4. VISION AND GOALS OF A SMART CITY

This section describes the USDOT's vision of a successful Smart City, and the specific goals that collectively describe important elements of the planned demonstration.

The USDOT recognizes that each city has unique attributes, and each city's proposed demonstration will be tailored to their vision and goals. This section serves to present the USDOT's high-level vision and goals without making each item a requirement for award. Rather, this section is designed to provide a framework for applicants to consider in the development of a city's proposed demonstration.

Specific goals of the Smart City Challenge include:

- Identify the transportation challenges and needs of the citizen and business community and demonstrate how advanced technologies can be used to address issues in safety, mobility, and climate change, now and into the future.
- Determine which technologies, strategies, applications, and institutional arrangements demonstrate the most potential to address and mitigate, if not solve, transportation challenges identified within a city.
- Support and encourage cities to take the evolutionary and revolutionary steps to integrate advanced technologies – including connected and automated vehicle technologies – into the management and operations of the city, consistent with the USDOT vision elements.
- Demonstrate, quantify, and evaluate the impact of these advanced technologies, strategies, and applications towards improved safety, efficiency, and sustainable movement of people and goods.
- Examine the technical, policy, and institutional mechanisms needed for realizing the potential of these strategies and applications – including identifying technical and policy gaps and issues – and work with partners to address them.
- Assess reproducibility and qualify successful smart city systems and services for technology and knowledge transfer to other cities facing similar challenges.

The USDOT's vision for the Smart City Challenge is to identify an urbanized area where advanced technologies are integrated into the aspects of a city and play a critical role in helping cities and their citizens address challenges in safety, mobility, sustainability, economic vitality, and address climate change. These challenges in transportation will be met by advancements in ITS, connected and automated vehicles, to name a few. Management systems within a smart city – both within transportation and across other sectors of a city – share information and data to communicate between cities and their

citizens allowing citizens to achieve benefits by maximizing efficiencies based on the intelligent management of assets and sharing information using integrated technology solutions and use of this information by the public and industry.

The USDOT's ideal Smart City would be a mid-sized city with a population between approximately 200,000 and 850,000 people within the city (Census-designated place) limits using 2010 Census data; a dense urban population; an environment conducive to demonstrating proposed strategies; an existing public transportation system; and commitment to integrating transportation services with the sharing economy. This city (Census place) would ideally include a significant share (greater than 15%) of the population of its urbanized area. The ideal site would have continuity of committed leadership, authority, and capacity to carry out the demonstration throughout the period of performance and continue operation after the period of performance is over. The proposed site – or the geographic area of the demonstration – should generally be a separate and independent city preferably with a central business district. Cities with existing, robust advanced transportation infrastructure – including ITS equipment, an existing traffic management center (TMC), and shared use transportation options (e.g., bike share and car share) – are good candidates that have the groundwork needed for proposed demonstration sites to build upon. Cities with existing commitments to managing their data as a strategic asset and making open, machine-readable data available to the public – subject to applicable privacy, security and other safeguards – are also good candidates that have the necessary policy infrastructure to fuel entrepreneurship and innovation to improve citizens' lives, create jobs, and spur economic development.

The USDOT identifies twelve vision elements that comprise a Smart City. A successful proposal would align to some or all of the USDOT's vision elements and foster integration between the elements. Through alignment with these vision elements, the Smart City Challenge is expected to improve safety, enhance mobility, and address climate change. The vision elements reflect the strategic priorities and themes put forth in the USDOT's ITS Strategic Plan 2015-2019 (http://www.its.dot.gov/strategicplan/). Vision elements were derived from foundational research conducted by the ITS JPO's

EXPECTED OUTCOMES OF THE CHALLENGE

- **Improve Safety** – By using advanced technologies, including connected vehicle technologies, to reduce the number of collisions, fatalities, and injuries.
- **Enhance Mobility** – By providing real-time traveler information and emerging mobility services to improve personal mobility for all citizens.
- **Address Climate Change** – By implementing advanced technologies and policies that support a more sustainable relationship between transportation and the environment through fuel use and emissions reductions.

Connected Cities Research Program and communicated to 570 stakeholders during a free public webinar held by the ITS JPO on February 26, 2015. The USDOT vision elements build on enablers defined by the Smart Cities Council (http://smartcitiescouncil.com/smart-cities-information-center/the-enablers). The twelve vision elements include:

TECHNOLOGY ELEMENTS

This group of three Vision Elements includes technologies that are of the highest priority by the USDOT.

Vision Element #1: Urban Automation. Automated transportation offers tremendous possibilities for enhancing safety, mobility, accessibility, equity, and the environment. The Smart City can provide national leadership through its demonstration and assessment of automated transportation applications and systems for the movement of goods and people. There are many ways to incorporate automated transportation into a Smart City. For the purpose of illustration, some examples of automated transportation in an urban environment include:

- Self-driving vehicles coupled with smart infrastructure;
- Driver-assisted automation could reduce fuel use and congestion enabling closer spacing and narrower lanes for vehicles;
- Self-driving shuttles and other forms of fully automated vehicles could operate at low speeds enabling new mobility options for services such as first/last mile travel to local destinations and access to public transportation; and
- Fully automated trucks and buses may also be used in intermodal facilities, such as ports, depots, and maintenance facilities to improve driver and vehicle efficiencies.

The aforementioned examples are not intended to express preference for the purpose of evaluating proposals. Applicants are encouraged to propose innovative automation strategies that demonstrate safety, mobility, and/or environmental benefits in an urbanized area.

Vision Element #2: Connected Vehicles. Connected vehicles use vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications to provide connectivity that will enable countless safety, mobility, and environmental applications. Connected vehicle technologies allow vehicles to send and receive information about their movements in the network – offering cities unprecedented opportunities to provide more responsive and efficient mobility solutions in real-time and in the long term. Data derived from connected vehicles provide insights to transportation operators helping to understand

demand and assist in predicting and responding to movements around a city. A successful Smart City may demonstrate safety, mobility, and/or environmental applications. These applications – which can increase efficiency and accessibility, enhance safety and reduce congestion – may provide more responsive mobility solutions in real-time. In deploying connected vehicle and infrastructure services, Smart Cities may seek to integrate a variety of commercially available communication technologies including cellular, satellite, Wi-Fi and others. At the same time, Dedicated Short Range Communication (DSRC) technology operating in the 5.9GHz range may be used to expand demonstrations of V2V and V2I applications based on DSRC[1]. For more information on the USDOT's Connected Vehicle Research Program, visit: http://www.its.dot.gov/research.htm.

Vision Element #3: Intelligent, Sensor-Based Infrastructure. Smart cities contain and use a collective intelligent infrastructure that allow sensors to collect and report real-time data to inform every day transportation-related operations and performance and trends of a city. These data allow city operators to know how the city is operating and how the operation of facilities, systems, services, and information generated for the public can be enhanced. Intelligent infrastructure includes sensors that collect traffic, pedestrian, bicyclist, environmental data, and other information available throughout the city. A successful Smart City would integrate these data with existing transportation data and operations, allowing the city to improve operations of the transportation network. Additionally, these infrastructure could be used to monitor transportation assets to improve infrastructure management, reduce maintenance costs, prioritize investment decisions, and ensure a state of good repair.

INNOVATIVE APPROACHES TO URBAN TRANSPORTATION ELEMENTS

This group of six Vision Elements includes innovative approaches to urban transportation and is categorized as a high priority by the USDOT.

Vision Element #4: Urban Analytics. This vision element includes platforms for understanding and analyzing data to address complex urban challenges (e.g., personal safety and mobility, network efficiency, and environmental sustainability) and/or measure the performance of a transportation network. In a data-rich environment, cities and citizens are increasingly able to share, use, and leverage (previously unavailable) datasets to address complex urban problems or to improve current operations or capabilities. Urban analytics create value from the data that is collected from connected vehicles, connected citizens, and sensors throughout a city or available from the

[1] Specifically, IEEE P1609, 802.11p , and, SAE J2945/1 and J2735 standards

Internet using information generated by private companies. Analytics that utilize data from across various systems in a city have tremendous potential to identify new insights and unique solutions for delivering services, thereby improving outcomes. These analytics can also be used to address complex urban challenges (e.g., personal safety and mobility, network efficiency, and environmental sustainability) and/or measure the performance of a transportation network. Analytics can be used to predict future conditions and the potential benefits of implementing different operational strategies, control plans and response plans coordinated among agencies and service providers. Furthermore, analytics can be applied across sectors to create new and different applications. One example might be an application of travel demand management that also factors in environmental and energy consumption as part of the optimization – providing more context to citizens' personalized recommendations. Additionally, data analytics can also be used to understand the potential benefits of deployed solutions. To do so, transportation-related performance measures and evaluation are needed to quantify the intended and measured impact of all proposed solutions on personal safety and mobility, network efficiency, and environmental sustainability, representing the priorities of this challenge. For example, performance measurement may indicate greater access to jobs and services; reduction in congestion and delays; increase in transit, walking, or cycling; a reduction in crashes, injuries, and or fatalities; improved incident response and clearance times; and reductions in emissions.

Vision Element #5: User-Focused Mobility Services and Choices. This vision element consists of strategies, initiatives, and services that increase transportation choices and options by supporting and improving mobility for all travelers, including aging Americans and persons with disabilities. A major component includes advanced traveler information systems that provide real-time traffic, transit, parking, and other transportation-related information to travelers. Smart cities support sustainable mobility using traveler-oriented strategies that deliver innovative solutions across all transportation modes, including transit, bicycling, electric vehicles, and shared use mobility services, to improve the mobility of all travelers, including older Americans as well as people with disabilities. Shared-use transportation has grown tremendously in recent years with the increase in smartphone applications. The sharing economy and new transportation services are providing people with more options, helping to overcome barriers to the use of non-driving forms of transportation, and shifting individuals' travel choices. Advanced technology and services deployed throughout a city will allow people to adopt "car-free" and "car-light" lifestyles with dramatically less driving. For people to be willing to share assets there must be a seamless, low-friction way to do so. Mobility on Demand (MOD) is an emerging concept built on shared use approaches and a shift in mass transit. It augments public transportation and supports the efficient movement of people. Open data and technology enable the efficient

coordination, use, and management of all mobility services in the system. From the user's perspective, travel choices are simplified through open data and communications technology that provides personalized information – including traveler information, travel options, and integrated mobile payment – directly to the user. In smart cities, the integration of new technologies into the transportation system facilitates a dynamic supply of mobility services and operations by leveraging emerging mobility services, integrated transit networks and operations, real-time data, connected travelers, and cooperative ITS. The result is a more traveler-centric, transportation system-of-systems approach, providing improved mobility options to all travelers and users of the system.

Vision Element #6: Urban Delivery and Logistics. This vision element includes innovative solutions supporting efficient goods movement in ways that use data or deploy technology to create opportunities for a more efficient supply chain approach that delivers safer logistics management, improved on-time pickups and delivery, improved travel time reliability, reduced fuel consumption, and reduced labor and vehicle maintenance costs. As populations increase and urbanization continues, cities will need to identify innovative ways to effectively and efficiently move goods – including food, energy, and manufactured goods – into cities. Cities will need to investigate how innovative technology solutions may support more efficient urban goods movement. The Smart City may consider improving urban goods movements by including freight-specific information exchanges that enable dynamic travel planning to improve freight movement efficiency, including load matching and drayage operations. Additional strategies may leverage urban delivery hubs that use connected urban delivery vehicles and flexible (shared use) commercial delivery solutions. The aforementioned examples are for illustration purposes and are not intended to express preference for the purpose of evaluating proposals. Applicants are encouraged to propose innovative urban delivery strategies that demonstrate safety, mobility, and/or environmental benefits in an urbanized area.

Vision Element #7: Strategic Business Models and Partnering Opportunities. Opportunities exist to leveraging creative strategic partnerships that draw in stakeholders – including private sector, non-profit, foundation/philanthropic, academia/University Transportation Center (UTC), and other public agencies – to advance smart city solutions. The private sector is pushing innovation, especially by creating new opportunities to partner with government. The public sector is also pushing innovation, creating new opportunities/models for governance and interagency partnerships. Successful implementation of a Smart City will likely rely on strategic partnering opportunities between public agencies and the private sector – especially for cities that have limited resources to bring to bear on the challenges they face. Innovative partnerships among city or local government, planning organizations, the

private sector, vehicle manufacturers, academia, associations, and other stakeholder groups are needed to advance smart city solutions. Through cooperation, city governments may partner with non-governmental organizations that can bring resources to the city. Applicants are encouraged to use innovation to leverage Federal resources through cost share, in-kind donations, and partnering. The USDOT encourages Applicants to make robust use of partnerships, including partnerships that significantly leverage Federal resources, work already underway, and the technical capabilities of universities and other stakeholders who provide services to public agencies. In particular, cities are encouraged to partner with a University Transportation Center (UTC) or member of a UTC consortium to leverage product and service development assets and develop the workforce (http://www.rita.dot.gov/utc/).

Vision Element #8: Smart Grid, Roadway Electrification, and Electric Vehicles. This vision element includes strategies and initiatives that leverage the smart grid – a programmable and efficient energy transmission and distribution system – in an effort to support the adoption or expansion of roadway electrification, and electric vehicle deployment. As electric vehicles become more prevalent, opportunities exist for the vehicle to interact with the smart grid. Opportunities also exist for the integration of intelligent transportation systems with the smart grid and other energy distribution and charging systems. For example, smart-grid technology can enable electric vehicle-charging [grid-to-vehicle (G2V)] load to be shifted to off-peak periods, thereby flattening the daily load curve and significantly reducing both generation and network investment needs. Likewise, wireless inductive charging technologies provide opportunities to address range anxiety concerns associated with electric vehicles, allowing electric vehicles to charge their batteries wirelessly while the vehicle is stopped or in motion.

Vision Element #9: Connected, Involved Citizens. Connected citizens generate, share, and use data and information in new and useful ways. This vision element consists of strategies, local campaigns, and processes to proactively engage and inform citizens at the individual level by deploying hardware, software, and open data platforms in an effort to increase personal mobility. Advanced technologies would be used to enhance overall mobility for all citizens including people with disabilities, older adults, and young Millennials who will act as an important engine of the future economy. One example of connected, involved citizens is leveraging the use of crowdsourcing. Crowdsourced data provides communication conduits through mobile technologies to connect citizens with city operators about a myriad of topics. In a successful Smart City, citizens would provide user-generated content to cities. Another example of connected, involved citizens includes leveraging broad access to open government data providing a platform for citizens to serve as co-creators and co-producers of new and innovative transportation services.

SMART CITY ELEMENTS

This group of Vision Elements includes three smart city elements and is categorized as a priority by the USDOT.

Vision Element #10: Architecture and Standards. This vision element emphasizes architectures – governed by rules, documentation, and standards – that may be extended to a nationwide or broader deployment. Because vehicles and travelers move broadly across regions, uniform operation that is accessible to everyone is essential for safe and efficient transportation operations. Interoperable regional ITS architectures that can be extended to a nationwide or broader deployment based on accessible, well-defined standards is needed for consistent implementations that will lead to the required uniformly accessible operation. The National ITS Architecture is a mature architecture that provides a common framework for the ITS community to plan, define, and integrate ITS solutions. The Connected Vehicle Reference Implementation (CVRIA) was developed to extend the National Architecture to include detailed information to support development of fully interoperable regional connected vehicle architectures. The CVRIA and the associated SET-IT software tool will be fully integrated into the National ITS Architecture and software toolset to support development of interoperable regional architectures including complete ITS infrastructure and connected vehicle capabilities along with interface information needed for standards selection. The USDOT envisions that the Smart City stakeholders will use the CVRIA, the National ITS Architecture, and published and under-development ITS standards to demonstrate interoperable ITS capabilities which are nationally extensible.

To the extent viable, the USDOT envisions the Smart City will define and demonstrate integration of ITS systems with other systems which comprise a smart city. As part of this effort, the nature of required interfaces to other systems should be defined to utilize existing networking or other standards when available. Where new standards are needed, these needs should be fully documented. Further, to the extent viable, these interfaces should be documented using the CVRIA system architecture tools and feedback should be provided to the USDOT to facilitate expansion of CVRIA to accommodate these additional interfaces. To support nationwide deployment of ITS infrastructure and connected vehicle technologies, the demonstration site should use existing ITS standards, architectures, and certification processes for ITS and connected vehicle based technologies whenever viable, and document those cases where such use is not viable. To provide information required to refine ITS architecture and standards in support of nationwide deployment, the demonstration site should also

document their experiences and cooperate with architecture and standards developers to improve the quality of these products based on lessons learned in deployment.

Vision Element #11: Low-Cost, Efficient, Secure, and Resilient Information and Communications Technology (ICT). This vision element includes strategies and practices that advance information and communications technology (ICT) that is affordable, adaptable, efficient, secure and resilient, including integrated telecommunications platforms, enterprise software, storage, and visualization systems. This will include ICT that contributes to one common operating platform to inform city government decision-making. ICT infrastructure, technologies, and services are a critical part of a Smart City. ICT consists of unified communications and the integration of telecommunications, computers as well as necessary enterprise software, storage, and visualization systems, which enable users to access, store, transmit, and manipulate information. The success of a Smart City depends upon affordable ICT, from both a public, and personal perspective. The ICT in a Smart City, including telecommunications and computing, needs to be resilient, secure and respectful of privacy. Resilient design includes supporting standards common technology architectures and integrative policies. If one part of the system fails or is compromised, the entire system should not collapse, and the gap in service should be bridged effectively and restored quickly.

Privacy and security play a critical role in enabling smart cities because they build trust with people. Privacy and security constitute practices that safeguard data, privacy, and physical assets. Private information relates to any data emitted, collected, or stored about individuals. A key concept in privacy analysis is Personal Identifiable Information (PII). PII is any information that can be used to distinguish or trace an individual's identity. PII is not specific to any category of information or technology; each case and associated risks must be individually examined for context and the combination of data elements that are provided or obtainable. The Smart City needs to determine the extent to which their system or systems will collect or store PII and PII-related information, and ensure that there is a legitimate need for this information to meet the goals of the system and that the data is only accessible for and used for these legitimate purposes.

To support the overall security and privacy of participants in this Challenge, the USDOT is developing a prototype security credential management system (SCMS) which will be available for use in DSRC-based communications. The SCMS will provide digitally signed certificates that can be used to ensure trusted DSRC communications between connected vehicle devices, roadside devices and the SCMS. The USDOT will provide technical support for interfacing with the prototype SCMS, as well as tools intended to support the Smart City.

Physical security of the deployed devices and security for non-DSRC communications are not covered by the SCMS and should be addressed through other means in the demonstration. Rigorous, proven processes are needed to ensure that security mechanisms are embedded in systems and infrastructure to protect against attacks. Secure solutions must be integrated into architecture designs and security risks must be continually managed. Challenge sites are expected to use industry best practices as they relate to objects and interfaces used in their installations.

Vision Element #12: Smart Land Use. This vision element includes strategies and practices that ensure land use is optimized through a combination of planning and innovation deployments, altogether designed to lead to a better connected community that expands the range of transportation choices and access to employment, housing, education and health services. A successful Smart City ensures that land use is efficiently optimized. Urban land use concentrates growth in compact walkable urban centers to avoid sprawl. It also advocates compact, transit-oriented, walkable, bicycle-friendly land use, including neighborhood schools, complete streets, and mixed-use development with a range of housing choices. Smart land use values long-range, regional considerations of sustainability with the goals of achieving a unique sense of community and place; expanding the range of transportation, employment, and housing choices; equitably distributing the costs and benefits of development; preserving and enhancing natural and cultural resources; and promoting public health.

The following table summarizes and provides priority levels for each of the twelve Vision Elements.

Vision Element	Priority
Technology Elements	
Vision Element #1: Urban Automation	Highest Priority
Vision Element #2: Connected Vehicles	Highest Priority
Vision Element #3: Intelligent, Sensor-Based Infrastructure	Highest Priority
Innovative Approaches to Urban Transportation Elements	
Vision Element #4: Urban Analytics	High Priority
Vision Element #5: User-Focused Mobility Services and Choices	High Priority
Vision Element #6: Urban Delivery and Logistics	High Priority
Vision Element #7: Strategic Business Models and Partnering Opportunities	High Priority
Vision Element #8: Smart Grid, Roadway Electrification, and Electric Vehicles	High Priority
Vision Element #9: Connected, Involved Citizens	High Priority
Smart City Elements	
Vision Element #10: Architecture and Standards	Priority
Vision Element #11: Low-Cost, Efficient, Secure, and Resilient Information and Communications Technology	Priority
Vision Element #12: Smart Land Use	Priority

The USDOT is encouraging Applicants to consider these twelve elements in developing ideas for developing their city's vision for a Smart City. The city's vision should address real-world issues and challenges citizens and cities are facing. Specifically, Applicants should consider how emerging transportation data, technologies, and applications can be integrated with existing systems across a city, helping both cities, citizens, and businesses achieve goals for safety, mobility, sustainability, and economic vitality in an increasingly complex, interdependent and multimodal world.