U.S. Department of Transportation

Cooperative Agreement Award Number DTFH6116H00013

Title: "Smart City Challenge Demonstration"
(Phase 2 Award)

Signatures	
City of Columbus	U.S. Department of Transportation Federal Highway Administration
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Date: 8-30-16	Date: 8/30/16

Award Information

Award Information

Award No.:		DTFH6116H00013
Effective Date:		August 30, 2016
Awarded to:		City of Columbus 90 West Broad Street Columbus, Ohio 43215-9004 DUNS No: 609679548 TIN No.: 316400223
Sponsoring Office/ Federal Agency Name:		U.S. Department of Transportation (USDOT) Federal Highway Administration (FHWA) Office of Acquisition and Grants Management 1200 New Jersey Avenue, SE Mail Drop: E62-204 Washington DC 20590 Attn: Sarah Tarpgaard, HCFA-32
Total Amount:		Federal Share: $40,000,000 Recipient Cost Share: $19,000,000 Total Value: $59,000,000* *See also Leveraged Partner Resources clause, Section B
Catalog of Federal Domestic Assistance (CFDA) Number:		20.200 Highway Research & Development
Period of Performance		Four Years
Type of Award:		Cooperative Agreement (Cost Reimbursement, Cost-Sharing)
Authority:		23 U.S.C. §516(a)
Procurement Request (PR):		# HOIT212116168
Funds Obligated at Award:		$15,000,000
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TABLE OF CONTENTS

ATTACHMENTS

SECTION A – PROGRAM DESCRIPTION

1. STATEMENT OF PURPOSE

The purpose of the Smart City Challenge is to demonstrate and evaluate a holistic, integrated approach to improving surface transportation performance within a city and integrating this approach with other smart city domains such as public safety, public services, and energy. The United States Department of Transportation (USDOT) intends for this challenge to address how emerging transportation data, technologies, and applications can not only be integrated with existing systems in a city to address transportation challenges, but used to spur reinvestment in underserved communities. The Recipient shall carry out the Smart City Challenge to effectively test, evaluate, and demonstrate the significant benefits of smart city concepts.

The Recipient shall demonstrate how advanced data and intelligent transportation systems (ITS) technologies and applications can be used to reduce congestion, keep travelers safe, use energy more efficiently, respond to climate change, both connect and create opportunities for underserved communities, and support economic vitality.

The Smart City Demonstration is expected to provide safety improvements, enhance mobility, increase ladders of opportunity by incentivizing reinvestment in underserved communities, reduce energy usage, and address climate change.

2. LEGISLATIVE AUTHORITY

Specific statutory authority for conducting this effort is found in the Intelligent Transportation Systems Research Program in 23 U.S.C. §516(a), which authorizes the Secretary of Transportation to "…carry out a comprehensive program of intelligent transportation system research and development, and operational tests of intelligent vehicles, intelligent infrastructure systems, and other similar activities."

Funding is authorized under Section 6002(a) of Public Law 114-94, the Fixing America's Surface Transportation Act (FAST Act).

The authority to enter into a cooperative agreement for this effort is found under 23 U.S.C. § 502 - Surface Transportation Research, Development, and Technology, paragraph (b), which states:

(3) cooperation, grants, and contracts. — The Secretary may carry out research, development, and technology transfer activities related to transportation—
(A) independently;
(B) in cooperation with other Federal departments, agencies, and instrumentalities and Federal laboratories; or
(C) by making grants to, or entering into contracts and cooperative agreements with one or more of the following: the National Academy of Sciences, the American Association of State Highway and Transportation Officials, any Federal laboratory, Federal agency, State agency, authority, association, institution, for-profit or nonprofit corporation, organization, foreign country, or any other person.

3. BACKGROUND

In February of 2015, the USDOT released "*Beyond Traffic: Trends and Choices 2045."* Beyond Traffic examines the long-term and emerging trends affecting our Nation's transportation system and the implications of those trends. It describes how demographic and economic trends, as well as changes in technology, governance, and our climate are affecting how people and goods travel today, and how they could affect travel in the future. It outlines choices that will require cities to think differently about how we move, how we move things, how we move better, how we adapt, and how we align decisions and dollars.

Smart cities are emerging as a concept that can be used to address these issues starting today. The trends identified in *Beyond Traffic 2045* have major implications for cities. Cities deliver many benefits – greater employment opportunities, greater access to healthcare and education, and greater access to entertainment, culture and the arts. People are moving to cities at an unprecedented rate. Our population is expected to grow by 70 million over the next 30 years, and most of this population growth will be concentrated in metropolitan areas or cities. Growing urbanization will continue to put significant strain on city infrastructure and transportation networks.

Transportation is critical to making a city work. Transportation is deeply connected to economic opportunity providing Americans with connections to employment, education, healthcare, and other essential services. Many cities see advantages in urbanization, but these cities are also saddled with concentrated growth, shrinking revenues, and increased transportation demand. Inefficiencies in our transportation system cost Americans, on average, each over 40 hours stuck in traffic each year – an annual financial cost of $121 billion. At the same time, Americans spend more on transportation than they do on food, healthcare, and clothing. Low-income Americans spend nearly a

quarter of their annual income on transportation while high-income American spend about one-tenth on transportation. Finally, research indicates that cities account for 67% of all greenhouse gases (GHGs) released into the atmosphere. The transportation sector is the second-biggest source of GHGs, responsible for 28% of U.S. emissions.

To overcome these challenges, cities must find ways to foster the emergence of technologies that have the potential to transform transportation. A number of trends in technology are taking place. Improvements to how we collect and analyze data, how communications and mobile platforms evolve, how rapidly connected and automated vehicle technologies emerge, and how soon all modes of transportation transition to using clean forms of energy hold the promise of making our future transportation system safer, more accessible and efficient, and more environmentally sustainable.

With Intelligent Transportation Systems (ITS) laying the groundwork for innovative transportation solutions, many cities are currently serving as laboratories for new types of transportation services and cleaner transportation options leveraging those solutions. Smart cities are emerging as a next-generation approach for city management by taking steps forward along the transportation technology continuum. Integrating ITS, connected vehicle technologies, automated vehicles, electric vehicles, and other advanced technologies – along with new mobility

EXPECTED OUTCOMES OF THE SMART CITY CHALLENGE

- **Improve Safety** – By using advanced technologies, including connected vehicle technologies, to reduce the number of collisions, fatalities, and injuries for both vehicle occupants and non-vehicle occupants.
- **Enhance Mobility** – By providing real-time traveler information and emerging mobility services to improve personal mobility for all citizens including people with lower incomes, people with disabilities, and older adults.
- **Enhance Ladders of Opportunity** –By providing access to advanced technology and its benefits for underserved areas and residents, increasing connectivity to employment, education and other services, and contributing to revitalization by incentivize reinvestment in underserved communities.
- **Address Climate Change** – By implementing advanced technologies and policies that support a more sustainable and cost-effective relationship between transportation and the environment through more efficient fuel use and emissions reductions.

concepts that leverage the sharing economy – within the context of a city will provide enhanced travel experiences and makes moving people and goods safer, more efficient, and more secure. By enhancing the effective management and operation of the transportation system, smart city solutions can leverage existing infrastructure investments, enhance mobility, sustainability, and livability for citizens and businesses, and greatly increase the attractiveness and competitiveness of cities and regions.

4. VISION AND GOALS OF THE SMART CITY DEMONSTRATION

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

To show what is possible when communities use technology to connect transportation assets into an interactive network, the USDOT's Smart City Challenge concentrates federal resources into one city, selected through a nationwide competition. The Smart City Challenge seeks to demonstrate and evaluate a holistic, integrated approach to improving surface transportation performance within a city and integrating this approach with other smart city domains such as public safety, public services, and energy. The USDOT intends for this challenge to address how emerging transportation and other data, technologies, applications, and clean energy can be integrated with existing and new systems in a city to address transportation challenges.

This section presents the USDOT's high-level vision and goals without making each item an award requirement. Rather, this section provides a framework for the Recipient to consider in conducting the demonstration.

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 the challenges in safety, mobility, access to opportunity, sustainability, clean energy, economic vitality, and climate change. Advancements in ITS, connected vehicles, automated vehicles, electric vehicles, and other advanced technology will be a critical part of meeting these transportation challenges, as will the merging Internet of Things (IoT) which offers data from various sectors (e.g., energy and weather) and sources (e.g., the private sector and connected citizens). A smart city uses these data to maximize efficiencies within their management systems while enabling an open, growing ecosystem of third party services that provide additional benefits to citizens.

The Smart City Demonstration shall seek to improve access to reliable, clean, safe, and affordable transportation for a wider spectrum of its underserved communities. The Smart City Demonstration shall develop novel ways to reform the digital divide and use smart technologies and concepts to strengthen connections to jobs, remove physical barriers to access, and strengthen communities through neighborhood redevelopment. The Smart City Demonstration shall sequence deployment of these technologies and innovations so they benefit underserved communities early in the process. The Smart City Challenge identifies these concepts as Ladders of Opportunities. Ladders of Opportunity projects may increase connectivity to employment, education, services and other opportunities, increase access to digital resources, broaden the availability of affordable clean transportation options, support workforce development, or contribute to community revitalization, particularly for underserved areas.

The Smart City Demonstration shall seek to improve safety, enhance mobility, enhance ladders of opportunity, accelerate the transportation to clean transportation, and address climate change. Specific goals of the Smart City Demonstration 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, access to opportunity, energy efficiency, 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 vehicles, automated vehicles, and electric vehicles – into the management and operations of the city, consistent with the USDOT vision elements (see Attachment 1).
- 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 of interoperable solutions and qualify successful smart city systems and services for technology and knowledge transfer to other cities facing similar challenges. Follow systems engineering best practices and utilize

available architectures and standards to develop interoperable, reproducible systems with national extensibility, including the use of open source technologies.

- Work with Federal partners and programs focused on providing technical and financial resources for optimizing the usage of advanced and affordable clean transportation options.
- Collaborate with regional agencies on the best use of a city's Federal transportation assets and Federal workforce to accelerate the deployment of clean transportation and connected and automated vehicle technologies.

The Smart City Demonstration shall include a commitment to integrating with the sharing economy; and a clear commitment to making open, machine-readable real-time and archived data accessible, discoverable and usable by the public to fuel entrepreneurship and innovation.

The USDOT identified twelve vision elements that comprise a Smart City. The Smart City Demonstration shall 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 Demonstration is expected to improve safety, enhance mobility, enhance ladders of opportunity, accelerate the transition to clean transportation, and address climate change. See Attachment 1, Smart City Vision Elements.

5. STATEMENT OF WORK

The Recipient shall conduct the Smart City Demonstration in accordance with the approved Technical and Budget Applications, incorporated herein as Attachments 2 and 3, subject to the terms of the award.

The Recipient shall perform and provide the following tasks (Tasks A – J, below) and deliverables needed to demonstrate, quantify, and evaluate the impact of advanced technologies, strategies, and applications towards improved safety, efficiency, ladders of opportunity, and sustainable movement of people and goods. The following tasks and deliverables are also needed to foster transferability/reproducibility to support technology and knowledge transfer to other cities facing similar challenges.

TASKS:

TASK A: PROGRAM MANAGEMENT

TASK B: SYSTEMS ENGINEERING APPROACH

TASK C: PERFORMANCE MEASUREMENT

TASK D: DATA PRIVACY REQUIREMENTS

TASK E: DATA MANAGEMENT AND SUPPORT FOR INDEPENDENT EVALUATION

TASK F: SAFETY MANAGEMENT AND SAFETY ASSURANCE

TASK G: COMMUNICATIONS AND OUTREACH

TASK H: INTERNATIONAL COLLABORATION

TASK I: PARTICIPATION IN RELEVANT ITS ARCHITECTURE AND STANDARDS DEVELOPMENT EFFORTS

TASK J: INTERIM AND FINAL REPORTING

Delineation of Tasks and Deliverables

TASK A: PROGRAM MANAGEMENT

Implementation of a Smart City Demonstration will require a disciplined approach to manage the execution of the work and make sure the team responsible for implementing the Smart City Demonstration delivers the highest quality products on time and within budget. Common processes and procedures should be used to ensure quality, timeliness, and cost control. Effective program management should consider:

- **Scope Management.** This includes ensuring that all required activities are performed. The Recipient should have mechanisms in place for verifying and controlling the overall scope of the Smart City Demonstration.
- **Schedule Management.** This includes managing the timely execution of work activities. A Project Schedule should list all activities required to bring all required work to a successful completion. Successful schedule management should identify how the team will monitor the project schedule and manage changes after a baseline schedule has been approved. Schedule management includes

identifying, analyzing, documenting, prioritizing, approving or rejecting, and publishing all schedule-related changes.

- **Communications Management.** This includes the systematic planning, implementing, monitoring, and revision of all the channels of communication within the project partners and with other stakeholders. For the purposes of the Smart City Challenge, a *partner* refers to an organization or individual on the Smart City Team. A *stakeholder* refers to an organization or individual potentially impacted by the Smart City demonstration itself, regardless of whether they are team members (partners) or not. Communications management ensures effective internal team communications and governance methods, as well as communications with the USDOT's Agreement Officer Representative (AOR).
- **Cost Management.** This includes the process of planning and controlling the budget for the Smart City Demonstration. Effective cost management should ensure that any issues with funding surface quickly, before cost overruns can occur.
- **Quality Management.** This includes effectively managing the quality of the products produced, from planning to delivery. Quality management includes procedures to be followed to implement a quality program and provide the USDOT with visibility into product quality (e.g., process and product evaluations, record keeping, nonconformance tracking, and reporting channels). Quality management addresses both Quality Control (QC) and Quality Assurance (QA) processes. QC is defined as the monitoring and controlling actions required during a project to ensure that a product – or performed service – adheres to a defined set of quality criteria. QA ensures that the appropriate quality planning and QC mechanisms are defined and utilized to prevent mistakes or defects.
- **Configuration Management.** This includes managing how items to be placed under configuration control are identified, when they are identified, and when they are placed into a configuration control process or system. Configuration management may include establishing a Configuration Control Board (CCB) and include procedures for handling proposed changes to items under configuration control, and the role of the USDOT in configuration control.
- **Risk Management.** This includes identifying, prioritizing, and managing program risks in a timely and efficient manner. Risks that may impact the schedule, scope, or costs of activities performed under the program should be identified, documented, and tracked. Plans for mitigating risks should be identified and implemented.

Shortly after award, representatives from the Recipient's Smart City Demonstration team shall attend a kick-off meeting to be held in Washington, DC, or the Recipient's location, with the AOR and its representatives to ensure that all parties have a common understanding of the AOR's requirements and expectations. The Recipient shall bring its key personnel to this meeting and the host (either USDOT or the Recipient) shall arrange the location, the agenda, and the list of other attendees. This kickoff meeting shall occur no later than four weeks after award of the Cooperative Agreement.

The Recipient shall prepare a Program Management Plan (PMP) that describes the activities required to perform the work, per current PMBOK guidance[1]. The PMP shall explain the roles and responsibilities of all key individuals within the program/project team. At a minimum, the PMP shall contain a Scope Management Plan, a Schedule Management Plan, a Communications Management Plan, a Cost Management Plan, a Quality Management Plan, Configuration Management Plan, and a Risk Management Plan.

The PMP shall be accompanied by a detailed Smart City Demonstration Project Schedule, considered to be a logical component of the PMP, although it may be a physically separate electronic file. The Project Schedule shall list all activities required to bring all required work to a successful completion and shall contain – at a minimum – three levels of the Work Breakdown Structure (WBS). The Project Schedule shall be updated monthly. The Project Schedule shall describe the following:

- Name of the work activity;
- Expected start and end dates;
- Name of the individual with the primary responsibility for accomplishing the work;
- Dependencies with other work activities in the Project Schedule; and
- All deliverables, procurements, or milestones resulting from the work activity.

The PMP shall be delivered in draft to the Agreement Officer's Representative (AOR). The AOR will provide the Recipient review comments on the draft PMP, estimated to be provided within two weeks after receipt of the draft PMP. After receiving the AOR's comments and resolving them, the Recipient shall provide the "final" version of the PMP and its related documents. During the course of the Smart City Demonstration, the

[1] PMI (2012), A Guide to the Project Management Body of Knowledge, 5th Ed.

Recipient may propose modifications to the PMP. Any such modifications shall go through the cycle of draft submission, AOR review and comment, comment resolution, and submission of a "final" version.

The Recipient shall document the status of developing and implementing agreements, contracts, and subcontracts among partner organizations in a Partnership Status Summary. This includes all agreements associated with the planning, development or implementation of the main elements of the ConOps, performance measures and targets, operational changes associated with the Smart City Demonstration, governance framework and processes, and financial agreements. This agreement shall also include a vision of how these arrangements are expected to be altered or adapted in the post-grant period to ensure a transition to permanent operational practice. The Recipient shall deliver a draft version of the Partnership Status Summary to the AOR for review in accordance with the project master schedule. The Recipient shall prepare a revised document in response to AOR comments. The AOR must accept and approve all comment resolutions before the revised document is considered final or return for re-revision with comments.

The USDOT requires the Recipient to provide Quarterly Progress Reports and Quarterly Progress Briefings. See Section C.3. Reporting, for format and due dates.

<u>Quarterly Progress Reports and shall include:</u>

- A narrative of accomplishments by task and projected activities in the next quarterly period.
- All list of all deliverables and deliverable status (not initiated, in progress X% complete, draft delivered, in revision X% complete, final delivered, accepted).
- Identification of any problems, planned solutions, and/or requests for USDOT assistance.
- An updated project schedule with a schedule risk narrative, a technical risk narrative, a partnership risk narrative.
- A summary of costs incurred for the reporting period and to date to include Federal share, Cost share, and total.
- A comparison of costs incurred to the budgeted costs for the reporting period and to date to include Federal share, Cost share, and total.
- Projected cost-to-complete.
- A summary of communication and outreach efforts.

- Subcontractor Status Summary: A summary of Subcontractor Coordination and Management activities to include as applicable:
    - Status of key procurements if available (do not provide procurement sensitive information but rather only general status information).
    - Status of key subcontract awards.
- Leveraged Partner Resources Status Summary: A summary of activities related to Leveraged Partner Resources, to include the following items as applicable.
    - Progress, achievements, deliverables/milestones, problems, risks.
    - Status of developing and implementing Partnership agreements.
    - Changes to partnership agreements, arrangements or plans.

For Quarterly Progress Briefings, the Recipient shall present the information contained in Quarterly Progress Reports. Briefings shall be conducted in person to the extent possible, alternating quarters between the Smart City Demonstration site and at the USDOT headquarters in Washington, DC, or as otherwise mutually agreeable to the parties.

Required Deliverables

- Kick-off Meeting
- Project Management Plan (PMP)
- Project Schedule and Monthly Project Schedule Updates
- Partnership/Stakeholder Status Summary (Draft and Final)
- Quarterly Progress Reports and Briefings

TASK B: SYSTEMS ENGINEERING APPROACH

Effective development and implementation of the technical and institutional solutions to enable an efficient, interoperable, and replicable smart city demonstration requires rigorous application of established systems engineering best practices. To reduce the risk of schedule and cost overruns and increase the likelihood that the demonstration will meet users' needs, the Recipient shall provide evidence of following a systems engineering process when implementing its vision. Benefits of following such -an approach include improved stakeholder participation; more adaptable, resilient systems; verified functionality and fewer defects; higher level of reuse from one project to the next; and better documentation.

The International Council of Systems Engineering (INCOSE) defines *Systems Engineering* as:

> *"An interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem.*
>
> *Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation. Systems Engineering considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs."*

The USDOT recognizes the benefits of following a systems engineering approach and supports innovative approaches that a Recipient may follow that are tailored to fit the needs of their demonstration. The USDOT also recognizes that components of the Smart City Demonstration may be digital in nature and may use other incremental and iterative development concepts, such as agile software development, to deliver applications. These modern systems engineering techniques represent practical approaches that allow for system developers to provide an initial capability followed by successive deliveries to reach the desired final product. Iterative development considers adaptive planning, evolutionary development, early delivery, continuous improvement, and encourages rapid and flexible response to change. This incremental, fast-paced style of development may help keep the solution open and flexible to accept new features and technologies. These techniques can be used to reduce the risk of failure and enable the ability to test and deploy so that features may be added often and put into production easily. By addressing the whole experience from start to finish (e.g., actions taken on-line, through mobile applications, and off-line touch point) system developers are able to identify pain points and prioritizes activities according to public needs. Incremental and iterative development emphasizes velocity and adaptability throughout the entire lifecycle.

To document how the Recipient plans to follow a systems engineering approach, a Systems Engineering Management Plan (SEMP) shall be developed. The SEMP shall describe what systems engineering process the Recipient plans to follow during the execution of the project's work and how the Recipient plans to manage the specific systems engineering activities that will be performed during the project.

Systems engineering deliverables to support the smart city demonstration include:

- **Concept of Operations (ConOps).** A Concept of Operations (ConOps) serves as the foundation document that frames the overall smart city system and sets the technical course for a project. Its purpose is to clearly convey a high-level view of the system to be developed. A Smart City Demonstration ConOps should describe the city's holistic, integrated solution to be deployed for the Smart City Demonstration, and how operational practice should be altered based on the introduction of new applications. Among other elements, the ConOps should include a set of proposed high-priority "needs" through structured stakeholder interaction, a context diagram, discussion of enhancements to operational practices, and use cases or scenarios. The ConOps shall explicitly describe how the Recipient plans to interface with all proposed partners including current and anticipated USDOT partners Paul Allen's Vulcan, Inc., Mobileye, Autodesk, Amazon Web Services, NXP, Alphabet's Sidewalk Labs, and others. IEEE Standard 1362-1998 includes guidelines for format and content to support development of a ConOps.
- **Demonstration Site Map and Installation Schedule.** The Demonstration Site Map should identify the specific geographic area and indicate locations related to key issues, current and proposed roadside technology locations, connected automated vehicle operations, and other explanatory features to support strategies that align with the city's proposed strategies. During the course of the effort, the Demonstration Site Map should be updated to reflect any changes decided during the demonstration effort. In addition, the Recipient Project Team should create a Site Installation Schedule that identifies infrastructure installation activities. For each type of infrastructure element to be installed, this schedule shall indicate:
    - The type of infrastructure element to be installed;
    - Planned installation start and end dates for each infrastructure element;
    - Organization or individual responsible for the installation;
    - Milestone(s) identifying when the installation of each type of infrastructure element is completed; and
    - Planned start and end dates for unit testing the operation of each infrastructure element (by type).

- **Systems Requirements Specification (SyRS).** System requirements define *what* the system will do but not *how* the system will do it. Working closely with stakeholders, requirements should be elicited, analyzed, validated, documented, and baselined. IEEE Standard 1233-1998 includes guidelines for format and content to develop a System Requirements Specification (SyRS). Requirements should include:
    - Functional Requirements. Including communications, security, and safety requirements.
    - Interface Requirements. Including identification of relevant standards (where appropriate).
    - Data Requirements. Including data-sharing requirements.
    - Performance Requirements. Including system performance targets and performance requirements.
    - Security Requirements. Including limits to physical, functional, or data access, by authorized or unauthorized users.

  The requirements should identify what the systems must accomplish; identify the subsystems; and define the functional and interface requirements among the subsystems. The role of each subsystem in supporting system-level performance requirements should be identified, including associated subsystem functional, interface, performance, security, data, and reliability requirements.
- **System Architecture and Standards Plan.** A Systems Architecture Document and Standards Plan should be developed that documents the architecture for systems associated with the Smart City Demonstration and associated standards that will be used. The architecture document should consider:
    - Enterprise Architecture. Describes the relationships between organizations required to support the overall system architecture.
    - Functional Architecture. Describes abstract functional elements (processes) and their logical interactions (data flows) that satisfy the system requirements.
    - Physical Architecture. Describes physical objects (systems and devices) and their application objects as well as the high-level interfaces between those physical objects.
    - Communications Architecture. Describes the communications protocols between application objects.

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 a comprehensive National ITS Architecture and single comprehensive 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. Prior to integration into a single comprehensive ITS architecture with a single integrated software tool, the CVRIA (and associated SET-IT tool) and the National ITS Architecture (and the associated Turbo Architecture Tool) will be available to support systems architecture efforts. The USDOT envisions that the Recipient 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 Recipient will define and demonstrate integration of ITS systems with other systems which comprise a smart city. As part of this effort, the Recipient shall develop a Standards Plan that identifies the nature of required interfaces to other systems, which should be defined to utilize existing networking or other standards when available. In following the systems engineering process, the Recipient shall identify information exchange needs and/or use cases. To the extent that such exchanges are supported by standards, the Recipient should catalog applicable standards that will be used. Where new standards are needed, these needs should be fully documented in the Standards Plan. 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 Recipient 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 Recipient 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.

- **System Design Document (SDD).** System design is created based on the system requirements specification (SyRS) including a high-level design that defines the overall framework for the system. Subsystems of the system are identified and decomposed further into components. Requirements are allocated to the system components, and interfaces are specified in detail. Detailed specifications are created for the hardware and software components to be developed, and final product selections are made for off-the-shelf components. IEEE Standard 1016-1998 (IEEE Recommended Practice for Software Design Descriptions) includes guidelines for format and content in to develop a System Design Document (SDD).
- **System Test Plan.** A System Test Plan should be used to demonstrate that the system satisfies all of the requirements. The System Test Plan should identify what methods (i.e., analysis, demonstration, inspection, and testing) will be used to ensure that the developed system satisfies the system's requirements.
- **Interface Control Documents (ICDs).** Since there will be likely be multiple organizations involved in the Smart City Demonstration development effort, Interface Control Documents (ICDs) should be developed so that all parties can build components of the system that will work together. ICDs inform different organizations building parts of the system that must interact with each other what the specific elements of that interface are and how those elements must be expressed. ICDs could be as simple as specifying what types of connecting wires must be used to couple two manufacturers' devices together. ICDs may be as complex as specifying the protocol suites and standards that must be used to ensure that two different computer devices can communicate over some form of telecommunications.
- **Testing Documentation.** System Integration should take place to ensure that the different pieces of the Smart City system interoperate correctly. Integration Unit testing should take place to ensure that individual components meet their specifications. Integration should take place to confirm that all interfaces have been correctly implemented and to confirm that all requirements and constraints have been satisfied. System testing should verify that the developed system satisfies the system's requirements To support testing the Recipient should consider the following:
    - o Test Descriptions. Test Descriptions include written descriptions of the individual verification and validation processes that will occur as part of the effort to ensure that the system was built correctly and that the correct system was built. Test descriptions should be linked back to the

requirements whose fulfillment they will determine. The document should include a requirements-to-test procedure matrix that shows the test coverage relationship among the tests and the requirements. Every requirement should have at least one test case associated with it and each test case should have at least one requirement associated with it.

- Test Cases. Each test case include a set of test inputs, execution conditions, and expected results developed for a particular objective, such as to exercise a particular path within a system or a software application or to verify compliance with a specific requirement or set of requirements.
- Test Procedures. Test Procedures spell out exactly how one verifies and validates that the component of the system undergoing integration actually functions as intended and as desired. If test data are going to be used as part of the verification and validation process in this step, the test procedures should also spell out how one will determine that the system actually performed the correct transformations on the data entered.
- Test Data. Test Data should include scripts used to execute software operations, data that must be entered by someone as part of the process of verification and validation of the system and its component integration, or a description of what system-generated data will flow through different components of the system to accomplish a system function.
- Test Results. Documents that describe the results of each test conducted.

- **Operations and Maintenance Plans.** Operations and Maintenance (O&M) plans should describe policies and high-level procedures governing operation and maintenance of the system. Minimally, it should address the activities described in the project's Concept of Operations and any other activities needed to achieve the project's objectives.

Note: The Recipient may elect to conduct formal walkthroughs (see IEEE Standard 1028-1997) for key systems engineering deliverables to solicit inputs and feedback from stakeholders to help ensure consensus.

To support knowledge and technology transfer efforts, all systems engineering documentation developed for the Smart City Demonstration should be developed with the intent to share publically and be formatted for Section 508 compliance.

Required Deliverables

- Systems Engineering Management Plan (SEMP)
- Concept of Operations (ConOps)
- Demonstration Site Map and Installation Schedule
- Systems Requirements Specification (SyRS)
- System Design Document (SDD)
- System Architecture and Standards Plan
- System Design Document (SDD)
- System Test Plan
- Interface Control Documents (ICDs)
- Testing Documentation
- Operations and Maintenance Plans
- Other Systems Engineering documents – as identified by the Recipient and agreed to by the USDOT – that provide evidence of following a systems engineering approach

TASK C: PERFORMANCE MEASUREMENT

A primary objective of the Smart City Challenge is to demonstrate, quantify, and evaluate the impact of advanced technologies, strategies, and applications toward addressing the city's challenges. To understand the impacts of smart city strategies, a set of rigorously defined performance measures and associated quantitative performance targets for each performance measure that are achievable within the timeframe of the Smart City Demonstration shall be defined. A Performance Measurement Plan shall be developed by the Recipient that identifies performance measures as well as plans for collecting data and reporting on performance.

The Smart City Demonstration should focus on combinations of technology solutions that align with the USDOT's twelve vision elements. As part of the demonstration, the Recipient shall identify performance measures and a set of quantitative performance targets associated with each performance measure. Performance measures shall be developed to address how integrated Smart City strategies impact safety, mobility, ladders of opportunity, a transition to clean transportation, economic vitality, and/or address climate change.

In particular, performance measures should describe how the Smart City Demonstration may:

- Reduce traffic-related fatalities and injuries;
- Reduce traffic congestion
- Improve travel time reliability;
- Increase the use and integration of electric vehicles;
- Increase the transition to clean energy;
- Reduce transportation-related emissions;
- Improve personal mobility and increase accessibility for all citizens, including low-income individuals and persons with disabilities;
- Optimize multimodal system performance;
- Increase the number of mobility options and services;
- Improve public access to real-time integrated multimodal transportation information;
- Provide cost savings to transportation agencies, businesses, and the traveling public;
- Increase the connectivity between city services and connected travelers;
- Increase connectivity to employment, education, services and other opportunities; and/or
- Provide other benefits to transportation users and the general public.

The Performance Measurement Plan should discuss the types of data the Recipient plans to collect and how the Recipient plans to collect the data to support ongoing performance of the Smart City Demonstration. Proposed hypotheses should be documented as well as methodologies for collecting: (i) pre-demonstration data that can be used as a performance baseline, (ii) continuous data during life of the demonstration to support performance monitoring and evaluation, (iii) cost data including unit costs and operations and maintenance costs, and (iv) information on the timeframe that applications or other technology solutions are deployed during the course of the demonstration period. The Performance Measurement Plan should also address how the Recipient will release these performance measures as open data.

As part of the Smart City Demonstration, the Recipient is expected to respond to the USDOT's Survey on Deployment Tracking. The USDOT's Deployment Tracking Project has conducted national surveys on a regular basis since 1997, with the most recent previous survey conducted in 2013. The purpose of this effort is to assist the USDOT in measuring the deployment of ITS technology nationally. The ITS Deployment Tracking

Project surveys transportation agencies in the largest U.S. cities on a regular basis. For more information, visit: http://www.itsdeployment.its.dot.gov/. In addition, the Recipient may also be asked to respond to other USDOT survey instruments related to ITS or other deployment tracking.

Required Deliverables

- Performance Measurement Plan
- Response to USDOT Deployment Tracking Surveys (as required)

TASK D: DATA PRIVACY REQUIREMENTS

As noted elsewhere in this document, data collected by the Recipient in connection with the Smart City Demonstration will include Personally Identifiable Information (PII) and Sensitive Personally Identifiable Information (SPII).

- **PII** is information that can be used to distinguish or trace an individual's identity, such as their name, Social Security number, biometric records, etc., alone, or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as date and place of birth, mother's maiden name. The definition of PII is not anchored to any single category of information or technology. Rather, it requires a case-by-case assessment of the specific risk that an individual can be identified by examining the context of use and combination of data elements. Non-PII can become PII whenever additional information is made publicly available. This applies to any medium and any source that, when combined with other available information, could be used to identify an individual
- **SPII** is a subset of PII which if lost, compromised or disclosed without authorization, could result in substantial harm, embarrassment, inconvenience, or unfairness to an individual. Sensitive PII requires stricter handling guidelines because of the increased risk to an individual if the data are compromised. The following PII is always (de facto) sensitive, with or without any associated personal information:
    - Social Security number (SSN)
    - Passport number
    - Driver's license number
    - Vehicle Identification Number (VIN)
    - Biometrics, such as finger or iris print

- Financial account number such as credit card or bank account number
- The combination of any individual identifier and date of birth, or mother's maiden name, or last four of an individual's SSN

In addition to de facto Sensitive PII, some PII may be deemed sensitive based on context.

Categories of Records Collected. Typically, the Recipient may include many of the following forms of personal information about individual participants and their motor vehicle and motor vehicle use:

Participant Background Information

- Individual Identifiers;
- Full Name (First, Middle, Last);
- Demographic information, including age and gender;
- Individual subject research identifier created by DOT; and
- Driver's license number, issuing state, and qualifiers.

Vehicle Identifiers

- Personal vehicle identification number (VIN) and registration information;
- Vehicle Identification Number (VIN) of government issued vehicles; and
- Identifiers for equipment installed by DOT in personal or government issued vehicle.

Contact Information

- Mailing/Residential Address;
- Phone number(s);
- Email address(es);
- Institutional or organizational affiliation;
- Work/Business related contact information; and
- Occupation and work schedule.

Eligibility Information

- Driver history and habits;
- Medical history relevant to the scope of the research project; and
- Outcomes of criminal background check.

Project Information

- Vehicle sensor information;
- Video or still images, including infrared;
- Audio recordings;
- Dynamic information about a vehicle, including location, heading,
- proximity to and interaction with other vehicles and infrastructure;
- Dynamic information about a driver's interaction with the vehicle, including steering wheel, turn signal, and accelerator and brake pedal positions; and
- Data collected from drivers by means of surveys, focus groups, or interviews.

USDOT Data Privacy Policy. Improper handling of PII or SPII by a Recipient could have significant adverse impacts on the privacy of individuals. For this reason, USDOT is committed to ensuring that the Recipient institutes sufficient data privacy controls to mitigate the risk of harm to individuals that would result in the improper handing or disclosure of the PII and SPII collected from individuals in connection with a DOT-funded Smart City Transportation Project.

The Recipient shall:

- Devote sufficient resources, and develop and adhere to policies and procedures to ensure that privacy-risks stemming from a Smart City Demonstration are mitigated appropriately and in accordance with the privacy controls identified below;
- Develop and submit for USDOT approval a Data Privacy Plan that documents the technical, policy and physical controls that it will put in place (and require its sub-grantees and contractors to put in place) to mitigate potential privacy harms; the plan should include a System Security Plan (SSP) or other documentation sufficient to verify that the Recipient will store PII only on IT infrastructure that is subject to appropriate security controls;
- Ensure that sub-recipients, contractors, and partners who handle or may access PII or SPII developed by the Recipient in connection with a Smart City Demonstration adhere to the Recipient's Data Privacy Plan and have policies and procedures in place to safeguard the security and privacy of participant data. To this end, the Recipient shall include in all sub-grant agreements and contracts appropriate data security and privacy requirements;
- Upon request by USDOT, provide sufficient documentation to demonstrate that its IT infrastructure, policies and procedures (and those of any sub-grantee or

contractors having access to PII or SPII) comply with the privacy control requirements set forth below, including but not limited to confirming that PII and SPII will be stored only on IT infrastructure employing security controls commensurate with the risk to the individual that would result from unauthorized access, disclosure, or use of the information.

Required Privacy Controls. Generally, the Recipient (and their sub-awardees and contractors) shall develop and document in their Data Privacy Plan the following privacy controls, which shall apply (as appropriate) throughout the data lifecycle:

- Collection of PII
  - Collect only PII that the researcher has been authorized to collect by USDOT.
  - Collect the minimum PII required for the research and not more.
- Notice to Human Subjects
  - Provide appropriate advanced notice, if at all possible at the point of collection, to the individuals from whom the PII is being collected.
  - Obtain advanced approval for the notice from the USDOT Contracting Officer.

  Use and Sharing of PII
  - Ensure that Recipient personnel acknowledge PII responsibilities to ensure that PII is used only as authorized.
  - Not use PII for purposes other than those authorized by USDOT.
  - Ensure that access to PII is on a "need to know" basis for authorized purposes only.
  - Not exceed authorized access to PII, or disclose PII to unauthorized persons.
- Security
  - Protect all PII, electric or hardcopy, in their custody from authorized disclosure, modification, or destruction so that the confidentiality, integrity and availability of the information are preserved.
  - Store PII only on IT infrastructure employing security controls commensurate with the risk to the individual that would result from unauthorized access, disclosure, or use of the information.
  - Encrypt all PII in transit or at rest.
  - Encrypt all PII transmitted or downloaded to mobile computers/devices.

- Ensure that all individuals having access to PII have received training in the policies and procedures that protect PII**.**

- Maintenance and Disposal
  - Maintain PII in accordance with the applicable NARA records schedule (available from the NHTSA Contracting Officer or, in the case of NHTSA–conducted research, from the NHTSA Records Officer).
  - After conclusion of the research project, maintain PII only as permitted by the NARA schedule and, in the case of contractor-conducted research, relevant data rights classes in the applicable contract.
- Privacy Documentation
  - Document compliance with the provisions of the Recipient's Data.
  - Privacy Plan and the Data Privacy and Security provisions in the Grant Agreement.
  - Upon request, provide to the USDOT Contracting Officer sufficient documentation to demonstrate compliance with the Recipient's Data Privacy Plan and the Data Privacy and Security provisions in the Grant Agreement.
- Privacy Reporting
  - Immediately report to the USDOT Contacting Officer any suspected loss of control or any unauthorized disclosure of PII by the Recipient, its sub-grantees or contractors.
  - Immediately report to the USDOT Contacting Officer all suspected or actual unauthorized collection, use, maintenance, dissemination or deletion of PII by the Recipient, its sub-grantees or contractors.

Additional Information. There are many types of privacy and security controls available to safeguard the confidentiality of PII. NIST Special Publication 800-122 (Guide to Protecting the Confidentiality of PII)[2] provides guidelines for a risk-based approach to protecting the confidentiality of PII. Additional information about privacy and security safeguards that may protect PII can be found in Appendix J to NIST Special Publication 800-53.[3] Furthermore, NIST provides guidance regarding big data

[2] NIST Special Publication 800-122 (Guide to Protecting the Confidentiality of PII) may be found at: http://csrc.nist.gov/publications/nistpubs/800-122/sp800-122.pdf

[3] NIST Special Publication 800-53, Appendix J (Security and Privacy Controls for Federal Information Systems and Organizations) can be found at: http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-53r4.pdf

architectures and security requirements in NIST Special Publication 1500-1[4] and NIST Special Publication 1500-4.[5]

The Recipient may wish to include in their Data Privacy Plan the following checklist to help demonstrate that they considered the privacy and security controls detailed above. It also may be used by the Recipient to help verify that its subawardees and subcontractors have done so.

Checklist. Please review NIST Special Publication 800-122 for additional information about the questions below or the information that the Recipient may be required to produce in connection with their Privacy Plans. If you still require assistance, please contact the Agreement Officer handling the relevant procurement/contract for additional information.

1. Has your organization ever performed work for a Federal agency that involved handling PII?

   Yes. The City handles Federal Tax Information governed by IRS Publication 1075. IRS Contact: Jackie Nielson, Fed State Coordinator, Ohio District Dept. of the Treasury, 614-280-8739

2. Does your organization have any policies/procedures to protect the security and confidentiality of PII?

   Yes. The City has Executive Orders, policies and procedures to protect the security and confidentiality of PII. City Executive Orders and Policies are posted at https://www.columbus.gov/hr/Executive-Orders-and-Policies/

3. Does your organization have any policies/procedures to control and limit access to PII?

   Yes. The City has Executive Orders and Policies to control and limit access to PII. City Executive Orders and Policies are posted at https://www.columbus.gov/hr/Executive-Orders-and-Policies/

[4] NIST Big Data Interoperability Framework: Volume 1 Definitions, http://dx.doi.org/10.6028/NIST.SP.1500-1

[5] NIST Big Data Interoperability Framework: Volume 4, Security and Privacy, http://dx.doi.org/10.6028/NIST.SP.1500-4

4. Does your organization store PII on network drives and/or in application databases with proper access controls (i.e., User IDs/passwords)?

   Yes. The City assigns unique identifiers and requires complex passwords.

5. Does your organization limit access to PII only to those individuals with a valid need to know?

   Yes. The City limits access to PII only to those individuals with a valid need to know.

6. Does your organization prohibit or strictly limit access to PII from portable and mobile devices, such as laptops, cell phones, and personal digital assistants (PDA), which are generally higher-risk than non-portable devices (e.g., desktop computers at the organization‘s facilities)?

   Yes. Executive Order 2007-03 prohibits such actions.

7. Does the information system used by your organization to store PII contain automated or easy-to-use process to ensure that only authorized users access PII – and only to the extent that each user has been authorized to do so?

   Yes. The City uses Active Directory to assign unique identifiers, require complex passwords and control access to private or sensitive information.

8. Does your organization monitor events that may affect the confidentiality of PII, such as unauthorized access to PII?

   Yes. The City monitors events and configures alerts for events that may affect the confidentiality of PII.

9. Does your organization audit its information systems on a regular or periodic basis?

   Yes. The City performs security assessments by various methods including access, rule and configuration reviews. The City is also subject to external audits including an IRS Safeguards Review.

10. Does your organization analyze information system audit records for indications of inappropriate or unusual activity affecting PII, investigate suspicious activity or suspected violations, report findings to appropriate officials, and take necessary actions?

    Yes. The City has a Security Incident Response Plan written to provide a well-defined, organized approach for handling any potential threat to systems and data.

11. Does your organization restrict access to information system media containing PII, including digital media (e.g., CDs, USB flash drives, backup tapes) and non-digital media (e.g., paper, microfilm)?

    Yes. The City maintains strict control over the internal or external distribution of any kind of media. Digital containing sensitive information is physically secured from unauthorized access, labeled, inventoried and is tracked via logs. Non-digital media containing sensitive information is only kept when necessary for business purpose and physically secured from unauthorized access.

12. Does your organization restrict access to portable and mobile devices capable of storing PII?

    Yes. Executive Order 2007-03 prohibits copying sensitive information to such devices.

13. Does your organization require that information system media and output (such as printed documents) containing PII be labeled to indicate appropriate distribution and handling?

    Yes. PO 22 requires that media must be classified so that the sensitivity of the data can be determined.

14. Does your organization securely store PII, both in paper and digital forms, until the media are destroyed or sanitized using approved equipment, techniques, and procedures?

    Yes. Physical and logical access to media containing PII is strictly controlled. Encryption is used on digital media.

15. Does your organization sanitize digital and non-digital media containing PII before disposing of or reusing the media?

    Yes. Paper media is destroyed using cross cut shredders. Digital media is sanitized prior to reuse or destroyed as part of disposal.

Required Deliverables

- Data Privacy Plan

TASK E: DATA MANAGEMENT AND SUPPORT FOR INDEPENDENT EVALUATION

Management systems within a smart city – both within transportation and across other sectors of a city – are expected to share data to allow for communication between cities and their citizens and enable an open, growing ecosystem of third part services that provide additional benefits to citizens. Systems that allow for data sharing also enable cities to maximize efficiencies through intelligent management of assets across sectors. Open data and technology enable the efficient coordination, use, and management of all mobility services in the system. A Data Management Plan should be submitted per requirement of the USDOT Public Access Plan. Requirements are outlined at http://ntl.bts.gov/publicaccess/creatingaDMP.html.

The Recipient shall develop a Data Management Plan that describes how data – including data across multiple sectors in a city – will be collected, managed, integrated, and disseminated before, during, and after the Smart City Demonstration. This includes real-time and archived data that are inputs to and outputs from systems managed by the city and its partners. The document shall discuss the city's plans for 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 – to fuel entrepreneurship and innovation to improve citizens' lives, create jobs, and spur economic development. In cases where the data includes PII or other restrictions, the document shall address how the city the city will make that data available, as possible, in a secure environment for the use of qualified researchers. The Data Management Plan shall also describe:

- The data the city currently collects and plans to collect as part of the Smart City Demonstration and how these data will be used by the lead agency, project partners, other agencies, and stakeholders to further address city challenges.

- Opportunities to integrate transportation data with other functions or services in a city (such as public safety, human services, transit, and public works) to improve the management and operations of the city. Likewise, it shall describe how other data could be integrated with transportation data to improve transportation operations.
- The terms of existing and future data sharing agreements that will be put in place during the project period and the city's approach to preserving project data for future use. If the city plans to partner with outside organizations (nonprofits, universities, corporations, etc.) it shall address whether and specify how (e.g., limitation on sharing or use) data from those organizations or interests will be collected, managed, and shared across sectors or with the public, if appropriate.
- The terms and conditions that exist or will be established and managed in partnership agreements, data or information sharing agreements, agency specific policies and operating procedures to establish and maintain the systems and interfaces to maintain the integrity of the data and share the information identified in the plan.
- Practices that safeguard data, privacy, and physical assets. The Data Management Plan shall identify the extent to which their system or systems will collect or store Personal Identifiable Information (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. If PII is collected, practices for scrubbing or removing PII from data sets shall be described so that data may be used for independent evaluation and/or made available to the USDOT's Research Data Exchange (RDE).

As part of the Smart City Demonstration, an Independent Evaluation will be conducted by the USDOT. The Independent Evaluator will conduct an evaluation applying quantitative and qualitative evaluation methodologies to conduct before and after performance assessments; cost-benefit assessments of the demonstration; assess user acceptance/citizen satisfaction of the demonstration; document lessons learned, challenges and approaches for mitigating, addressing, and /or overcoming them; estimate total impacts, costs, and return-on-investment (ROI) of the demonstration; and assess if the Smart City Demonstration achieved its vision.

The Recipient shall develop an Evaluation Support Plan detailing their expected support to the independent evaluation effort. During demonstration, the Recipient shall execute its Evaluation Support Plan. The support may include provision of frequently collected

data and corresponding meta data; provision of frequently monitored performance measures estimates and desired targets; limited availability of the site for the independent evaluators to conduct additional field tests and experiments to supplement data not available from the site; and participation in surveys and interviews conducted by the independent evaluators.

Systems deployed as part of the Smart City Demonstration must be capable of generating the data needed to calculate measures over time – that is, to show how well the systems are performing with respect to performance measures and targets identified in the Performance Measurement Plan. Independent evaluation will also be required to validate site system performance with respect to the targeted measures, to collect or infer contextual data that allows for the isolation and mitigation of confounding factors, and to provide supplementary evaluation with respect to a broader set of safety, environmental, mobility and public agency efficiency measures of interest to USDOT. The Recipient is responsible for supporting the independent evaluator’s access to the site and to site staff to conduct evaluation-related experiments, interviews, and surveys.

To support independent evaluation, the Recipient shall apply data quality measures and processes including security protocols to convert the raw data into processed, quality data and ensure that those data are stored in a secure database, with the database schema defined by the Independent Evaluator. The Recipient shall securely transmit these data to support evaluation, on a schedule and using a medium agreed upon with the Independent Evaluator, to the Independent Evaluator’s location. Data collected for use by the Independent Evaluator shall be considered “owned” by the USDOT. The Recipient shall transmit only those data required to support evaluation by the Independent Evaluator; any additional data that the site collects for its own use shall also be stored in its own secure data storage system, but kept separate from data required by the Independent Evaluator and the USDOT. However, the Recipient may use data collected for the Independent Evaluator in its own analyses.

Connected vehicle, mobile device, and infrastructure sensor data captured during the Smart City Demonstration are expected to be broadly shared with the community to inform prospective deployers of smart city applications. Incorporating data sharing practices into the overall design of the Smart City Demonstration will also enable more innovation and participation. However, data sharing is subject to the protection of intellectual property rights and personal privacy and must be handled securely. Appropriately prepared system control, performance and evaluation data are expected to be shared with the USDOT and posted in timely fashion on resources such as the

Research Data Exchange (RDE) (www.its-rde.net) stripped of PII. The USDOT envisions that this data sharing capability will better support the needs of ITS researchers and developers while reducing costs and encouraging innovation. Data accessible through the RDE will be well-documented and freely available to the public. The USDOT expects appropriate data – determined by the Recipient and the USDOT – to be made freely available to the public on the RDE. Hence, the Recipient shall transfer appropriate data collected under the Smart City Demonstration to the RDE.

While the RDE currently only supports dissemination of archival data that has been stripped of PII, the USDOT may develop future capabilities to support the dissemination of real-time data, sharing sensitive data with qualified researchers, and automate cleansing of data sets to remove PII to enable public dissemination. The USDOT expects to work closely with the Recipient to ensure that data produced during the demonstration is shared efficiently and cost effectively, leveraging these and other shared resources as appropriate to increase the completeness and timeliness of data exchange.

Preference for real-time data from third party providers, etc.
The Recipient shall enter into Memoranda of Understanding (MOU) or equivalent with third party providers of data, including Contractors, that document the terms under which the data is being provided or acquired. The Recipient shall require, to the extent possible, such agreements to state that third party data sources shall be provided as real-time data streams and provide the Recipient with unlimited rights to use and disseminate the real-time and archived data for any purpose, consistent with applicable data security and privacy requirements.

Requirement for real-time BSM data feed, though flexibility on scale
During the Smart City Demonstration, the Recipient shall provide a real-time, streaming data feed from Connected Vehicles (CV), including but not limited to the Recipient's standards-compliant Basic Safety Message (BSM) data, for operational testing and use by the Recipient and third party users.

> Note: To control costs and complexity, the Recipient may choose to limit the scale and scope of this real-time data feed. For example, the Recipient may limit the geographic area from which this real-time data will be disseminated or the length of time the real-time feed will be made available.

Preference for open source tools
The USDOT strongly prefers that the Recipient acquire and develop open source technologies throughout the course of the Smart City Demonstration and that any code developed for the project is, via contract or equivalent mechanism, open source and available for license-free use and enhancement by third parties. Data rights under this agreement shall be in accordance with 2 CFR 200.315, Intangible property.

Required Deliverables

- Data Management Plan
- Independent Evaluation Support Plan
- Data to support USDOT's Independent Evaluation
- Data provided to the USDOT's Research Data Exchange (RDE)

TASK F: SAFETY MANAGEMENT AND SAFETY ASSURANCE

The Recipient shall describe any underlying safety needs associated with the safety of all travelers, subjects, and other personnel associated with the Smart City Demonstration.

The Recipient shall develop a Safety Management Plan that includes a systematic approach to achieving acceptable levels of safety risk with the demonstration. The Recipient shall establish and define the methods, processes, and organizational structure needed to meet safety goals. These processes should build upon the processes and procedures that already exist for city operations, but also consider how new strategies deployed as part of the Smart City Demonstration may impact those processes. Safety scenarios shall be developed that are related to the applications and technologies – including but not limited to automated vehicle deployments – selected for demonstration. These scenarios shall include an analysis of likelihood and potential impact. Potential mitigating actions taken at various times and locations shall be identified for each scenario. A set of "safety needs" shall be derived from this scenario-based analysis. The Recipient shall identify levels of safety risk associated with the Smart City Demonstration, using established processes where possible, (e.g., ISO 26262 ASIL). The nature of these assessment processes will be dependent on the applications selected and the nature of the specific safety risks.

During the demonstration, the Recipient shall evaluate the continued effectiveness of implemented risk control strategies and support the identification of new hazards. The

Recipient shall continually provide insight and analysis regarding methods/opportunities for improving safety and minimizing risk.

If some or all components of the Smart City Demonstration plan to use human participants, the Recipient shall obtain Human Use Approval from an accredited Institutional Review Board (IRB). Under federal regulations, an IRB is a group of individuals that has been formally designated to review and monitor research involving human subjects. In accordance with federal regulations, an IRB has the authority to approve, require modifications in (to secure approval), or disapprove research. This review serves an important role in the protection of the rights and welfare of human research subjects. The purpose of IRB review is to assure, both in advance and by periodic review, that appropriate steps are taken to protect the rights and welfare of humans participating as subjects in the research. Certain IRBs have been "accredited" by private accreditation agencies. Note that the USDOT will not act as an IRB for the purposes of this award. The Recipient is responsible for obtaining IRB approval for human participation within the Smart City Demonstration.

Required Deliverables

- Safety Management Plan
- Human Use Approval Summary

TASK G: COMMUNICATIONS AND OUTREACH

The Recipient shall have a comprehensive communications and outreach program that covers both outreach activities and the accommodation of requests for site visits by media, researchers, and others. Communications and outreach should consider:

- Media strategy for both local and national press;
- Media coordination with the USDOT;
- Web/social media presence;
- Trade show strategy;
- Outreach strategy to promote the demonstration locally;
- Community awareness strategy;
- Crisis communications plan in case of unforeseen events, natural disasters, and other threats; and
- Accommodation of site visits and demonstration of capabilities.

Public relations and marketing should consider the delivery of:

- News articles, press releases, brochures, fact sheets;
- Photos;
- Website content;
- Videos;
- Talking points, press events, PowerPoint slide decks; and
- Trade show events.

For Recipient consideration, levels of outreach are expected to include:

- Two local press conferences each year;
- Three articles a year to be published in industry trade journals;
- A promotional video (6-12 minutes) about the Smart City Demonstration, including two additional updates;
- A Smart City Demonstration website;
- Travel and participation in six workshops/conferences/trade shows each year with one of them being international; and
- Participation in four public USDOT-organized webinars per year regarding Smart City Challenge Demonstration progress/performance and lessons learned.

The Recipient shall include regular coordination with USDOT communications staff, to facilitate the branding, re-use and re-distribution of materials developed by USDOT and the Smart City Demonstration team.

Required Deliverables

- Communications and Outreach Plan
- Public relations and marking materials defined by the Recipient
- Outreach Products, including:
    - A promotional video (6-12 minutes) about the Smart City Demonstration, including two additional updates;
    - A Smart City Demonstration website;
    - Travel and participation in six workshops/conferences/trade shows each year with at least one outside of the United States or in support of international cooperation; and
    - Participation in four public USDOT-organized webinars per year regarding Smart City Challenge Demonstration progress/performance and lessons learned.
- Other communications and outreach deliverables as identified by the Recipient

TASK H: INTERNATIONAL COLLABORATION

The USDOT is interested in sharing lessons learned from the Smart City Demonstration with its international partners. The USDOT currently has memorandums of understanding (MOUs) with the European Commission, Japan, Korea, Canada, and Mexico. The Recipient will be expected to collaborate on similar projects with international partners with which USDOT has research coordination agreements for the purpose of expanded learning. The format of the collaboration may include hosting foreign scanning tours, complementary alignment of evaluation activities, or it could involve a partial alignment of deployment or research activities and objectives to create twinned complementary project components. These exchanges assume that the international partners will fund projects on topics of relevance to the USDOT, and that an agreement can be reached among the international partners, USDOT, and the program managers of the research and deployment programs. The USDOT will identify areas of shared interest with its international partners from among awarded programs and initiate collaboration discussions. No funds will be exchanged between USDOT and foreign-funded programs; each side will have responsibility for their respective budgets.

The proposal should include an estimate of travel funds needed for three team members to participate in one international and one US meeting each year of approximately three days duration, plus six days of effort for meeting preparation, and six days for reports preparation associated with the collaboration aspects of this project. These terms are for planning purposes only and do not constitute a commitment by the USDOT to support research exchange with foreign-funded programs; USDOT reserves the right to renegotiate these terms as funding, priorities, and opportunities for collaboration with the international partners may change.

Required Deliverables

- Participation in one International Collaboration meeting each year of approximately three days duration, plus six days of effort for meeting preparation, and six days for reports preparation associated with the collaboration aspects of this project

TASK I: PARTICIPATION IN RELEVANT ITS ARCHITECTURE AND STANDARDS DEVELOPMENT EFFORTS

The Recipient shall assist in supporting activities of the ITS Architecture and Standards Programs where those activities are impacted by Smart City initiatives. Making use of published and developmental ITS architectures and standards, the Recipient will encounter cases where additional needs become evident as well as cases where improvements or corrections to existing architecture and standards are warranted. The Recipient shall take appropriate actions to assure that these lessons-learned are made available to support evolution of architecture and standards to improve suitability to support nationwide or greater interoperability of ITS as well as interoperability of ITS with other smart city systems and architectures. Such support will include participation in select Standards Development Organization (SDO) working groups/committees, including providing input to their work in the form of technical information (e.g., objectives, user needs, data requirements) about the Smart City initiative and lessons learned from Smart City Development and deployment activity. When appropriate, in-person participation in select meetings will be included. Participation in relevant ITS Standards development efforts may include providing technical input for multiple SDOs and standards-relevant organizations such as the International Organization for Standardization (ISO) Technical Committee 204 (TC204) and possibly TC22, European Telecommunications Standards Institute (ETSI), European Committee for Standardization (CEN), Institute of Electrical and Electronics Engineers (IEEE), SAE International (SAE), Institute of Transportation Engineers (ITE), American Association of State Highway and Transportation Officials (AASHTO), National Electrical Manufacturers Association (NEMA), and National Institute of Standards and Technology (NIST).

The Recipient is expected to provide one appropriately knowledgeable expert for this participation. In-person participation requirements are estimated at 6 meetings of 3 days each per year, of which 2 are expected to be held outside of the United States. Additional efforts are expected to be required including remote participation during conference calls/webinars as well as drafting of technical input. The Recipient shall request USDOT prior approval for all international travel. The USDOT covers labor and travel costs associated with architecture and standards participation from the Recipient and private sector participants. For each working group/committee meeting with in-person participation, the Recipient shall provide a report to the USDOT describing the meeting outcomes, any impacts to the Smart City Demonstration, and inputs made by the Smart City program.

Required Deliverables

- Attendance at 6 architecture and standards meetings, of which 2 are expected to be held outside of the United States
- Architecture and Standards Meeting Trip Reports

TASK J: INTERIM AND FINAL REPORTING

The USDOT requires the Recipient to submit interim and final reports. Interim reports shall be submitted each year discussing the progress to date and summarizing issues and opportunities. A final report for the Smart City Demonstration shall provide a summary of what was accomplished, the benefits and costs and lessons learned. This document shall be developed with the intent to share publically and be formatted for Section 508 compliance. The final report shall describe:

- Deployment costs (i.e., systems and unit costs) and operational costs (i.e., operations and maintenance costs) of the project compared to the benefits and cost savings the project provides; and
- How the project addressed city challenges and met the original expectations defined in the city's Smart City vision, such as —
    - Data on how the demonstration helped to improve safety, mobility, sustainability, ladders of opportunity, economic vitality, and/or address climate change;
    - The effectiveness of providing a holistic approach to addressing transportation challenges by deploying applications and strategies consistent with the USDOT's twelve vision elements; and
    - Lessons learned and recommendations describing how the demonstration met the objectives identified by the USDOT for the Smart City Challenge and recommendations for other locations considering implementation of similar solutions.

Required Deliverables

- Smart City Demonstration Interim Reports (annually)
- Smart City Demonstration Final Report

6. TABLE OF DELIVERABLES

The following due dates are based on an estimated award effective date of August 31, 2016.

In the event an update to the due dates contained in the following Table of Deliverables is required and/or deemed necessary by the parties, the update, when expressly approved by the AOR in writing, shall replace the previously approved version of the Table and will be considered incorporated into this award by reference with no formal agreement amendment needed. The Recipient shall comply with the latest version of the Table as expressly approved in writing by the AOR. The Recipient shall implement a version tracking approach to efficiently manage updates to the Table. The Recipient shall include the latest approved version of the Table in the Task A Project Schedule Monthly Updates, or if applicable, include a proposed Table update for consideration by the AOR. Proposed Table updates shall be supported by adequate narrative justification to fully explain the need for the update.

Task	Deliverable	Due Date	Section 508 Compliant?
A	Kick-off Meeting – conduct a kickoff meeting at the USDOT or the Recipient's site.	Within four weeks after award	No
A	Project Management Plan (PMP)	10/24/2016	No
A	Project Schedule	9/26/2016	No
A	Project Schedule Monthly Updates	Monthly	No
A	Partnership/Stakeholder Status Summary (Draft and Final)	9/26/2016	No
A	Quarterly Progress Reports and Briefings – submit progress reports to document technical activities performed. See Quarterly Progress Reports clause below.	Quarterly	No
B	Systems Engineering Management Plan (SEMP)	11/21/2016	Yes

Task	Deliverable	Due Date	Section 508 Compliant?
B	Concept of Operations (ConOps)	2/27/2017	Yes
B	Demonstration Site Map and Installation Schedule	3/31/2017	Yes
B	Systems Requirements Specification (SyRS)	6/12/2017	Yes
B	Interface Control Document (ICD)	7/3/2017	Yes
B	System Design Document (SDD)	9/18/2017	Yes
B	Test Plan (TP)	8/13/2017	Yes
B	System Architecture and Standards Plan	3/24/2017	Yes
B	Other Systems Engineering documents – as identified by the Recipient and agreed to by the USDOT – that provide evidence of following a systems engineering approach	TBD	Yes
C	Performance Measurement Plan	12/21/2016	Yes
C	Response to USDOT Deployment Tracking Surveys (as required)	TBD	No
D	Data Privacy Plan	7/31/2017	Yes
E	Data Management Plan	7/3/2017	Yes
E	Independent Evaluation Support Plan	12/21/2016	Yes
E	Data to support USDOT's Independent Evaluation	TBD	No
E	Data provided to the USDOT's Research Data Exchange (RDE)	TBD	No
F	Safety Management Plan	11/21/2016	Yes

Task	Deliverable	Due Date	Section 508 Compliant?
F	Human Use Approval Summary	2/1/2017	No
G	Communications and Outreach Plan	12/5/2016	Yes
G	A promotional video (6-12 minutes) about the Smart City Demonstration, including two additional updates;	TBD	Yes
G	A Smart City Demonstration website	11/18/2016	Yes
G	Travel and participation in six workshops/conferences/trade shows each year with one of them being international	TBD	No
G	Participation in four public USDOT-organized webinars per year regarding Smart City Challenge Demonstration progress/performance and lessons learned	TBD	No
H	Participation in one International Collaboration meeting each year of approximately three days duration, plus six days of effort for meeting preparation, and six days for reports preparation associated with the collaboration aspects of this project	TBD	No
I	Attendance at 6 architecture and standards meetings, of which 2 are expected to be held outside of the United States	TBD	No
I	Architecture and Standards Meeting Trip Reports	TBD	No

Task	Deliverable	Due Date	Section 508 Compliant?
J	Smart City Demonstration Interim Reports (annually)	Last Friday of September (annually)	No
J	Smart City Demonstration Final Report	9/23/2020	Yes

Note: Section 508 requirements are included in the General Terms and Conditions available online at: http://www.fhwa.dot.gov/aaa/generaltermsconditions.cfm.

7. PUBLICATION GUIDELINES

All ITS reports funded in full or in part by the USDOT'S ITS Joint Program Office (JPO), such as this award, must be published in the National Transportation Library (NTL), formerly EDL. NTL was established in 1998 by the Transportation Equity Act for the 21st Century (TEA-21) to maintain and facilitate access to statistical (and other) information needed for transportation decision-making at the Federal, State, and local levels and to coordinate with public and private transportation libraries and information providers to improve information sharing among the transportation community. All reports are cataloged, meta tagged, sourced, summarized in abstract form and are published by the USDOT.

For the documents designated to be Section 508 Compliant above, the ITS JPO Publication Guidelines apply. The Guidelines are available online:

http://its.dot.gov/communications/pubsguidance.htm

SECTION B – FEDERAL AWARD INFORMATION

1. TYPE OF AWARD

The award type is a Cooperative Agreement. This agreement is a cost-reimbursement award.

2. COST SHARING OR MATCHING

Cost sharing or matching is required in the amount cited on page 2 of this agreement. Per 2 CFR 200.29, Cost sharing or matching means the portion of project costs not paid by Federal funds. See 2 CFR 200.306, Cost sharing or matching. The following amounts, as included in the approved Budget Application (Attachment 3), are hereby incorporated into this award as required Cost Sharing or Matching, subject to the terms of the award and the requirements of 2 CFR 200.

Estimated Funding Source	**Estimated Cost Share Amount**	**Estimated Cash/In-kind**
City of Columbus	$8,000,000	Cash
State of Ohio (Ohio DOT)	$7,000,000	In-kind
Franklin County	$4,000,000	$1,000,000 cash, $3,000,000 in-kind
Total	$19,000,000	

Costs incurred by the Recipient to satisfy the cost sharing or matching requirement must be allowable under 2 CFR 200 and incurred during the period of performance of the agreement.

3. PERIOD OF PERFORMANCE

The period of performance for this Cooperative Agreement is four years from the effective date of the award.

The USDOT expects the demonstration to be implemented and tested within three years. The fourth year is expected to be used for finalizing the evaluation of the demonstration.

Ideally, the awardee, on a self-sustaining basis, will continue to operate the systems and services implemented in the Smart City Challenge after completion of the USDOT funded demonstration.

The Recipient may charge to the Federal award only allowable costs incurred during the period of performance (except as described in 2 CFR §200.461 Publication and printing costs) and any costs incurred before the Federal awarding agency made the Federal award that were authorized by the Federal awarding agency.

4. DEGREE OF FEDERAL INVOLVEMENT

The USDOT anticipates substantial Federal involvement between it and the Recipient during the course of this demonstration. The anticipated Federal involvement will include technical assistance, education and guidance to the Recipient.

5. LEVERAGED PARTNER RESOURCES

In addition to the Federal Share and the Recipient Cost Share identified on page 2 of the agreement, the Recipient shall use Leveraged Partner Resources to fund and perform the demonstration. Leveraged Partner Resources are resources from third party organizations in support of the demonstration. "Key" Leveraged Partner Resources, listed below, are considered essential to the demonstration and are, therefore, approved and incorporated into this award for informational and reporting purposes. The Key Leveraged Partner Resources listed herein are **not** subject to the requirements of 2 CFR 200, or the terms of the award, except as cited below.

The Technical Application and Budget Application dated July 29, 2016 are based on knowledge of partnership agreements as of the application date. Any new partnership agreements may affect the Applications, requiring updates/amendments in the future.

Requirement to Provide Copies of Key Partner Agreements: The Recipient shall provide to the Agreement Officer electronic copies of all signed Key Partner agreements, and any subsequent agreement amendments executed during the award period of performance. The Recipient shall submit such agreements and amendments within one week after execution of the agreement or amendment.

Requirement for Prior Approval of Changes to Key Partners and Agreements: The following list of Key Leveraged Partner Resources is hereby approved and incorporated into this award for informational and reporting purposes. In the event the Recipient

determines the need to remove, replace, or divert a Key Leveraged Partner Resource, or significantly change the nature of a Key Partner agreement, the Recipient must notify the Agreement Officer in writing to request prior written approval of the change. The Recipient's request shall provide details of the proposed change, describe the circumstances of the change, and provide the Recipient's assessment of the impact of the change upon the demonstration. The Recipient must obtain prior written approval from the Agreement Officer before entering into a new agreement with the proposed replacement partner or resource, or executing an amendment that significantly changes a Key Partner agreement. This requirement will enable the USDOT to review and approve in advance significant changes in the planned use of Key Leveraged Partner Resources.

Requirement for Notification of Non-Key Partner Changes: In the event the Recipient determines the need to remove, replace, or divert Leveraged Partner Resources that are part of the demonstration but are not designated as Key in the list below, the Recipient must notify the Agreement Officer in writing of the proposed change in partner, circumstances surrounding the change, and the Recipient's analysis of the impact upon the demonstration.

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
Paul Allen's Vulcan, Inc.	Funding to support the deployment of electric vehicles and other carbon emission reduction strategies.	$ 10,000,000
Mobileye	Installation of Mobileye's Shield +TM technology on transit buses.	$ 1,950,000
Autodesk	A year-long subscription to *Infraworks*, an information modeling platform that uses 3-D visualizations and real-world data to plan major engineering projects as well as on-site training.	$ 34,520

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
Amazon Web Services (AWS)	Credits to AWS Cloud services and AWS Professional Services. AWS will also provide solution architecture and best practices guidance to the Recipient.	$1,000,000
NXP	Wireless communication modules that allow cars to securely exchange data, such as hazard warnings, over distances of more than a mile to prevent accidents and improve traffic flow.	$2,500,000
Alphabet's Sidewalk Labs	Flow technology, an analytics platform that the Recipient can use to identify traffic-prone areas and parts of a city that are underserved by public transportation — all by using traffic patterns culled from aggregated, anonymized data. From that information the software can suggest solutions like ride-sharing, new transportation access or a rerouting of traffic to better serve the community.	$230,000
AT&T	AT&T has committed to provide in-kind partnering to the City to assist with the deployment of the Columbus Connected Transportation Network (CCTN). The proposed partnering includes professional services and technical support resources; communications and data management technologies; USB cellular modems and SIM cards and connectivity; hardware to support communications and data management services.	$1,000,000

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
DC Solar	DC Solar will partner with the City to deploy eight to ten mobile solar generators or EV charging stations in 11 month increments at locations in the City to be determined. Mobile solar generators and EV charging stations will demonstrate the use of renewable energy sources in support of fleet electrification and power generation.	$1,500,000
Continental	Continental will deploy a roadside infrastructure sensing system; onboard V2X system, and DSRC communication systems to enable communication between roadside and onboard systems; API interfaces on cloud backend comprised of APIs for accessing data from both onboard and roadside V2X systems; basic safety messages to demonstrate the effectiveness of the CCTN on alleviating transportation-related issues such as intersection safety warnings, traffic management, automated system to regulate the flow of traffic according to real time traffic information, in-car productivity and safety, V2X warnings based on driver profile, route optimization or navigation, and reduced traffic congestion through load balancing via rerouting services enhanced with real time navigation data; and gamification of driving with incentives for drivers to behave responsibly to improve traffic condition and safety.	$1,000,000
Experience Columbus	Included in Event Parking (Downtown)	$100,000

Key Leveraged Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
Ohio State University	Included in EAV (Commercial)/Program Management	$2,000,000
Greater Columbus Art Council	Included in Communications and Outreach	$1,000,000
HERE, Inc.	Included in Information Data Exchange (Enabling Technology)	$1,000,000
INRIX	Included in Information Data Exchange (Enabling Technology)	$1,424,000
Mass Factory (App&Town)	Included in Enhanced Human Services (Enabling Technology)	$40,000
SPARC	Included in CCTN Vehicles (Enabling Technology)	$388,200
Peloton	Included in Truck Platooning (Logistic)	$165,000
Honda	Included in CCTN Vehicles (Enabling Technology)	$2,600,000
Battelle	Included in Program Management	$1,000,000
Econolite	Included in CCTN (Enabling Technology)	$280,000
Columbus Partnership	Included in Testing of Autonomous Vehicles (Commercial)	$5,000,000
Columbus Partnership	Sustainment Cash Available as needed for USDOT and/or electrification deployments	$10,000,000
TOTAL		$44,211,720

In addition to the Federal Share and the Recipient Cost Share identified on page 2 of the agreement, the Recipient shall use Leveraged Electrification Partner Resources to fund and perform demonstrations in conjunction with the Vulcan electrification grant. Leveraged Electrification Partner Resources are resources from third party organizations in support of the Vulcan electrification demonstration. "Key" Leveraged Partner Resources, listed below, are considered essential to the Vulcan electrification demonstration and are, therefore, referenced and incorporated into this award for informational and reporting purposes. The Key Leveraged Electrification Partner Resources listed herein are **not** subject to the requirements of 2 CFR 200, or the terms of the award.

Key Leveraged Electrification Partner Resources		
Key Partner	**Description of Resources**	**Estimated Amount**
City of Columbus	Deploying EV and EV charging infrastructure.	$ 2,500,000
American Electric Power	Decarbonization of power supply and deployment of electric vehicles and other carbon emission reduction strategies.	$ 29,100,000
The Ohio State University	Deploying EV and EV charging infrastructure, and University investment in mobility and smart grid related research.	$ 13,000,000
Columbus Partnership	Deploying EV and EV charging infrastructure, and investment in mobility and smart grid related research.	$ 7,500,000
Mid-Ohio Regional Planning Commission	Installation of EV charging infrastructure	$ 600,000
FleetCarma	Installation of advanced telematics devices to track and optimize fleet fuel efficiency strategies.	$ 300,000
TOTAL		$ 53,000,000

6. ELECTRIFICATION TECHNICAL WORKING GROUP

To leverage, collaborate, align and integrate the USDOT-funded Smart City demonstration activities with the Smart City demonstration activities funded and managed by the Key Partner, Paul Allen’s Vulcan, Inc., and other Partners, the Recipient shall establish and manage an Electrification Technical Working Group (TWG) to meet, communicate and coordinate on a regular basis with the goal of facilitating integration of electrification activities within the Smart City demonstration and beyond as appropriate. The TWG meetings and interactions shall be designed to facilitate communications, knowledge sharing, identification of project risks, review and provision of feedback on project deliverables of mutual interest, and allow for the Recipient to brief the TWG on progress, schedule and discuss any problems related to electrification activities in the Smart City demonstration.

7. DATA TECHNICAL WORKING GROUP

To leverage, collaborate, align and integrate the USDOT-funded Smart City demonstration activities with the Smart City demonstration activities funded and managed by Partner organizations, the Recipient shall establish and manage a Data Technical Working Group (TWG) to meet, communicate and coordinate on a regular basis with the goal of facilitating integration of data management activities within the Smart City demonstration and beyond as appropriate. The TWG meetings and interactions shall be designed to facilitate communications, knowledge sharing, identification of project risks, and using best practices to fulfil requirements around replicability, openness, independent evaluation, and sharing of open, controlled access, real-time, and archival data. The TWG will enable review and provision of feedback on project deliverables of mutual interest, and allow for the Recipient to brief the TWG on progress, schedule and discuss any problems related to data management activities in the Smart City demonstration.

8. INTEGRATION OF EMERGENT CONCEPTS AND TECHNOLOGY

During the period of performance, the parties anticipate new and updated concepts and technology to emerge and/or mature. In order to ensure the Smart City demonstration is adequately and flexibly positioned to embrace promising emergent new concepts and technology and/or reconsider use of planned concepts and technology, the parties agree to evaluate and discuss, on a regular basis, changes to the Smart City demonstration activities, plans, budget and schedule. During the course of performance, changes to the demonstration plans may be appropriate to adapt emergent concepts, enhance the goals of the demonstration, support other relevant research, and/or support relevant and related testing activities. If a change is deemed appropriate, necessary, and in the best interest of the Government and the Recipient, the agreement may be amended by mutual agreement of the parties accordingly.

SECTION C - FEDERAL AWARD ADMINISTRATION INFORMATION

1. FEDERAL AWARD NOTICES

Only the Agreement Officer (AO) can commit the USDOT. The award document, signed by the AO, is the authorizing document. Only the AO can bind the Federal Government to the expenditure of funds.

2. ADMINISTRATIVE AND NATIONAL POLICY REQUIREMENTS

General terms, conditions, and governing regulations that apply to this agreement are available online at: http://www.fhwa.dot.gov/aaa/generaltermsconditions.cfm

The online list dated March 6, 2015 of "GENERAL TERMS AND CONDITIONS FOR ASSISTANCE AWARDS" apply to this award and are incorporated herein by reference. The online general terms include Payment, Section 508 compliance, AOR authority, Travel, etc. The Recipient shall comply with the list of general terms available online at the website listed above.

In addition to the general terms available online, the following special terms and conditions apply to this agreement.

A. PUBLIC ACCESS TO DOCUMENTS

The Recipient agrees that the resulting deliverables/documentation submitted to the USDOT under this Agreement may be posted online for public access and/or shared by USDOT with other interested parties. The USDOT anticipates the documents cited herein may be posted on a USDOT website or other appropriate website.

B. INDIRECT COSTS

The Recipient is authorized for reimbursement of fringe benefits and insurance costs related to direct labor incurred. No other indirect costs are allowable under this Agreement. The following estimated rates are hereby approved for use under this agreement:

Type*	***Indirect Rate***	***Estimated Rate (%)***	***Base***
Prov.	Fringe	18.95%	City Direct Labor
Prov.	Insurance Rate	Varies by employee from 13.81% - 46.76%	City Direct Labor except Student Interns

*Types of Rates: Pred - Predetermined; Fixed - Fixed; Final – Final; Prov: Provisional/billing; or De minimus.

In the event the Recipient determines the need to adjust the above listed rates, the Recipient will notify the AO of the planned adjustment and provide rationale for such adjustment. In the event such adjustment rates have not been audited by a Federal agency, the adjustment of rates for billings must be pre-approved in writing by the AO.

This Indirect Cost provision does not operate to waive the limitations on Federal funding provided in this document. The Recipient's audited final fringe benefits and insurance costs are allowable only insofar as they do not cause the Recipient to exceed the total obligated funding.

C. DATA RIGHTS

The Recipient must make available to the FHWA copies of all work developed in performance with this Agreement, including but not limited to software and data. Data rights under this agreement shall be in accordance with 2 CFR 200.315, Intangible property.

D. PERSONALLY IDENTIFIABLE INFORMATION (PII)

Personally Identifiable Information (PII) as defined at 2 CFR 200.79 and 2 CFR 200.82 at will not be requested unless necessary and only with prior written approval of the AO with concurrence from the Agreement Officer's Technical Representative (AOR).

E. AVAILABLE FUNDING

The total estimated amount of Federal funding that may be provided under this Agreement is $40,000,000 for the entire period of performance, subject to the limitations shown below:

(1) Currently, Federal funds in the amount of $15,000,000 are obligated to this agreement.

(2) Subject to availability of funds, and an executed document by the AO, the difference between the current funding and the total estimated amount of Federal funding may be obligated to this Agreement.

(3) The FHWA's liability to make payments to the Recipient is limited to those funds obligated under this Agreement as indicated above and any subsequent amendments.

F. KEY PERSONNEL

Pursuant to 2 CFR 200.308(c)(2), the Recipient must request prior written approval from the AO for any change in Key Personnel specified in the award. The following person(s) are/have been identified as Key Personnel:

Name	Title/Position
Aparna Dial	Program Manager
Randy Bowman	Deputy Program Manager

G. PROGRAM INCOME

Pursuant to 2 CFR 200.307, Program income earned during the agreement period must be added to the Federal award and used for the purposes and under the conditions of the Federal award, unless otherwise approved by the AO. Program income must not be used to offset the Federal or Recipient contribution to this project.

H. SUBAWARDS AND SUBCONTRACTS APPROVAL

Note: See 2 CFR §200.330, Subrecipient and contractor determinations, for definitions of subrecipient (who is awarded a subaward) versus subcontractor (who is awarded a subcontract).

Note: Recipients with a procurement system deemed approved and accepted by the Government or by the AO are exempt from the requirements of this clause. See 2 CFR 200.317 through 200.326.

Unless described in the application and funded in the approved award, the Recipient must obtain prior written approval from the AO for the subaward, transfer, or contracting out of any work under this award. **This provision does not apply to the acquisition of supplies, material, equipment, or general support services.**

The following subawards and subcontracts are currently approved under the Agreement:

Name
NONE

Approval of each subaward and subcontract is contingent upon a fair and reasonable price determination, and approval by the AO for each proposed subcontractor/sub-recipient. Consent to enter into subawards and subcontracts will be issued through written notification from the AO or a formal amendment to the Agreement.

I. ORDER OF PRECEDENCE

The Recipient's technical and budget applications are accepted, approved, and incorporated herein as Attachments 2 and 3. In the event of any conflict between this agreement document and the Recipient's applications, this Agreement document shall prevail.

J. DESIGNATION AS RESEARCH OR NON-RESEARCH AGREEMENT

This agreement is designated as: RESEARCH

K. CONFERENCE SUPPORT RESTRICTIONS

The Recipient must obtain written approval from the AOR prior to incurring any costs for conference support. See the definition of conference as contained in 2 CFR 200.432.

Food and beverage costs are not allowable conference expenses for reimbursement under this Agreement.

Note: Costs of meals are allowable as a travel per diem expense for individuals on travel status and pursuant to the Travel clause of this Agreement.

L. AGREEMENT PERFORMANCE REQUIREMENTS SUMMARY

N/A

M. DISPUTES

The parties to this Agreement will communicate with one another in good faith and in a timely and cooperative manner when raising issues under this provision. Any dispute, which for the purposes of this provision includes any disagreement or claim, between the FHWA and the Recipient concerning questions of fact or law arising from or in connection with this Agreement and whether or not involving alleged breach of this Agreement, may be raised only under this Disputes provision.

Whenever a dispute arises, the parties will attempt to resolve the issues involved by discussion and mutual agreement as soon as practical. In no event will a dispute which arose more than three months prior to the notification made under the following paragraph of this provision constitute the basis for relief under this article unless FHWA waives this requirement.

Failing resolution by mutual agreement, the aggrieved party will document the dispute by notifying the other party in writing of the relevant facts, identify unresolved issues and specify the clarification or remedy sought. Within five working days after providing written notice to the other party, the aggrieved party may, in writing, request a decision from one level above the AO. The AO will conduct a review of the matters in dispute and render a decision in writing within thirty calendar days of receipt of such written request. Any decision of the AO is final and binding unless a party will, within thirty calendar days, request further review as provided below.

Upon written request to the FHWA Director, Office of Acquisition and Grants Management or designee, made within thirty calendar days after the AO's written decision or upon unavailability of a decision within the stated time frame under the preceding paragraph, the dispute will be further reviewed. This review will be

conducted by the Director, Office of Acquisition and Grants Management. Following the review, the Director, Office of Acquisition and Grants Management, will resolve the issues and notify the parties in writing. Such resolution is not subject to further administrative review and to the extent permitted by law, will be final and binding. Nothing in this Agreement is intended to prevent the parties from pursuing disputes in a United States Federal Court of competent jurisdiction.

N. DISADVANTAGED BUSINESS ENTERPRISE (DBE) PROGRAM REQUIREMENTS

The DBE regulatory requirements at 49 CFR Part 26 apply to this agreement, but rather than developing its own DBE Program, the Recipient may apply the FHWA-approved DBE Program Plan of the State Department of Transportation (State DOT) in which it is located. The Recipient should set a DBE goal for the project through procedures set forth at 49 CFR 26.45 and the State DOT's Program Plan, and make its own determination about whether or not race conscious goals are appropriate and necessary to help meet its project goal.

3. REPORTING

ADDRESSES FOR SUBMITTAL OF REPORTS AND DOCUMENTS

The Recipient must submit all required reports and documents, under transmittal letter referencing the Agreement number, as follows:

Submit an **electronic copy** to the Agreement Officer at the following address:

Sarah.Tarpgaard@dot.gov

Submit an **electronic copy** to the AOR at the following address:

Kate.Hartman@dot.gov

Submit an electronic copy to the ITS JPO at the following address:

ITSProjects@dot.gov

QUARTERLY PROGRESS REPORTS

The Recipient must submit an electronic copy of the Standard Form - Performance Progress Report (SF-PPR), to the AOR and the Agreement Officer on or before the 30th of the month following the calendar quarter being reported.

The SF-PPR content directions are available online in various locations such as:

http://www.fema.gov/media-library/assets/documents/29485

The Performance Progress Report must include the required certification pursuant to 2 CFR 200.415.

Calendar quarters are defined as:		Reports due on or before:
1st :	January – March	April 30th
2nd:	April – June	July 30th
3rd:	July – September	October 30th
4th:	October – December	January 30th

NOTE: The first Quarterly Progress Report shall include the period from award through December 2016, and is due January 30, 2017.

Include the following information as attached pages:

a. SF-425, Federal Financial Report, and

b. SF-425A, Federal Financial Report Attachment (if applicable).

The Recipient shall include in Block 10, Performance Narrative, the items listed in Task A above. USDOT recommends an attachment to the SF-PPR to provide the quarterly progress report content.

See the Statement of Work, Task A, for progress report content requirements.

ANNUAL BUDGET REVIEW AND PROGRAM PLAN

The Recipient must submit an electronic copy of the Annual Budget Review and Program Plan to the AOR and the Agreement Officer 60 days prior to the anniversary date of this Agreement. The Annual Budget Review and Program Plan must include the required certification pursuant to 2 CFR 200.415. The Annual Budget Review and Program Plan must provide a detailed schedule of activities, estimate of specific performance objectives, include forecasted expenditures, and schedule of milestones for the upcoming year. If there are no proposed deviations from the Approved Budget Application (Attachment 3), the Annual Budget Review must contain a statement stating such. The Recipient must meet via teleconference or web conference with the USDOT to discuss the Annual Budget Review and Program Plan. Work proposed under the Annual Budget Review and Program Plan must not commence until AO’s written approval is received.

SMART CITY VISION ELEMENTS

The USDOT identified twelve vision elements that comprise a Smart City. The Smart City Demonstration shall 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 Demonstration is expected to improve safety, enhance mobility, enhance ladders of opportunity, accelerate the transition to clean transportation, and address climate change.

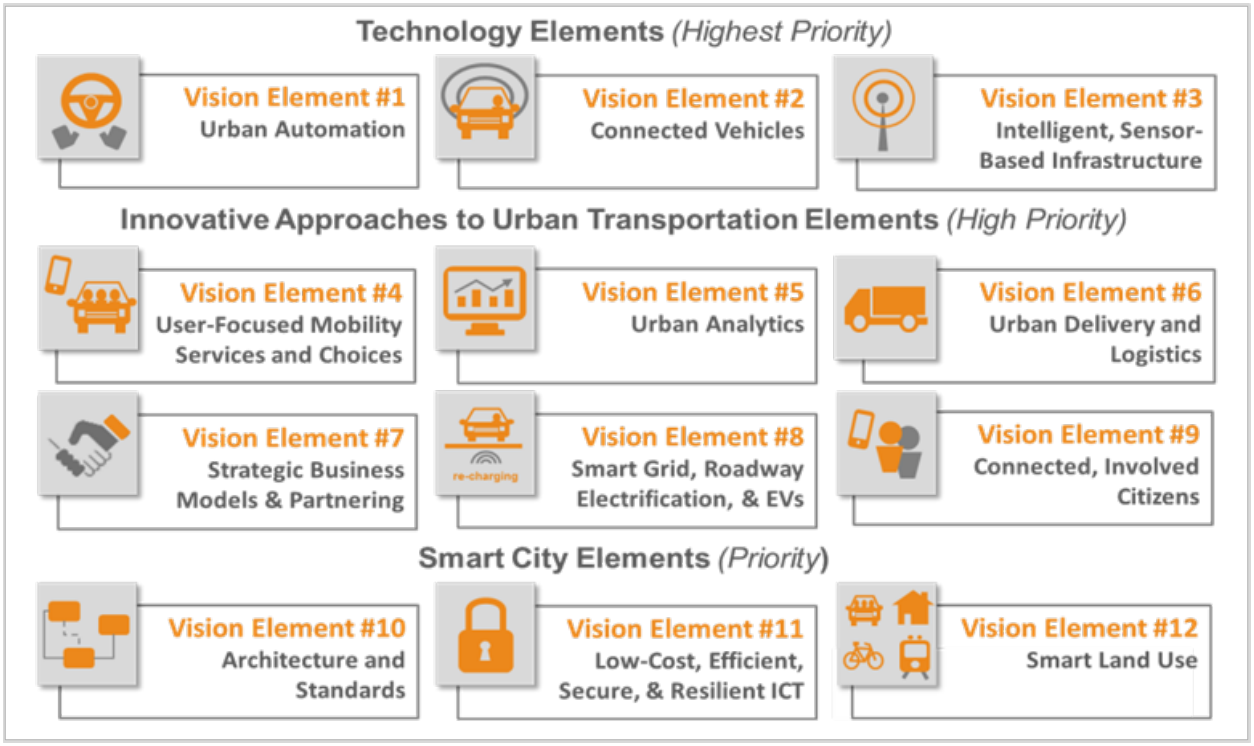

Figure 1. Beyond Traffic: The Smart City Challenge Vision Elements

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/) and the USDOT's Strategic Plan 2014-2018 (https://www.transportation.gov/dot-strategic-plan). Vision elements were derived from foundational research conducted by the ITS JPO's 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 are depicted in Figure 1 and described in more detail below.

TECHNOLOGY ELEMENTS

This group of three Vision Elements includes technologies that are of the highest priority to 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;
- Self-driving shuttles and other forms of fully automated vehicles operating at low speeds to enable new mobility options for services such as first/last mile travel to local destinations and access to public transportation;
- Fully automated trucks and buses used in intermodal facilities, such as ports, depots, and maintenance facilities to improve driver and vehicle efficiencies; and
- Driver-assisted automation to reduce congestion and localized pollution and smog.

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, help to understand demand, and assist in predicting and responding to movements around a city. When made accessible to a broader ecosystem of developers, these data can enable new research and applications that further benefit citizens.

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. Applications may be developed and managed by cities or third parties. 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 and potential applications, 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 allows sensors to collect and report real-time data to inform transportation-related operations and performance and trends of a city. These data allow city operators to evaluate how the city is operating and how to enhance the operation of facilities, systems, services, and information generated for the public. Intelligent infrastructure includes sensors that collect traffic, pedestrian, bicyclist, environmental data, and other information available throughout the city. A successful Smart City will integrate these data with existing transportation data and operations, allowing the city to improve operations of the transportation network. Additionally, 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. Where possible, a Smart City will make these data accessible to a broader ecosystem of developers to enable new research and applications. Smart Cities should leverage existing infrastructure investments, including sensors operated by other public sector agencies, academia, the private sector, and personal mobile devices.

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 and improve current operations and 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 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. Analytics can be used to predict future conditions and the potential benefits of implementing different

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

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. In a Smart City, these performance measures should be made publicly available as open data.

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 across all modes 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 provide people with more options and help to overcome barriers to the use of non-driving forms of transportation. Advanced technology and services deployed throughout a city empower people to adopt "car-free" and "car-light" lifestyles with dramatically less driving if they so choose. 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 system users.

Vision Element #6: Urban Delivery and Logistics. This vision element includes innovative solutions that support efficient goods movement through use of data or 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 energy use, and reduced labor and vehicle maintenance costs. As populations increase and urbanization continues, cities need to identify innovative ways to effectively and efficiently move goods – including food, energy, and manufactured goods – into and throughout cities. 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.

Vision Element #7: Strategic Business Models and Partnering Opportunities. Opportunities exist to leverage creative strategic partnerships that draw in stakeholders – including those from the private sector, non-profit organizations, foundations and philanthropic organizations, academia/University Transportation Centers (UTC), Federal agencies, and other public agencies – to advance smart city solutions. The private sector is pushing innovation and developing new technologies and approaches that can be augmented through new collaborations with government. The public sector is also pushing innovation, creating new opportunities/models for governance and interagency partnerships that will increase return on investment while accelerating deployment. 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, regional Federal agencies, planning organizations, the private sector, vehicle manufacturers, academia, associations, and other stakeholder groups are needed to advance smart city solutions and identify sustainable business models to maintain and expand capabilities in the future. Through cooperation, city governments may partner with non-governmental organizations that can bring resources to the city.

Note: The Connected Vehicle Reference Implementation Architecture (CVRIA) and associated SET-IT software tool provides a means to depict the institutional relationships with the enterprise layer of the architecture. For more information, visit: www.iteris.com/cvria.

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, robust electric vehicle charging infrastructure, and the acceleration of electric vehicle deployment. With electric vehicles (note: the term electric vehicles or "EVs" include full Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Extended Range Electric Vehicles (EREVs)) becoming more prevalent and more advanced, increasing 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. Technology like this can help bring the numerous economic and environmental benefits of electric vehicles to the forefront of a city by coupling and integrating with a robust deployment of electric vehicle charging infrastructure. Likewise, wireless inductive charging technologies increase opportunities for uninterrupted usage of electric vehicles, allowing electric vehicles to charge their batteries wirelessly while the vehicle is stopped or, with certain technologies, even while in motion. Electric vehicles are increasingly available across vehicle class (e.g., transit buses and medium duty vehicles) and price points. Providing access to electric vehicles through car share programs can provide increased access for underserved communities, reduce total operational costs, and contribute to improvements in local air quality.

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, opting-in to provide data from smartphones. Another example of connected, involved citizens includes leveraging broad access to open government data providing a platform for citizens and entrepreneurs 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 complete and well-documented systems architectures – governed by rules, documentation, and standards – that may be extended to a nationwide or broader deployment and support interoperability between systems. 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 and other infrastructure system 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. Multiple system architectures will need to interoperate with the ITS architecture to efficiently support a smart city.

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, scalable, efficient, secure and resilient. This may include telecommunications platforms, enterprise software, storage, visualization systems, and operations to inform decision making. 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 interoperable, unified communications and the integration of telecommunications, and computing 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 that enables dynamic ingest, sharing, and use of data. 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, which 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 which may include sharing it with qualified researchers. Wherever possible, efforts should be made to provide public access to versions of the data that remove any PII-related elements.

> Note on Smart City Challenge Demonstration Award: The USDOT is developing a prototype security credential management system (SCMS) which will be available for use in DSRC-based communications in the Smart City Demonstration. 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 the Recipient 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 using existing appropriate best practices 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. Smart cities 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 designed for 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, shared-use, 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 and citizen needs 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.