintain an award-winning Intelligent Transportation Systems (ITS) infrastructure including **CHART** incident response, traffic sensors and data, activity traffic management, integrated corridor management, and travel demand management. The Baltimore City TMC is in charge of non-freeway traffic control and coordinates with SHA and MTA on ITS and traffic management on freeways and transit, respectively. Baltimore and its regional agency partners are known nationally for their ability to deploy new ICT, ITS and TMC technologies. Baltimore is a recipient of the Integrated Corridor Management demonstration grant from the USDOT FHWA, the Advanced Demand and the Dynamic Network Modeling grant from SHRP2 with a focus on active traffic management. Areas of needs regarding ICT, ITS, and IMC include low Internet access and low smart phone market share in low-income neighborhoods, and signal communications.

| 2.3 Additional Baltimore Advantages



Environment Conducive to Technology Demo

With the termination of the Red Line rail transit proposal in West Baltimore, the city, region and state are eager to adopt smart city technologies that not only facilitate personal, commodity, and digital traffic, but serve as the foundation for connecting low-income inner city residents with the new-economy job growth that continues across the region. Recently, the city designated West Baltimore as part of the “Sustainable Communities” making this area eligible for funding from a variety of state agencies. The city’s comprehensive plan was also recently updated for the first time in 30 years, immediately followed by “Transform Baltimore,” the City’s completely revised and modernized zoning ordinance. These critical and progressive planning tools, as well as the recently adopted economic development, sustainability, climate change, disaster, and food systems plans, provide a strong institutional foundation for smart city development in Baltimore. Baltimore is also participating in the USDOT Ladders of Opportunity Program with a focus in West Baltimore.



Committed Leadership and Capacity

In the wake of the Freddy Gray protests, the city government is committed to returning Baltimore, and especially West Baltimore to prosperity and equity. On Martin Luther King Day 2016, the Mayor of Baltimore, along with major regional and state government leaders, announced the Innovation Village initiative in West Baltimore to promote developments and job creation. The Governor of Maryland also just allocated \$135 million for “[BaltimoreLink](#),” a new multimodal transit strategy for connecting Baltimore residents and jobs. As part of the regional “Opportunity Collaborative,” the city produced a “Regional Plan for Sustainable Community Development” that received national acclaim. To help implement the regional plan, the state recently committed **\$700 million** for replacing vacant buildings with new affordable and mixed use housing with West Baltimore being the focus area. B’Smart also aligns well with the high-priority long-standing city goals of improving transit, connecting communities, enhancing safety and security, and addressing climate adaptation. Baltimore has identified urban congestion mitigation, transit service improvement, safety, and emission reduction as the top transportation goals for the City, consistent with the USDOT goals.



Integration with the Sharing Economy & Open Data Access

B’Smart strives to expand, improve and electrify vehicle, bike, and ride sharing programs, and to develop sharing economy ecosystems for both passenger and freight with dynamic on-demand crowd-sourced services with built in e-payment. A bold innovation in low-cost ICT and CV vehicle network technology will be deployed to provide free Internet access to all of West Baltimore. Data from users, mobile devices and smart infrastructure sensors will be integrated to support customized, real-time travel information, passenger and freight trip planning, performance monitoring, and decision-making. Baltimore is the inventor of the now multi-city [CitiStat](#) program that collects city data and provides access to city officials, entrepreneurs and citizens. Through partnership with the University of Maryland and Johns Hopkins University, Baltimore is part of the internationally leading [RITIS](#) platform for integrating, sharing and analyzing urban data, and connected with the [MetroLab Network](#) and [21st Century Cities Initiative](#), two major multi-city alliances for smart city technology transfer.

3 Technology Overview and Site Map

The proposed **B'Smart** technology deployments, consistent with the **12 USDOT Smart City Vision Elements**, are summarized in the table below and detailed in Section 4.

USDOT Vision Elements	Baltimore Smart City Vision Elements	Goals Achieved	Risk	Key Partners*
1. Urban Automation	Electric and Automated Vehicle Sharing-Ride Sharing Automated and Dynamic Shuttle Services Automated Mag-Lev Personal Rapid Transit (PRT) Automation for Parking, Freight and Safety	S,M,G,E	High	Ford, GM, Lyft, Bosch, Verizon, GE, Voyage Control, SkyTran, SidewalkLabs, U Michigan GOVonomy
2. Connected Vehicles	Next Generation Low-Cost V2X and V2I Technologies Connected Smart Signal and Traffic Management Outsourced Wider-Area Connected Vehicle Tech. CV-Enabled Mesh Network for Public Access to Internet	S,M,G,E,J	Low	U Maryland, U Michigan, Eberle Design, Econolite, Port of Baltimore, Veniam, Telogis, Cyberg, GOVonomy
3. Intelligent, Sensor-Based Infrastructure	Users, Vehicles and Cell Phones as Probe Sensors Smart Infrastructure Sensors and Virtual Sensors	S,M,E	Low	U Maryland, TomTom, INRIX, HERE, Ford, Telogis, Google/Waze,
4. Urban Analytics	B'Smart Urban Analytics Platform Performance Monitoring and Prediction	S,M,G	Low	U Maryland, Johns Hopkins U, Urban Insights, BU-BNIA
5. User-Focused Mobility Services and Choices	Ecosystem for Mobility-on-Demand (MOD) Services Incentive-Based Demand Management for Optimization Real-Time Traveler Information for All Vehicle/Bike/Ride Sharing Services with Job Creation	M,G,E,J	Medium	Lyft, GM, Ford, Split, Transit Choices, Commuter Connections, CMTA, MDOT, MTA, Sidewalk Labs, AARP
6. Urban Delivery and Logistics	Connected and Automated Port Crowd-Sourced Urban Delivery with Job Creation Dynamic Freight Trip Planning Service	S,M,G,E,J	Medium	Port of Baltimore, Roadie, Under Armour, Voyage Control, Veniam, Cyberg
7. Partnerships	Discussed separately in Section 5 of the proposal		Low	All
8. Smart Grid, Roadway Electrification and Electric Vehicles	Vehicle Electrification EV Infrastructure and Incentives Cleaner Energy Sources for Smart Grid	M,G,J	Low	GE, Ford, BG&E, BEVI, TimberRock, EnviroBro, NREL, Cyberg, MEA, MCEC, MDCC, MDE,
9. Connected, Involved Citizens	Rate Your Ride and Rate Baltimore Open Data Portal for Promoting Entrepreneurship	E,J	Low	CMTA, U. Maryland, Community Associations
10. Architecture and Standards	Bandwidth, Storage, Security, Privacy, etc.	S,M,G	Medium	Cisco, Verizon, Bosch, GE, INRIX, U. Maryland
11. Low-Cost, Efficient, Secure and Resilient ICT	Low-Cost ICT in West Baltimore and more	S, M, E, J	Low	Cisco, Verizon, Bosch GOVnomy
12. Smart Land Use	Innovation Village Economic and Land Development in West Baltimore	M,G,E,J	Low	Sagamore Dev., Abell Found., Coppin State U

Related B'Smart Goals: S – Safety; M – Mobility; G – Green/Sustainability; E – Equity; or J – Job Creation

Risk Level Assessment: Green ♦ – Low) Yellow ♦ – Medium; and Red ♦ – High

* **Partners** – Partnerships discussed in this proposal indicate interests from the partners in working with Baltimore to deploy smart city technologies (see Appendix for partner detail), but do not at this stage indicate a commitment from the City.

B'Smart Vision Elements will be initially deployed at the three West Baltimore Smart Community Hubs, the multimodal corridors connecting these hubs, the Smart City Innovation District, and the Port of Baltimore (see annotated site map below). Certainly Vision Elements, such as low-cost connected vehicle solutions, B'Smart sharing economy ecosystem, open data sharing and urban analytics platforms, will immediately make citywide impact. With strategic partnerships and business models developed through this USDOT grant, Baltimore intends to expand this implementation framework based on Smart Community Hubs to the entire city and the region, and transfer technologies to other cities.



Deployment Locations
Yellow – At or near the three Smart Community Hubs in West Baltimore for Hub Creation;
Red – Along Route 40 and Route 1 multimodal corridors connecting the three hubs for Hub Connection;
Green – Covering the entire Smart City Innovation District for improving Hub Accessibility;
Purple – At Port of Baltimore or Smart Community Hubs for Hub Logistics; or
Gray – Covering the entire City of Baltimore.

4 Smart City Vision Elements

A primary focus of B'Smart is to solve unique and often understudied issues regarding smart city technology deployment in low-income communities, such as low smartphone/internet market share, low car ownership, price sensitivity, citizen education and community security. In addition to meeting USDOT expectations on all 12 Vision Elements, Baltimore has designed and plans to implement smart city solutions that are especially valuable in low-income communities and highlighted with a “**Ladders of Opportunity**” symbol in the narratives below.

| 4.1 Urban Automation

Key barriers to opportunity for low-income residents and businesses in West Baltimore to access opportunities are the monetary and time costs of transportation. While the average city resident spends 16% of their income on transportation, low-income residents spend more than 30% of their income on transportation. Baltimore values urban automation as a means to reduce the costs for its residents to access/egress Community Hubs and travel between hubs, while simultaneously improving safety, mobility and sustainability at the same time.

Electric/Automated Vehicle and Ride Sharing In partnership with GM, Baltimore will implement EV vehicle sharing and ride sharing at the West Baltimore Marc Hub with the new 200-mile range Chevrolet Bolt EV, **reducing fuel costs for low-income renters and riders.** The city will gradually introduce automation to this vehicle fleet as B'Smart expands to Lexington Market and Penn-North Hubs.



Automated Personal Rapid Transit (PRT) Advances in urban transportation automation enable new automated PRT modes that promise much higher person throughputs and higher speed than existing urban travel modes. Baltimore has had preliminary discussions with an automated PRT start-up company named [SkyTran](#) (see support letter from SkyTran) to explore deployment options for a futuristic velocity-based-magnetic-levitation system. These next-generation automated PRT vehicles move on a network of slim elevated guideways that enable fast, on-demand, and point-to-point travel. Though any potential relationship with SkyTran is dependent on successful testing and demonstration of this innovative technology and its ability to carry passengers, SkyTran remains a potential game-changing development that could dramatically leverage smart community hubs created in Baltimore through USDOT's support in the Smart City Challenge.





Automated and Dynamic Shuttle Services Parking cost is high at major job centers in Baltimore. The Ford GoRide dynamic shuttle service will be introduced in Baltimore to provide



efficient and on-demand shuttle services to transport West Baltimore residents from Community Hubs and relative low-cost remote parking facilities to job centers. Replacing the shuttle fleet with automated electric buses at a later stage would make it financially viable for the city to **offer automated shuttle services to West Baltimore residents as a free hub connection and hub accessibility option.**

Urban Automation for Parking, Freight and Safety Baltimore also plans to partner with leading companies (e.g., [Bosch](#), [Voyage Control](#), [Veniam](#), [Mobileye](#), [Sidewalk Labs](#)) to explore additional urban automation technologies such as automated parking, freight and port automation, automation-based transit driver assistance, and pedestrian safety systems.

| 4.2 Connected Vehicles

Baltimore envisions a citywide CV deployment, “Connected Baltimore,” with low-cost technologies. This will ensure smooth travel across the entire city without “end of service” bottlenecks occurring when system boundaries are reached. Immediate applications will focus on arterial connected signal management, first-responder safety and CV-enabled integrated corridor management for Hub Connections and Hub Accessibility.

Next Generation Low-Cost V2X and V2I Technologies Baltimore, in partnership with the University of Maryland and University of Michigan, has developed a concept of low-cost city-wide V2I and V2X technologies based on Wi-Fi and other existing communication networks. These technologies allow the city to monitor performance and understand how the operations of facilities and services can be enhanced in near-real time. Baltimore will enable CV data from transit, first responders, commercial vehicles, city and public vehicles, and pedestrians through massive, yet extremely low-cost deployments by leveraging new technologies from its university and private sector partners.



Connected Smart Signal and Traffic Management Baltimore’s aging infrastructure consists of hundreds of signalized intersections with little connectivity to each other. Connected Baltimore will integrate high-resolution controller data, re-identification data, outsourced probe data, and connected vehicle data. Through partnerships with the [University of Maryland](#),



Google/Waze, Eberle Design, Econolite, TomTom, University of Michigan, and others, Baltimore will deploy DSRC and Wi-Fi-based CV technologies to enable the collection of detailed signal and sensor actuation data at 0.01-second resolution that supports signal maintenance, safety applications, transit priority, freight priority, traveler information for in-vehicle systems, real-time coordinated signal operations between freeway and

arterial networks, and next-generation performance criteria. Re-identification data provides travel time samples at 1-second resolution and privacy-protected origin-destination data, helping the city understand where vehicles enter the network, their routes, and exit points.

Outsourced Wider-Area CV Technology Commercial vehicle operations in Baltimore are significant given the city’s many port terminals, an Amazon distribution system, Under Armour operations, and Johns Hopkins health care logistics. Furthering the vision of Connected Baltimore, the city has partnered with Telogis to access real-time CV data from over 250,000 commercial vehicles, including headlight use, seatbelt use, wiper use, emissions, driving behavior, traction control engagement, origin-destination, and more. This information will be integrated with aforementioned CV data sources to help Baltimore understand environmental conditions and passenger/ freight travel patterns to make informed, real-time decisions for a smart mobility system.



CV-Enabled Public Internet Access A key opportunity barrier in low-income communities

is poor Internet access that prevents many from benefiting from Smart City technologies. B’Smart recognizes that connected vehicles and infrastructure (e.g., smart street lights, transit stations) are ideal low-cost Wi-Fi hotspots that can expand wireless Internet coverage by forming a **vehicle-infrastructure mesh network offering free Internet access in low-income communities**. This technology relies entirely on existing fiber and Wi-Fi infrastructure, and only requires installing a



multi-network On-Board/On-Infrastructure Unit equipped with Wi-Fi/DSRC/cellular interfaces on city vehicles, buses, commercial vehicles from partners and street infrastructure. Free, public Wi-Fi access should also attract small businesses, new residents, and persons from other neighborhoods to West Baltimore, in a way that also **reunites the communities and the city**.



| 4.3 Intelligent, Sensor-based Infrastructure

B'Smart incorporates data sources from deployed smart city infrastructure that, when coupled with the nationally leading [RITIS](#) and [CitiStat](#) urban analytics tools in Baltimore, will provide an advanced platform for addressing complex urban challenges both in and beyond Baltimore.

Users, Vehicles and Cell Phones as Probe Sensors Baltimore plans to utilize public-private partnership agreements with dozens of committed data providers (e.g., Google/Waze, TomTom, INRIX, HERE, Verizon) managed through RITIS at the University of Maryland – home to the largest transportation data center in the U.S. – to collect and integrate user-generated data and smart infrastructure data, including: **(1)** Data

from mobile and cell phone communication providers including real-time population location, origin-destination, seismic activity and more; **(2)** Data from connected vehicles, buses, commercial vehicles and signals on origin destination, speed, route, location, and ridership; **(3)** Data from sharing economy ecosystem apps through which users generate data as probe sensors; **(4)** User ratings from the Rate-Baltimore connected/involved citizen app on City service performance; and more.



Smart Infrastructure Sensors and Virtual Sensors Baltimore will expand and improve smart infrastructure with physical and virtual sensors, such as:

(1) Bike and pedestrian sensors built into high volume sidewalks, cross walks and bike share systems (partners: Ford, Sidewalk Labs); **(2)** Virtual freight sensors providing information on freight origin destination, volume, route, and weight (University of Maryland); **(3)** Wireless and solar powered smart parking meters that measure occupancy, road conditions, vehicle idling, and collect parking revenue (BEVI); **(4)** Smart street lights that also monitor infrastructure condition and **improves community security with better street lighting** (GE); **(5)** On-board sensors in automated and connected vehicles (Telogis, Voyage Control, Ford, GM); and **(6)** Video network surveillance system with video analytics for transportation and low-income community security (Bosch).

| 4.4 Urban Analytics

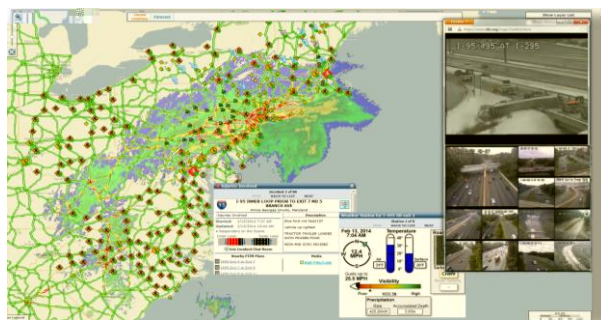
With real-time and archived data from existing and new sensors, B'Smart includes an integrated Urban Analytics Platform that enables performance monitoring, performance prediction, system optimization, and multi-city analytics sharing. This platform will include new performance metrics related to equity and economic opportunities in West Baltimore.



community security with better street lighting (GE); **(5)** On-board sensors in automated and connected vehicles (Telogis, Voyage Control, Ford, GM); and **(6)** Video network surveillance system with video analytics for transportation and low-income community security (Bosch).

B'Smart Urban Analytics Platform – Ready from Day One The B'Smart Urban Analytics Platform will leverage existing industry-leading systems, including RITIS, CitiStat, and 21st Century Cities Initiative, all led by Baltimore or its university partners. Since the core data sharing and analytics engine is already in place with more than \$35 million prior federal and state investments in RITIS alone, the B'Smart Urban Analytics Platform and its data assets will be quickly deployable, secure, low cost to maintain, scalable, and easy to replicate in other regions; it will attain measurable benefits on "day one." This also allows Baltimore to spend more of the USDOT Smart City Challenge grant on other Vision Elements.

A key innovation planned for the B'Smart Urban Analytics Platform is the realization of self-creating, dynamic, and predictive city dashboards and visual analytics. Whereas most analytics and dashboard systems require users to configure settings, define parameters, and otherwise make queries, B'Smart intends to employ forward-thinking, machine-learning, big-data concepts that dynamically and continually analyze incoming data, compare it to historic data, search for patterns, look for correlations and statistical outliers, and then report only the interesting and important elements that are discovered. In this sense, the B'Smart dashboards are "self-creating," intelligent, predicative, optimizing, and searching for problems, patterns, and solutions that humans might not even think to explore. The result is a more informed government, better served citizens, and more efficient, sustainable and safe mobility.



Performance Monitoring and Prediction Baltimore designs its performance measures and monitoring/prediction systems that will allow the city to continually monitor and refine its deployments in order to ensure maximized benefits of each application and tailoring them to various operations and environmental conditions. See Section 6 for additional details.

| 4.5 User-focused Mobility Service and Choices

Sharing economy for passenger travel, including automated vehicle/bike/ride travel modes introduced in Section 4.1, is integrated in a **B'Smart Ecosystem** for dynamic on-demand mobility services, with considerations for low-income, elderly and disabled users, built on partnerships between the city, transit agencies, universities and the private sector (e.g., Lyft, GM, Ford, Split) for seamless modal integration, transfer and e-payment.

Ecosystem for Mobility-on-Demand (MOD) Services

The B'Smart Sharing Economy Ecosystem is where dynamic travel demand meets on-demand mobility service providers working together to offer the most affordable, efficient and sustainable travel options. Users enter their trip origin, destination, and arrival time, and all providers of mobility services (e.g., transit, rapid/personal transit, ride sharing, ride hailing, vehicle sharing, bike sharing, parking) offer service price and level of service information. Users choose a service provider or a combination of service providers and complete payment within the same ecosystem. For equity and multimodalism, B'Smart stresses an open ecosystem that promotes market entries and allows multiple service providers to collaborate, helping users complete a trip with connecting services from multiple service providers (e.g., ride share on Lyft to a bus hub, ride a city bus, and then use Ford e-bike sharing to get to the final destination). B'Smart's payment system will also include **low-income user credits and discounts** for West Baltimore families.



Incentive-Based Travel Demand Management for System Optimization

Another B'Smart innovation is employing predictive analytics and control optimization to minimize traffic delay, energy use and emissions with personalized incentives that strategically encourage system users to adjust their travel decisions that are good for themselves and optimize transportation system performance. By strategically introducing personalized long-term (e.g., rewards for joining vehicle share and ride share programs), pre-trip (e.g., rewards for delaying departure until after rush hour) and real-time incentives (e.g., rewards for en-route diversion to

- Long-Term Incentives:**
 - Join new Ride-Share Program: 1000pts
 - Eco Drive Target for May 2015: 25 MPG (Current: 20 MPG)
 - CONGRATULATIONS! GOLD LEVEL: +50% bonus for every point you earn!
- Pre-Trip Incentives:**
 - Destination: DOE HQ Preferred Arrival: 8am: 200pts
 - Depart: 6:50 am Arrive: 7:35 am: 200pts
 - Eco-Driving Target for trip is 28 MPG: 100pts
 - Total Points 15414 Rank 3 out of 15 Among all users Top 23%
- Real-Time Incentives:**
 - Eco-Driving 28 MPG CURRENT: 25 MPG Tip: Brake more softly.
 - ACCIDENT AHEAD DETOUR
 - DETOUR 20 min vs. 35 min +50pts
 - 50pts You saved 15 min You saved others 10 min

less congested routes and for adopting eco-friendly driving behavior), the City can encourage some users through monetary and non-monetary incentives to adjust their travel choices for the optimization of system energy use and efficiency. This technology is funded with a \$4.5 million grant from the U.S. DOE and developed by the [National Transportation Center](#) at the University of Maryland for Baltimore with planned deployment in 2017.



Real-Time Traveler Information for All Real-time traveler information, including that for sharing economy modes, will be provided via web, smartphone, and existing ITS and ATIS system to all citizens. An effort that is already ongoing in Baltimore and would be greatly accelerated by the USDOT Smart City Grant is the **development of wayfinding tools for the elderly and disabled** who may require modes and routes with ADA compatibility.



Vehicle/Bike/Ride Sharing Services with Job Creation Many of the existing and proposed sharing economy modes such as vehicle/bike/ride sharing will have depots at the three Smart Community Hubs in West Baltimore for Hub Connection and Hub Accessibility. To **enable low-income West Baltimore residents without cars to join the sharing economy work force**, Baltimore, in collaboration with GM and Lyft, will provide Bolt EVs at the Smart Community Hubs that qualified residents in West Baltimore can rent as contracted drivers to offer ride hailing and ride sharing services as contracted drivers. All sharing economy modes will be integrated into the B'Smart ecosystem and [Commuter Connections](#), which has been promoting vehicle/ride sharing in Baltimore for over four decades.



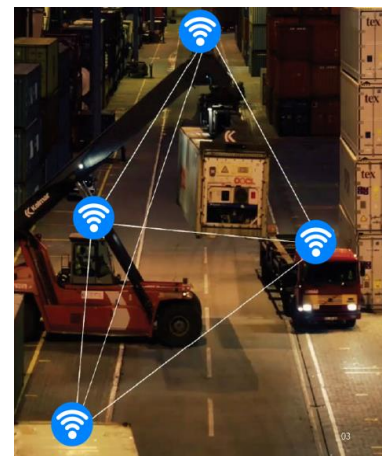
Don't own a vehicle?
No problem!
Rent-Drive-Earn Money



| 4.6 Urban Delivery and Logistics Innovations

With the many Port of Baltimore terminals in the city, B'Smart is well positioned to deploy smart city technologies that address freight transportation issues related to port operations and city logistics. Key Vision Elements include connected and automated Port of Baltimore and crowd-sourced city logistics operations anchored at Smart Community Hubs in West Baltimore.

Connected and Automated Port Freight delays at ports and intermodal facilities significantly increase shipping costs and worsen urban congestion. In a connected and automated Port as B'Smart envisions it, all vehicles, containers, machines and control centers are connected to each other with similar low-cost vehicle mesh networks for connected passenger vehicles and with virtual freight sensors. This technology tracks the movement of all shipped goods inside the port and transmits real-time information to control centers for operations optimization and shipment coordination. Benefits include reduced truck delay and ship docking time, smart port traffic management, safety and security, and real-time user information.



Crowd-Sourced Urban Delivery with Job Creation A B'Smart sharing economy ecosystem for urban delivery will dynamically match crowd-sourced delivery capacity with shipping demand, with the proposed Smart Community Hubs in West Baltimore serving as the new city logistics centers for package consolidation and shipment. **Citizens and commercial carriers can turn underutilized space in their personal vehicles and trucks (e.g., less-than-truckload space) into income** while reducing the number of freight delivery trucks in the city. **EVs and electric cargo bikes at the Smart Community Hubs can be rented by residents in West Baltimore to deliver goods, which creates new jobs** in the low-income community and at the same time reduces fuel use and emissions. On-demand carriers collect parcels from customers and deliver parcels to city logistics centers at Smart Community Hubs for consolidation and ship via crowd-sourced methods to final destinations. **Restaurants, retail shops, and other service businesses will also be attracted to areas around the Smart Community Hubs to utilize this low-cost, reliable delivery service**, providing additional new jobs in West Baltimore. A key partner is **Roadie**, the inventor of the neighbor-helping-neighbor crowd-sourced delivery.



Dynamic Freight Trip Planning Service With the B'Smart Urban Analytics Platform incorporating commercial vehicle sensors and system prediction, dynamic freight trip planning services via web, smart phone and in-vehicle systems will be provided to shippers, carriers and receivers for dynamic freight mode, scheduling and routing decision support/optimization, as well as customized commercial vehicle travel information provision (Telogis, Voyage Control).

| 4.7 Strategic Partnerships and Business Models

A major strength of the Baltimore proposal is from the city's existing partnerships with regional and state governments, universities, non-profits and corporations. This proposal is the product of more than 100 meetings and phone calls with city partners. To avoid repetition, detailed description of strategic partnerships and business models is only included in Section 5.

| 4.8 Smart Grid, Roadway Electrification and Electric Vehicles

Baltimore has been a leader in promoting EV, EV infrastructure, renewable energy and smart grid developments. EV sharing, e-bike sharing and electric transit fleet are also integral parts of B'Smart and its Smart Community Hub vision. Baltimore envisions EV as an environmentally friendly technology for potentially reducing mobility costs in West Baltimore and beyond.



Vehicle Electrification Since 2010, GM and GE have partnered with Baltimore on EV to develop clean transportation options for urban residents. Baltimore received Maryland Energy Administration funding in 2015 to introduce EV into the city vehicle fleet, and is committed to contributing to a statewide plan of having **60,000 EV by 2020**. The Port of Baltimore has also employed EV for port operations. B'Smart will **expand EV availability to low-income citizens and businesses in West Baltimore by placing EV and e-bikes at the Smart Community Hubs for vehicle/bike/ride-sharing programs and by employing electric buses and shuttles**. Expansion of EV-ready Smart Community Hubs to other areas of Baltimore is supported by industry and community partners including Ford, BG&E, BEVI, GE, and Sagamore. The city will also work with the Port of Baltimore to expand its vehicle electrification program to apply EV-based terminal tractors, yard mules, employee shuttles, cranes and marine shore power.



EV Infrastructure and Incentives Baltimore is dedicated to electrifying privately-owned vehicles and has developed various EV incentives to encourage this conversion including: residential and commercial tax credits, rebate programs, EV charging stations at gas stations, train stations, and workplaces, and EV pilot programs. Innovative, personalized incentives such as reward points and social/peer recognition through the B'Smart sharing economy ecosystem will be introduced with funding from this USDOT Smart City Grant.



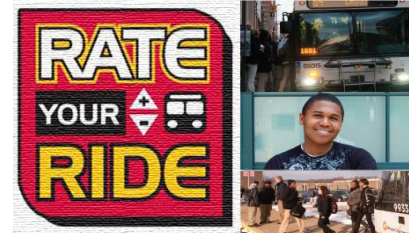
Cleaner Energy Sources for Smart Grid Baltimore has worked cooperatively with the State of Maryland and the local utility, Baltimore Gas and Electric (BG&E) on smart grid applications to assure cleaner energy sources, strong grid operations, grid resilience and security, while encouraging EV usage. 38% of Baltimore's net electricity generation comes from Maryland's only nuclear power plant at Calvert Cliff and 7% from renewable energy sources. BG&E has recently been awarded **\$200M** from US DOE for advanced smart grid metering infrastructure and home energy management improvements. B'Smart aims to **partner with BG&E and local energy startups to steer major benefits, like reduced home energy costs from lower-cost solar and other renewable energy sources, toward West Baltimore**, and employ local residents as BG&E employees to build and maintain Smart Community Hubs as smart-grid hubs in West Baltimore.



|4.9 Connected, Involved Citizens

Connected, involved citizens are data providers, data users, performance evaluators, informed entrepreneurs and community contributors in a smart city. A spotlight B'Smart effort is to improve the access for West Baltimore residents and businesses to the B'Smart data sharing and urban analytics platforms, so they may identify entrepreneurship opportunities in their communities through technology and job training programs at Smart Community Hubs.

Rate Your Ride and Rate Baltimore Baltimore citizens currently evaluate their transit rides with the [Rate-Your-Ride](#) tool. B'Smart includes a proposal for a more comprehensive Rate-Baltimore web and mobile app that enables citizens and businesses to evaluate all city services.



Open Data Portal for Promoting Entrepreneurship Selected and processed B'Smart data without sensitive information will be published to all citizens and businesses via the existing CitiStat platform. This **open data portal can help citizens and businesses understand and evaluate the evolving market demand and promote entrepreneurship.** For instance, long waiting times for dynamic ride sharing services imply demand and profitability for new entrants in that market. A household planning to open a new service business can improve its business location choice by exploiting newly available pedestrian and bike volume data. Entrepreneurs may monitor crowd-sourced delivery data and be inspired to open a local store with in-demand merchandises and services. Training courses on data analytics and business startups by professors from local partnering universities (e.g., U. of Maryland, Johns Hopkins U., Morgan State U., Coppin State U.) and successful entrepreneurs from partner corporations will be offered at Smart Community Hubs in West Baltimore to **help its residents start their entrepreneurship endeavors, which could in turn create new jobs in their communities.** The training program will be established by the USDOT grant and gradually transitioned into a partner-funded program at no cost to low-income trainees, possibly managed by the USDOT-funded [National Transportation Center](#) at the University of Maryland. In addition, patient



origin-destination information obtained from B'Smart data collection will be shared with the Johns Hopkins Health Care System, the biggest employer in the State of Maryland and a partner on this proposal. Such information will assist the hospital system to optimize location choices of new clinics and health care facilities, and specifically **make health care more accessible to low-income communities by locating more facilities in or near Community Hubs.**

|4.10 Architecture and Standards

B'Smart is supported by Cisco, Verizon, Bosch, GE, GM, Ford, and University of Maryland (National Transportation Center, Center for Advanced Transportation Technology, Energy

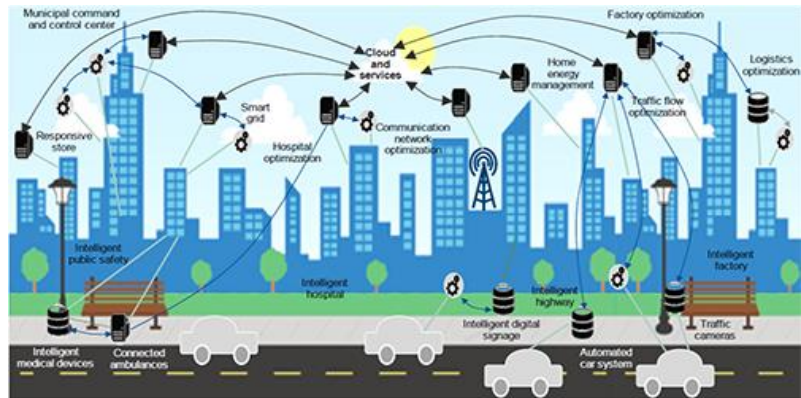
Research Center, and Maryland Cybersecurity Center) that are industry and academic leaders of ITS, CV, AV, EV, smart grid, cybersecurity and other smart city architecture and standards. The Baltimore team has worked actively with various ITS Standards bodies, and continues to work with the USDOT ITS Architecture group, Society of Automotive Engineers and numerous other standards including new CV standards that go beyond vehicle safety messages. With these standards embedded in the B'Smart integrated smart city platform built on RITIS with member cities from 35 states, the B'Smart experience on technology architecture and standards is better situated for redeployment and reuse among other smart cities at low cost. The Baltimore team is cognizant of the architectural challenges and is well versed in risk mitigation on:

Bandwidth: The Baltimore team is located on a backbone node of the Internet and has bandwidth capacity to handle all data transferred from B'Smart in real time.

Storage: The Baltimore team will and has existing capability to store all data indefinitely.

Security: Highest standards of physical and virtual data security used to protect 6 billion new RITIS transportation data records each day.

Privacy: Private and sensitive data will be secured using encryption and aggregation.



Cisco Plans an IoT-Enabled Smart City

| 4.11 Low-cost, Efficient, Secure and Resilient ICT

Toward an integrated ICT platform for B'Smart and other smart cities, Baltimore will further develop the RITIS platform being used for ITS applications right now in the city, with assistance from ICT industry leaders including Cisco (hardware), Google (software) and Verizon (Telecom and IT services). The combined system of systems that feeds into the B'Smart ICT platform will abide by all standards, protocols and regulations applicable to each technology deployment. Through partnerships with the University of Maryland and the University of Michigan, the B'Smart ICT platform will continue to leverage the existing work from AASHTO, ETSI, CAMP, SAE, and CVRIA to implement multiple levels of cost, efficiency, security and resilience requirements. For example, Baltimore will ensure

communication security on the DSRC and other communication levels, and communication security on higher levels (e.g. TLS protected communication for financial transactions that involve 3rd party servers of financial institutions) for sharing economy payment technologies. The goal at the beginning of a USDOT Smart City Challenge Grant in Baltimore is to have an integrated ICT platform design and transferrable architecture ready.

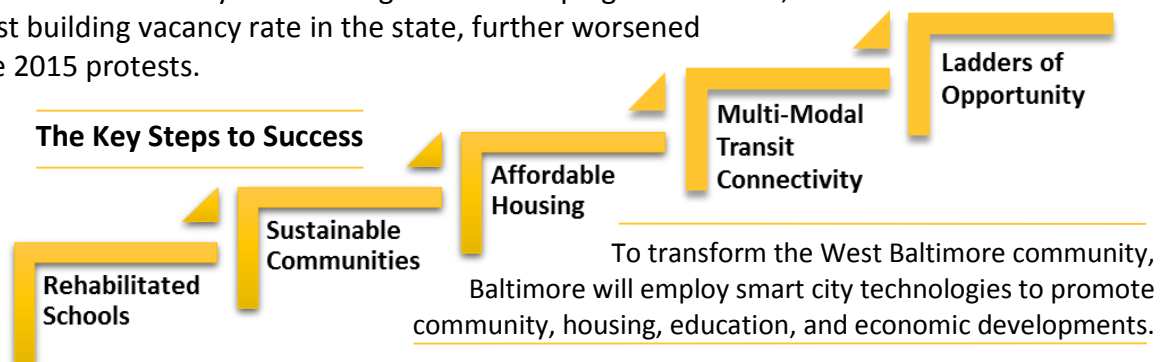




Low-Cost ICT for West Baltimore As the primary B'Smart goal is connecting low-income communities to economic opportunities, offering low-cost ICT to West Baltimore residents is a high priority. Related B'Smart technology deployment proposals include: **(1) Free public Wi-Fi access for West Baltimore residents and businesses**, based on CV-enabled vehicle mesh network technology; **(2) Free Wi-Fi and computer/smart phone user portals within proposed Smart Community Hubs**; **(3) Free public Wi-Fi hotspots on all city buses and new mobility service vehicles** in West Baltimore and at Smart Community Hubs; and **(4) Exploring partnership opportunities with foundations, communities, and Verizon to offer new or refurbished smartphones and data plans at extremely low cost in West Baltimore.**

| 4.12 Smart Land Use

As smart mobility and sharing economy technologies help connect West Baltimore to existing economic opportunities, the B'Smart land use strategies focus on attracting new business developments and new jobs to West Baltimore and on reuniting communities. Specifically, the proposed Smart Community Hubs in West Baltimore will serve as multifunctional nodes in a polycentric development strategy, supported by newly approved zoning ordinance and comprehensive plan documents in Baltimore. New developments in and around the hubs will include mixed-income housing with specific unit shares affordable to existing residents. Mixed-use zones in the area encourage the creation of small office and retail spaces, small business incubators and high-speed broad-band connectivity. Two of the proposed Smart Community Hubs are also designated Baltimore job centers, which **provide free workforce training for jobs in industries that provide ladders to opportunity.** The **introduction of low cost, safe, efficient and sustainable mobility services for passengers and freight travel**, anchored at the Smart Community Hubs and serving the entire Smart City Innovation District, should also **attract service and logistics businesses to West Baltimore.** This USDOT Grant could also leverage \$700 million of State of Maryland funding for redeveloping vacant units; West Baltimore has the highest building vacancy rate in the state, further worsened by the 2015 protests.






Innovation Village On MLK Day 2016, the Baltimore Mayor and state leaders announced the establishment of a first-ever **Innovation Village** in West Baltimore. This Smart City Innovation District, sponsored by the Mount Royal Corporation, Coppin State University, and the Maryland Institute College of Art, **features a community-driven development approach and supports an integrated plan to revitalize the West Baltimore neighborhood**, long plagued by disinvestment and blight. Transportation is key to the success of Innovation Village. Specifically, Innovation Village will focus on organizing and building "live learn work play" intersections.

5 Implementation & Partnerships

Implementation Plan The City of Baltimore plans to establish a B’Smart Governing Board (the Board) to oversee the implementation of the USDOT Smart City Challenge Grant, led by the Mayor and City Department of Transportation with representatives from USDOT, key regional, state, transit and local agencies, and selected academic, community, and non-profit organizations. The Board will institute: (1) A Program Management Committee led by the city and a general contractor, as well as members from partners subcontracted to implement vision elements; (2). A Science and Technology Committee led by the University of Maryland with members who are local and national experts on smart city technologies, and that assist the Board in designing programs and projects and evaluating performance; and (3) An Outreach Committee in charge of technology transfer activities, based on the existing Baltimore Smart City Taskforce. Conflict of interest will be carefully avoided at all stages of the decision-making process. The Board will conduct open competitions to select contractors. Cost/risk sharing and recruitment of West Baltimore residents and businesses will be contract requirements.

The preliminary plan for implementing the various Vision Elements is to employ a phased approach due to project interdependencies and risk management needs. With many proposed Vision Elements building on ongoing efforts, these shovel-ready projects will be funded in Phase 1 and should start making measurable impact by the second year of the USDOT Grant. Other lower-risk projects will be implemented in Phase 2 to allow time for local communities, citizens, and businesses to provide inputs. High-risk, high-reward projects will be implemented in Phase 3, so the City will have enough time to understand the technology risks and evaluate demos from technology providers before implementation.

Phases	Vision Element Implementation
<i>Phase One Starting in Fall 2016</i>	VE3 Intelligent Sensor-Based Infrastructure VE4: Urban Analytics VE7: Partnerships and Business Models VE9: Connected Involved Citizens VE10: Architecture and Standards 
<i>Phase Two Starting in Spring 2017</i>	VE2: Connected Vehicles VE5: Sharing Economy VE6: Urban Delivery and Logistics VE8: EV, Electrification and Smart Grid VE11: Low-cost, safe, secure & resilient ICT VE12: Smart land use 
<i>Phase Three Starting in Spring 2018</i>	VE1: Urban Automation 

Risks and Risk Management

Baltimore has carefully selected a set of lower-risk smart city technologies to achieve the B’Smart vision and goals, complemented by several high-risk, high-reward technologies on urban automation, due to their potential for significantly reducing transportation costs for West Baltimore residents and businesses (see the Table in Section 3 for technology risk details). The phased Implementation Plan helps minimize project risks too. For instance, in Phase 2, the city will deploy dynamic EV shuttle services for first/last-mile connection to Smart Community Hubs. The deployment of *automated* EV for dynamic shuttle services in Phase 3 will be contingent on the success of the Phase 2 projects. For all high-risk, high-reward projects, Baltimore will require significant cost sharing from the winning contractor. The institutional and policy risks

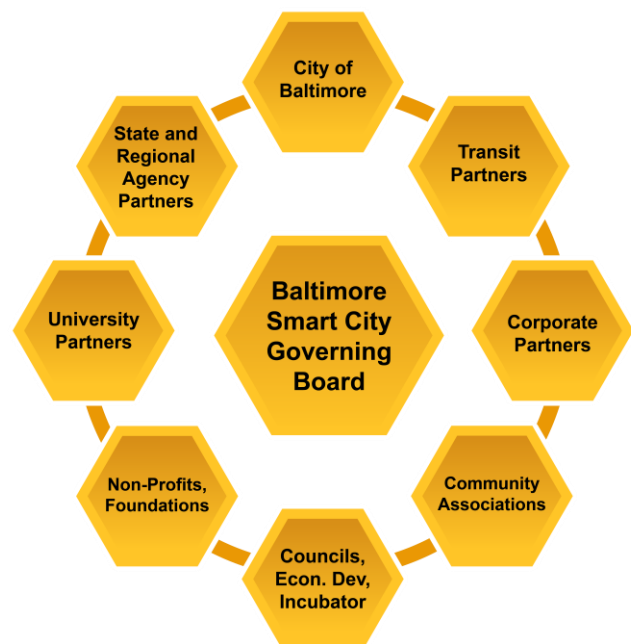
for B'Smart are typical in most cities, including the requirement of extensive agency coordination, lack of staffing expertise, possible leadership and staff changes. A Baltimore advantage stems from the proposal's focus on West Baltimore and strong commitment from all levels of city, regional, and state governments to bringing this community back to prosperity. These supports, rooted deeply in community needs and citywide consensus, will not disappear due to leadership or staffing change at one or more agencies.

Strategic Partnerships and Business Models The Baltimore Regional Plan for Sustainable Development of June 2015 recommends improving transportation access and connectivity of low-income neighborhoods to high-growth job centers, and aligning affordable housing in neighborhoods that are close to growing job centers. Building on the Plan recommendation, a unique B'Smart Public-Private-Philanthropic Partnership (P4) will be formed for long-term sustained leadership and support for smart city development in Baltimore. This partnership is broader in membership and stakeholder compositions (see graph) than the B'Smart Governing Board that is for technology implementation within the scope of this USDOT Smart City Challenge. B'Smart P4 will align the interests and opportunities of private, public, academic, not-for-profit, quasi-government and community entities specializing in transportation, research, work force development, housing, real estate, energy, utility, information and communications, and social economic equity.

The first priority of this partnership is to develop a comprehensive strategic plan for Smart Baltimore, drafted, adopted and approved by all major stakeholders in the city, region and state. Subsequently, B'Smart P4 will work through liaisons at key public-sector agencies integrating the Smart Baltimore Plan into their business plans and long-range plans. This will establish the foundation for sustained and diversified funding support for smart city technology deployment, all coordinated by the Smart Baltimore Plan vision and goals.

Part of the USDOT Grant, in collaboration with Baltimore and Maryland Small Business Development Centers, would help establish a small business and start up incubator at the West Baltimore Marc Hub, the first to be rebuilt into a Smart Community Hub. B'Smart business contracting models for technology deployment will also be explored and shared, including Design-Build-Finance-Operate-Maintain-Transfer or any of its variants, build-own-operate and lease-develop-operate.

The City of Baltimore is also pleased to work with the USDOT partners, such as **Vulcan** and **Mobileye**, to address climate change and vehicle-pedestrian-bike safety issues together.

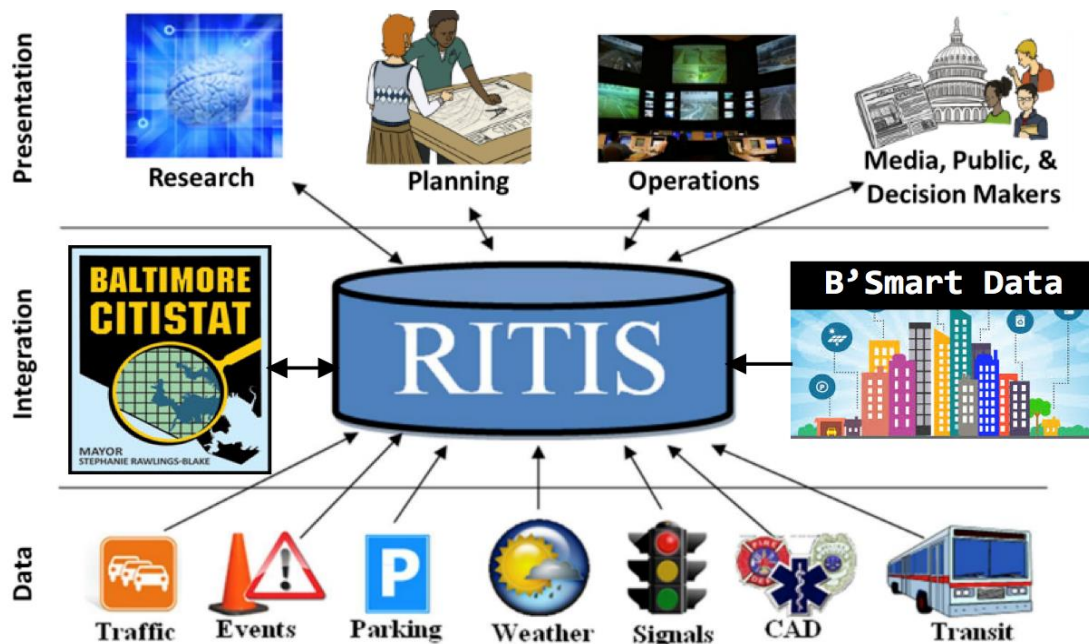


6 Data & Performance Monitoring

Data Collection & Sharing The city of Baltimore has access to a wide range of data sources that support the Smart City Challenge, including crowd sourced GPS probe data, all infrastructure sensor data, real-time bus data, urban delivery and logistics data, connected vehicles data, parking, weather, event, signal data and more. This access is through a partnership with the University of Maryland, which hosts the largest transportation data center in the U.S. and archives 6 billion data records each day. Data sharing agreements with all local, regional and state agencies, dozens of leading data providers including Google/Waze, INRIX, TomTom, HERE, and cities in over 35 states are already in place through the [RITIS](#) platform.

B'Smart RITIS Data Collection and Sharing Platform Overview

(The Regional Integrated Transportation Information System (RITIS) collects, standardizes, fuses, and visualizes various data sources and systems into a platform for use by a wide range of users and applications)



In addition, Baltimore [CitiStat](#), embedded in the Mayor’s Office, systematically collects and analyzes data in order to identify areas city-wide that are in need of improvement. New data feeds from the deployment of proposed Smart City technologies will be collected or otherwise obtained from technology partners through data sharing agreements, integrated with existing data items, and shared with the decision makers, planners, operators, researchers, media and the general public (each with their individual data portals with different data access rights). All data feeds will be subject to industry-leading privacy and security protection already established in RITIS. All B'Smart data records will be physically stored in a secure data center with limited access and cybersecurity procedures. Potentially sensitive data will be encrypted during data transfer and on storage mediums to reduce potential exposure.

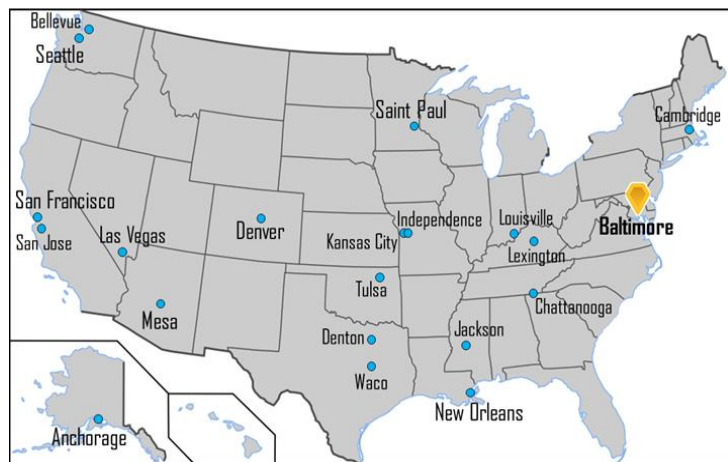
Performance Monitoring and Prediction B'Smart program performance will be measured and reported independently by the University of Maryland, which has already been responsible for producing regional transportation system performance reports for local and regional governments in Baltimore. Performance metrics including safety, mobility, sustainability, equity and job creation, will be published with live dashboards and openly shared. The existing multimodal performance-monitoring platform in Baltimore will be extended to include capabilities for measuring the impact of newly introduced smart city technologies, and for predicting/optimizing technology performance with advanced modeling and simulation tools.



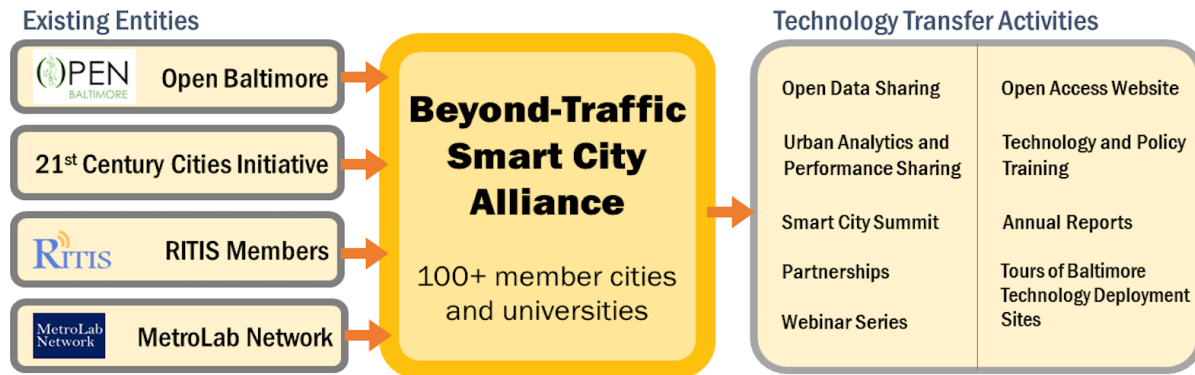
These predictive and optimizing tools are based on a state-of-the-art agent-based model system for citywide, large-scale simulation of all its population and vehicles, and are already developed for Baltimore with previous federal funding to Maryland DOT and its university partners. These next-generation urban analytics tools provide not only estimated total technology benefits, but also distributional effects by income, gender, age, location, etc. for equity analysis.

7 Technology Transfer

Baltimore benefits from several existing multi-city data sharing and best-practice sharing platforms for technology transfer (T2), wherein Baltimore or its partners play leadership roles. “Open Baltimore,” an open data platform to catalyze T2 to other cities, is on the leading edge of identifying and sharing best practices, including the development of publicly accessible resources, encouraging the use of data standards to enhance cross-city analysis and collaboration, and convening cities both in person and remotely to share success stories and challenges. The Center for Government Excellence, part of the [21st Century Cities Initiative](#) at Johns Hopkins University, is well positioned to leverage its experience working with 20 mid-sized cities (see graph; more than 50 member cities by June 2016) on performance management and open data, and to play a key role in developing a framework for disseminating best practices in Baltimore to other cities across the country. In addition, government agencies in 35 states are already members of the [RITIS](#)



platform that Baltimore will employ for B’Smart data collection and urban analytics. Lastly, Baltimore plans T2 activity in collaboration with [the MetroLab Network](#) of smart cities.



Baltimore proposes to establish and lead a **“Beyond-Traffic Smart City Alliance,”** with more than 100 members just from the above four established platforms. Key technology transfer activities by this Alliance will include open data sharing, urban analytics and performance sharing, an annual Smart City Summit including tours of deployment sites in Baltimore and other cities, a webinar series, technology and policy training for city leaders and staff, a website sharing success stories and lessons learned, and an annual report on the current state of the practice of smart city developments across the U.S., and partnership development with universities, non-profits and corporations. Baltimore will also work with its university partners to develop a series of online courses and workshops for training and knowledge dissemination.

For immediate T2, Baltimore intends to reach agreements with all partners to share B’Smart architecture and standards, as well as integrated data collection, urban analytics and decision-making platforms that other cities can utilize to deploy smart city technologies.

8 Team Qualifications

City of Baltimore Qualifications Since 2001, Baltimore has had multiple successes in promoting and deploying 21st Century, hi-tech solutions through citywide initiatives to address citizen and business needs. Examples include technology demonstration initiatives in health care, bio, and cybersecurity technology sectors, which have created vibrant new businesses and added more than 22,000 new jobs to date. Baltimore has shown its capability of effectively managing federal grants (e.g., Ladder of Opportunity, TIGER) and making measurable impact through strategic planning, partnership building and outcome-based decision-making. Baltimore meets and exceeds all USDOT requirements for the Smart City Challenge. City, regional and state leaders have reaffirmed their commitment to community revitalization in Baltimore’s most vulnerable communities, demonstrated by sizable investments in transportation, schools, infrastructure and development, including the launch of the Baltimore’s first innovation district, the [Innovation Village](#) in West Baltimore.

B'Smart Technical and Implementation Qualifications B'Smart hosts a diverse and experienced team of experts in technology and program implementation, including all key regional and state government agencies, internationally leading universities, non-profit groups and corporate partners (see tables in Section 3 and Appendix A for partner qualification summary and relevance to the proposed Vision Elements). These assets give Baltimore the confidence to start the USDOT Smart City Challenge in the communities that are facing serious challenges and have the most urgent needs; that, among other qualifications, demonstrate the city's drive to transform a USDOT investment into impact, example and success.

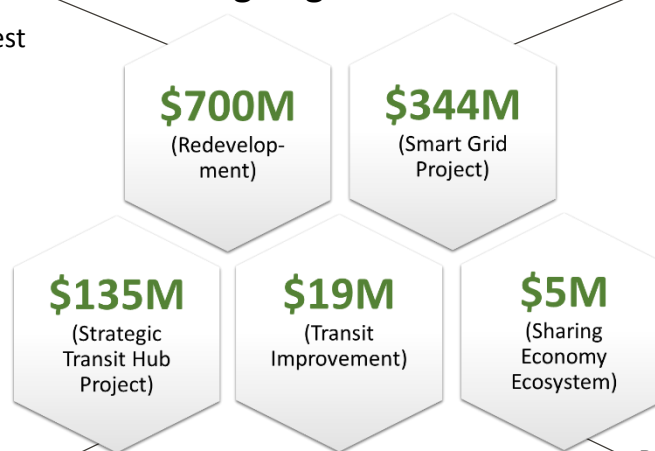
9 Cost Share & Matching Resources

Leveraging Ongoing Investments in West Baltimore: In the aftermath of the 2015 protests in West Baltimore, city, state, and community partners have committed hundreds of millions of dollars, investing in transit, schools, and economic development that will benefit this community. The USDOT grant will be able to leverage and exponentially augment the impact of these ongoing investments by introducing innovations in smart city technologies.

The State of Maryland has committed **\$700M** for redeveloping vacant units around the State (West Baltimore has the highest building vacancy rate)

Leveraging Over **\$1.2B** in Ongoing Investments

Baltimore and BG&E are on target to complete its smart grid system deployment project at a total cost of **\$344M** (after applying \$200 million in US DOE funds)



Maryland Governor Hogan announced **\$135M** to advance BaltimoreLink, a City transit improvement project (that includes the three West Baltimore Hubs in this proposal)

The combined federal, state and transit investments in the West Baltimore Marc Station area is estimated at **\$19M**

Baltimore and the University of Maryland received **\$5M** from the US DOE to develop a sharing economy ecosystem to incentive travel behaviors that minimize system-wide energy use & emissions

New Cost Share and Matching Funds: Baltimore will meet with existing and new partners at the full proposal stage of the application process and discuss cost share and matching commitments. The goal is to turn the \$50 million USDOT grant into a pool of resources several times larger for technology deployment and demonstration. Forms of cost share could include cash, in-kind, equipment/facility donation, and complementary use of software and platform.



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