Connected Vehicle Pilot Deployment Program Phase 1

Deployment Readiness Summary – New York City

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16. Abstract

This document describes the Deployment Readiness Summary for the New York City (NYC) Connected Vehicle Pilot Deployment (CVPD) Project. It demonstrates the completion of Task 1-12 deliverables of Phase 1 by the NYC team. The document also addresses how the project satisfies the requirements in the Broad Agency Announcement (BAA) for beginning the Phase 2 design/build/test and Phase 3 operation and maintenance of the NYC CVPD system. Additional details include a summary of teaming framework of signed agreements, the project scope, and key risks for Phases 2 and 3. Other planning documents developed under this project phase that influence this document are the Concept of Operations (ConOps), System Requirements Specification (SyRS), Partnership Status Summary, and Comprehensive Deployment Plan. Their publication numbers are FHWA-JPO-16-299, FHWA-JPO-16-303, FHWA-JPO-16-307, and FHWA-JPO-16-309.

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Finally, the team wants to thank the USDOT for sponsoring this project and laying the foundation for future connected vehicle deployments.

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Chapter 1. Introduction

The New York City (NYC) Connected Vehicle Pilot Deployment (CVPD) will be the largest deployment of connected vehicle technology to date. This project brings NYC another step towards reaching its ***Vision Zero*** goal of eliminating the injuries and fatalities due to traffic crashes.

The objective of the NYC pilot is to deploy connected vehicle (CV) applications on a significant number of vehicles composed of taxis, buses, commercial fleet delivery trucks, and other City vehicles, and approximately 310 signalized intersections along 1st, 2nd, 5th, and 6th Avenues, the major cross-town streets consisting of 14th, 23rd, 34th, 42nd, and 57th Streets in Manhattan and Flatbush Avenue in Brooklyn to reduce the number of vehicle crashes and pedestrian injuries. Additionally, infrastructure will be deployed along the FDR Drive and its ramps to address specific safety issues involving crashes with infrastructure. Table 1-1 identifies the City's needs, the CV application satisfying the need, and how this combination supports the Vision Zero program.

A significant number of vehicles in lower Manhattan will be outfitted in the NYC CVPD system. This will enable monitoring a significant number of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) interactions. The data collected from these interactions will be used to measure the benefits of the CV safety applications in reducing the crashes, injuries, and fatalities.

Table 1-1. New York City Department of Transportation (NYCDOT) Needs Summary

NYCDOT Needs	CV Application	Support for Vision Zero
Manage Speed On Surface Streets - 25 mph Regulatory Speed Limit	Speed Compliance	Notify the drivers when their speed exceeds the speed limit
Manage Speeds on Curves - Regulatory Speed Limit	Curve Speed Compliance	Advise drivers to comply with the speed limit on curves, thus reducing the potential of a rollover and subsequent major traffic incident
Manage Speeds in Work Zones - Speed Limit	Speed Compliance/Work Zone	Facilitate widespread adherence to the NYC speed limit. Additional time-of-day reductions, such as those associated with school zones or moving construction (e.g., pothole repair) zones
Reduce Crashes between Vehicles	Forward Crash Warning (FCW)	Warn drivers in case of an impending rear-end crash with another vehicle ahead in the same lane and direction of travel
Reduce Crashes between Vehicles	Emergency Electronics Brake Light (EEBL)	Notify drivers when a vehicle ahead generates an emergency brake event
Reduce Crashes between Vehicles	Blind Spot Warning (BSW) + Lane Change Warning/Assist (LCA)	Warn the driver if another vehicle, traveling in the same direction, occupies the blind-spot zone during an attempt to change lanes

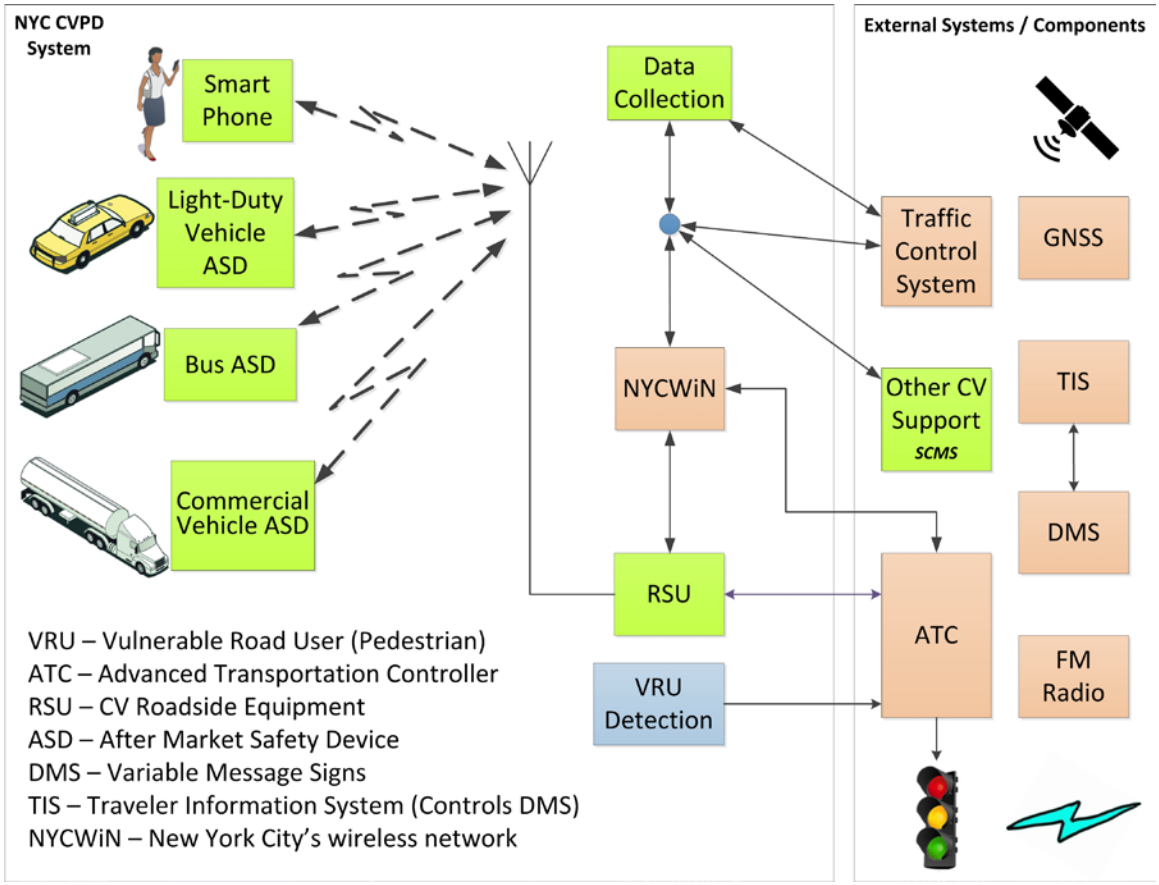
NYCDOT Needs	CV Application	Support for Vision Zero
Reduce Crashes between Vehicles	Intersection Movement Assist (IMA)	Warn the driver when it is not safe to enter an intersection because of high crash probability with other vehicles at stop-controlled and uncontrolled intersections
Reduce Crashes between Vehicles	Vehicle Turning Right in Front of Bus Warning (VTRW)	Warn bus drivers of vehicles pulling up behind a stopped bus, making a lane changes to pass around the bus, and exhibiting a path to cross directly in front of the bus
Reduce Crashes between Vehicles	Red Light Violation Warning (RLVW)	Advise drivers if a vehicle is on an approach that is likely to result in the vehicle violating the red light
Reduce Crashes between Vehicle and Infrastructure	Oversize Vehicle Compliance (OVC)	Provides warnings to vehicle drivers to avoid entering a height-restricted facility and imminent low clearance location
Reduce Crashes between Vehicles and Pedestrians/Bicyclists	Pedestrian in Signalized Crosswalk Warning (PEDINXWALK)	Provide in-vehicle indication of pedestrian / bicyclists at intersections equipped with CV technologies
Reduce Crashes between Vehicles and Visually/Audibly-Impaired Pedestrians	Mobile Accessible Pedestrian Signal System (PED-SIG)	Allows for an automated call from the smart device of a visually impaired pedestrian to the traffic signal and notify approaching drivers of the pedestrian's presence
Inform drivers of serious incidents	Evacuation Notification	Provides notification that an area is to be avoided and why (subset of Emergency Communications and Evacuation concepts)
Provide Mobility Information Heavily Congested Areas	Intelligent Signal System CV Data (I-SIGCVDATA)	Integration of CV movements with NYC's award winning Midtown in Motion (MIM) adaptive traffic signal system

1.1 Deployment Overview

This project brings New York City (NYC) another step ahead towards reaching the Vision Zero goal of eliminating the injuries and fatalities due to traffic crashes. The project's concept is simple - it introduces CV technology and communications into the NYC travel environment by equipping several large vehicle fleets with the technology and equips several areas with the corresponding CV infrastructure.

It is important to understand the implications of the CV technology deployment in New York City. A small portion of NYC roadway network will have CV infrastructure installed (i.e. ~310 Roadside Unit (RSU) locations). V2I applications such as Red Light Violation Warning, Speed Compliance, and Curve Speed Compliance will support connected vehicles operating in these areas. However, the geographic reach of the CV technology is much broader. Vehicles equipped with CV technology (i.e. Aftermarket Safety Devices (ASDs)) will travel in this infrastructure equipped area *and throughout the City's transportation network*. Thus the CV technology that supports V2V applications will function

anywhere two equipped vehicles are within range of one another. Equipped vehicle encounters may occur on the surface streets, in the tunnels and bridges crossing the rivers, at the airports, and on the City's higher speed facilities such as the FDR Drive and the Long Island Expressway. The large fleet size means that there will be many opportunities for the CV technology to perform over a large geographic area and diverse roadway environments. The envisioned NYC CVPD system is depicted in Figure 1-1 below.



Source: NYCDOT, 2016

Figure 1-1. NYC CVPD System Concept

The existing system elements, critical to the operation of the pilot system, are illustrated with beige backgrounds. These existing elements include the traffic management system, the traffic controller (ASTC), and supporting New York City Wireless Network (NYCWiN) communications infrastructure. New system elements which exist and will be reused, modified, or integrated into the NYC CVPD system have green backgrounds. ASDs, Smart Phones, RSU, and data collection/processing systems comprise the new system elements. The Vulnerable Road User (VRU) detection devices to be added to the system are shown with a blue background as these devices are relatively new in representing conventional ITS technology and will be deployed on a very limited basis.

1.2 Purpose of the Report

The purpose of the Deployment Readiness Summary is to provide an overview of the NYC team's progress to date and demonstrate its completion of the deliverables in Phase 1 of the NYC CVPD

project. The document describes how the developed system concept addresses the required elements listed in the Broad Agency Announcement (BAA) for starting Phases 2 and 3. This will also serve as a guide for delivering the Deployment Readiness Summary Briefing and planning how the NYC CVPD system will be designed, built, and tested in Phase 2 and operated and maintained in Phase 3.

1.3 Organization of the Report

Chapter 1 provides an overview of the NYC CVPD project and the purpose of this Deployment Readiness Summary document.

Chapter 2 provides a status update of each Phase 1 Task 1-12 deliverable.

Chapter 3 describes how the NYC CVPD project meets each of the eight required elements stated on page 68 of the BAA.

Chapter 4 summarizes the teaming framework in place with signed agreements, including governance and financial agreements.

Chapter 5 defines the NYC CVPD project scope including its geographic boundaries and number of vehicles and devices.

Chapter 6 explains the key technical risks including equipment acquisition and key institutional risks including the roles and responsibilities of the partners and stakeholders for Phases 2 and 3.

Chapter 2. Phase 1 Deliverables

This section provides a punch list of the Task 1-12 deliverables in Phase 1 of the NYC CVPD. The status options are listed below:

- Not submitted.
- Submitted draft version (date) – The draft version is submitted to United States Department of Transportation (USDOT). The pilot site is waiting for COR review or is revising the draft.
- Submitted revised version (date) – The revised version is submitted to USDOT with edits in response to comments. The pilot site is waiting for COR review or is finalizing the deliverable.
- Final deliverable approved (date) – The final version of the deliverable is approved by USDOT. The pilot site is working on the 508 format of the final deliverable.
- Submitted 508 version (date) – The 508 version of the final deliverable is submitted. The pilot site is waiting for the 508 review by USDOT publication staff.
- Published (date) – The final deliverable has been published online.

The provision or status of each task is shown in Table 2-1 below.

Table 2-1. Deliverable Status of Phase 1 Tasks 1-12

Task #	Task Name	Status
1	Program Management	On-going. Refer to USDOT's NYC 60-Day Outlook Summary.
2	Concept of Operations (ConOps)	Published (7/20/2016)
3	Security Management Operating Concept (SMOC)	Submitted 508 version (8/15/2016)
4	Safety Management Plan	Submitted 508 version (8/3/2016)
5	Performance Management Plan	Submitted 508 version (8/15/2016)
6	System Requirements Specification (SyRS)	Submitted 508 version (8/2/2016)
7	Application Deployment Plan	Submitted 508 version (8/29/2016)
8	Human Use Approval	Final deliverable approved (8/24/2016)
9	Participant Training and Stakeholder Education Plan	Submitted 508 version (8/5/2016)
10	Partnership Coordination and Finalization	Submitted 508 version (9/7/2016)
11	Deployment Outreach Plan	Submitted 508 version (8/8/2016)
12	Comprehensive Deployment Plan	Submitted 508 version (8/29/2016)

In the above table, the status for Task 1 is labeled with "on-going". This is because Task 1 Program Management extends over the entire Phase 1 period and consists of monthly status report and

Project Management Plan modifications. These reports are current as of the last published NYC 60-day Outlook Report dated August 4th.

The other task deliverables have been accepted for content and final 508 compliant versions are under review. NYCDOT expects to complete these versions of the deliverables prior to the end of the Phase 1 Period of Performance.

Chapter 3. Required Elements

Page 68 of the Phase 1 BAA states that "the deployment approach shall have the potential to accommodate the required fundamental elements." These requirements are as follows:

A. Include at least one USDOT-developed application in the pilot deployment. (Please see www.its.dot.gov/pilots for a list of the applications.)
B. Include two or more applications with clear synergy to either reduce costs or increase benefits, or both.
C. Identify some appropriate role for DSRC communications; thoughtful integration of non-DSRC communications technologies are also encouraged.
D. Utilize the SCMS as a tool to support general deployment security. In addition, the proposed pilot must utilize the SCMS for at least one of the proposed applications, and all applications where utilizing the SCMS is deemed appropriate (e.g., applications where trust and security are essential).
E. Agree to share data and open source code with the broader deployment community
F. Agree to interface with national SCMS.
G. Utilize CVRIA and use SET-IT tools as appropriate unless site provides compelling reasons otherwise.
H. Define team framework with single lead organizational entity with clear programmatic control, with identified single individual responsible for overall pilot deployment leadership.

This section describes how the above required elements are satisfied by the NYC CVPD system concept in Phase 1. It summarizes the supporting arguments related to each requirement and provides supporting references to Phase 1 documents. Any risks and their mitigation strategies identified by these required elements are listed in Chapter 6 of this document.

3.1 Element A: At Least One USDOT-Developed Application

The NYC CVPD system will incorporate the following V2I applications developed initially by USDOT: Mobile Accessible Pedestrian Signal System (PED-SIG) and Intelligent Signal System CV Data (I-SIGCVDATA). The original source codes for these applications will be obtained from USDOT's Open Source Application Data Portal (OSADP). The applications consist of the Multi-Modal Intelligent Traffic Signal System (MMITSS) application bundle on the OSADP. They will be modified as needed for the NYC CVPD system based on the NYC CVPD requirements and system design.

In addition to the above V2I applications, the NYC CVPD system will also include the following V2V applications developed by USDOT: Forward Crash Warning (FCW), Emergency Electronic Brake Light (EEBL), Blind Spot Warning (BSW), Lane Change Warning (LCW), and Intersection Movement Assist (IMA). The software for these applications are expected to be commercial off the shelf (COTS)

and deployed with minor adaptations. More specific details can be found in Task 7 Application Deployment Plan, FHWA-JPO-16-303.

3.2 Element B: Two or More Applications with Clear Synergy

As shown in Table 1-1, a major need for NYC is managing the vehicle speed on surface streets. The Speed Compliance (SPD-COMP), Curve Speed Compliance (CSPD-COMP), and Speed Compliance in a Work Zone (SPDCOMPWZ) applications will operate in conjunction with one another. Together, they will utilize the regulatory speed limit provided by the CV infrastructure and the vehicle's speed and location to provide warnings to the driver. SPD-COMP application will be the default application that alerts the drivers to reduce their travel speed and comply with the speed limit. If the vehicle is approaching a curve, the Curve Speed Compliance (CSPD-COMP) application will activate and warn the driver. Similarly, if the vehicle is approaching a school zone, a designated static work zone, or a moving work zone through a construction vehicle, the Speed Compliance in Work Zone (SPDCOMPWZ) application will be triggered. These applications will provide these alerts in the areas where CV infrastructure and necessary messages are deployed.

Another need for NYC is reducing crashes between vehicles. The V2V applications can work synergistically to achieve this goal. For instance, the FCW and EEBL applications may work in conjunction to reduce rear-end crashes. Similarly, the BSW and LCW applications may work together to reduce side-swipe crashes. In the NYC CVPD system, the applications will be configured to operate in synergy without conflicts to support the safety objectives of Vision Zero.

3.3 Element C: Appropriate Role for DSRC Communications

The NYC CVPD will only utilize Dedicated Short-Range Communication (DSRC) Wireless Access in Vehicular Environment (WAVE) technology (5.9 GHz) for all functions and applications listed above – including the security credentials distribution, data collection, and application uploading and adjustments. The system will operate through 6 of the 7 DSRC channels allocated for CV use. All field devices including both the RSU and the in-vehicle unit ASD will contain 2 radios; one will be dedicated to monitoring or transmitting on channel 172 where it can “hear” the Basic Safety Message (BSM) from all vehicles within range of the radio communications; this is critical for the V2V applications. In addition, it will be able to receive the Signal, Phase, and Timing (SPaT) message and the Map Data Message (MAP) and use this information to support the V2I safety applications. Channel 178 will be used as the control channel to inform approaching vehicles of available services through WAVE Service Advertisement (WSA) and indicating which channel and protocol should be used for the service. The other channels (174, 176, 180, and 182) will be used to support the over-the-air (OTA) software updates, application parameter management, and data collection from the in-vehicle event logs.

The NYC CVPD project will utilize the City’s private wireless network, NYCWiN, for all communications to/from the RSU as well as continuing to use this media for communications to the traffic controllers. The traffic controllers will have their firmware updated to support the CV applications; the previous procurement specification for the traffic controllers included sufficient

processing power and available memory for these additional tasks; as soon as the National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) working group finalizes the 1202 standard with the CV data elements, we will be ready to update the controller firmware.

The City is confronting a number of challenges to the deployment of the CV technology in the dense urban environment. First, the ranges of the RSU infrastructure will overlap in all directions; the block spacing is approximately 70 meters for streets and as much as 200 meters for the avenues. Since the DSRC range is approximately 300 meters and far greater ranges have been observed in some previous projects, we expect that operational adjustments will be needed such as variable power output levels. The existing communications design precludes peer-to-peer communications in order to manage security risks and provide location based configuration management (e.g. cabinet based identification enables controller replacement and database loading). This architecture is not conducive to multiple intersection controllers communicating with a shared RSU that produces MAP/SPaT messages for the multiple locations. In addition, where the density of vehicles for other projects has been very low, we are expecting that the percentage of instrumented vehicles is likely to approach 20% or more depending on the time-of-day and location since a large portion of the vehicles are taxicabs. All of the fleets which will be participating in this project service the midtown and lower section of Manhattan; hence one of the goals of the project is to foster frequent interactions amongst vehicles – all of which are to be equipped with the full complement of safety applications. The NYC CVPD will also likely see a significant number of participants within the range of several RSUs, resulting in the need for channel congestion mitigation and an opportunity to determine its effects.

3.4 Element D: Utilizing the SCMS

All OTA communication among vehicles and between vehicles and RSUs will be protected through using certificates issued by the Security Credential Management System (SCMS) and the security provisions of the IEEE 1609.2 standards. Credential management may be implemented by hardware or by software on individual devices. Exactly how the SCMS is implemented, including how often actors are authenticated, has significant implications for bandwidth and cost. These decisions will be an integral part of the application development process. Dedicated tests of SCMS will be conducted, and security will be included from the early stages of integration testing as described in Chapter 5 of the Task 7 Application Deployment Plan, FHWA-JPO-16-303.

3.5 Element E: Sharing Data and Open Source Code

3.5.1 Plan for Uploading Data to RDE

Some of the event data will be collected by the CV components (the ASDs and the RSUs), and other data will come from external sources (such as traffic control system data, crash databases and statistics, observed weather data, traffic counts, and travel times and speeds). All data will be scrubbed to remove any personally identifiable information (PII) using the data obfuscation protocols to be developed. This is described in the Task 5 Performance Measurement Plan document, FHWA-

JPO-16-302. Following this obfuscation process, the raw data will be destroyed[1], leaving only the obfuscated data. The obfuscated data will then be processed to develop performance metrics of the efficacy of the NYC CVPD application deployment and to calibrate microscopic simulation models to further estimate the effects of the NYC CVPD that cannot be directly observed in the field. Further details of the data sets, the obfuscation process to strip data of potential PII, the performance measures to be developed, and the evaluation plan are described in detail in the Task 5 Performance Measurement and Evaluation Support Plan Report.

The NYC CVPD data will be uploaded to the USDOT's Research Data Exchange (RDE) for use by the research community. This includes the ASD and RSU data that has been aggregated & obfuscated, the data from external sources, performance data from sources external to the CVPD, the possible confounding data (such as weather or work zones), and calculated performance metrics. As planning proceeds and particularly during the shakedown period, the anticipated volume of data will be estimated, and the team may decide, in cooperation with USDOT, whether to upload a representative subset of the data instead of the entire database.

While the ASD action log data will be obfuscated to prevent the matching of a driver action's to a specific time and location, the obfuscated data logs will be further reviewed before posting the data to the RDE to ensure that stakeholder and participant privacy is maintained. If some groupings of the obfuscated data and the confounding data have small numbers of samples, that data may be withheld from the RDE to prevent matching against other databases, such as crash records, that contain time and location details with PII.

The disaggregated privacy-cleansed data will be uploaded in 24 to 48 hour time windows, as it becomes available. The processed aggregated data will be uploaded quarterly or more often depending on the volume and details worked out with USDOT in phase 2 of the project.

3.5.2 Intellectual Property Rights and Posting Code to OSADP

Intellectual property rights to the software will be negotiated as part of the ASD & RSU procurement. Ownership will depend on the origin of the designs for the code and equipment, the level of federal funding, and any data rights that may be asserted by the vendors in their proposals. The bid specifications will require this type of disclosure.

The New York City CVPD will have at least one application that is built from code found in the OSADP. The conditions for posting newly developed code to OSADP will be determined as part of the procurement process. This is anticipated to include elements from the data analysis and the extraction of mobility data (at the TMC) as well as selected PED applications from the MMITSS program.

3.6 Element F: Interfacing with National SCMS

Privacy is a major consideration in the NYC CVPD project. Although the vehicles involved are regulated fleet vehicles, the City will be implementing a number of measures to protect the privacy of

[1] Refer to the Performance Measurement Plan Document (Task 5); this is necessary to avoid problems associated with Freedom of Information Requests and Subpoenas for information held by NYCDOT that could be used against drivers or vehicle owners.

the participants and to make sure that the data collected and used for the evaluation of the benefits and for maintenance support cannot be disaggregated and analyzed or merged with other data (e.g. police accident records) to determine the exact actions and location history of any specific operator or vehicle. The system will make use of the SCMS being developed by USDOT and the data will be encrypted, normalized, and obfuscated as soon as the analysis of the benefits has been determined. All communications will contain security certificates that will allow the receiver to authenticate the origin of the information.

The NYC CVPD team's intent is to utilize RSU (V4+ as modified) and ASD (V3 – as modified) specifications that conform to the USDOT standards where they exist as closely as reasonably possible and that all messages conform (where applicable) to the latest versions of SCMS, Society of Automotive Engineers International (SAE) J2735, SAE 2945/x, Institute of Electrical and Electronics Engineers (IEEE) 802.11p, IEEE 1609.x, NTCIP, International Organization for Standardization (ISO) 19091, and related standards. While we recognize that some of these are still being developed, all of these standards are expected to be stable by the end; of the 1Q2017 which is the planned start of the production units for this project. Note further that our procurement specifications are expected to “go beyond” the current documents listed above to include features such as OTA software updates, reliable and secure boot, guaranteed recovery from any power up/down sequences, and recovery from process or data “errors” or crashes.

3.7 Element G: Utilizing CVRIA/SET-IT Tools

In the beginning of Phase 1, the NYC CVPD team attended the Connected Vehicle Reference Implementation Architecture (CVRIA) Boot Camp hosted by USDOT to learn the reference architecture and System Engineering Tool for Intelligent Transportation (SET-IT) software. Page 13-14 of the BAA states that the CVRIA is "being developed as the basis for identifying the key interfaces across the connected vehicle environment which will support further analysis to identify and prioritize standards development activities." It will "also support policy considerations for certification, standards, core system implementation, and other elements of the connected vehicle environment." Based on the CVRIA, the SET-IT tool "integrates drawing and database tools with the Connected Vehicle Reference Implementation Architecture (CVRIA) so that users can develop project architecture for pilots, test beds, and early deployments."

The NYC CVPD team utilized the SET-IT tool as required in the BAA to input all of the stakeholders, applications, elements, and objects to generate the system needs, physical architecture diagrams, enterprise architecture diagrams, and enterprise context diagram for the NYCDOT CVPD project. The SET-IT software was also used to generate the initial draft ConOps document based on its internal template. USDOT comments on the SET-IT generated needs (based on the CVRIA application needs) and the ConOps format (i.e. noncompliant with IEEE Standard 1362-1998 guidelines) indicated that the SET-IT output would not meet their needs. While the BAA required SET-IT usage and the USDOT assured that the SET-IT generated outputs would be acceptable, this strong critique caused the NYC CVPD team to reconsider its approach to developing the ConOps. As a result, the team revised the ConOps based on stakeholder needs and use cases, and strictly conforming with the IEEE 1362-1998 outline guidelines in order to address USDOT's comments. The NYC CVPD team did use the SET-IT generated physical and enterprise architecture diagrams in its ConOps and clarified the relationship between user needs and system needs of the proposed NYC CVPD concept. The NYC CVPD team provided feedback to the SET-IT development team and suggestions for consideration in future releases.

3.8 Element H: Single Lead Organizational Entity

NYCDOT will be the prime contractor for the NYC CV Pilot project Phase 2&3. NYCDOT has integrated industry leading and locally well-known companies who possess the experience and track record of numerous CV and NYCDOT ITS successful project deliveries. This team consists of several partners who provided support throughout the first phase of this engagement. This partnering approach is one that the NYCDOT has used on many successful transportation projects.

The proposed key staff for this important project are three leading industry experts who led the design and integration of the NYC TCS, Advanced Transportation Controller (ATC), and MIM adaptive signal system with the NYCWiN. Dr. Talas, Mr. Benevelli, and Mr. Rausch possess more than 50 combined years of experience in working together to integrate ITS in NYC. They will lead the NYC CV Pilot – the next generation of technology to be integrated in NYC.

In his role as Project Management Lead, Dr. Talas is the individual responsible for overall pilot deployment leadership.

3.8.1 Mohamad Talas, Ph.D., P.E., P.T.O.E., Project Management Lead

Dr. Talas is the Deputy Director for the System Engineering Division for the New York City DOT and supervises 80 staff members in two units that oversee the development of ITS projects and initiatives currently in progress in New York City. These projects include the NYC CVPD (Phase 1), the Vehicular Traffic Computerization System (VTCS), the NYC Advanced Solid-State Traffic Controller (ASTC) for 12,000 intersections, and the NYC Midtown in Motion Project- Smart Lights and the NYC.

Dr. Talas currently manages Phase 1 of the NYC CVPD project with the goal to deploy this cutting edge technology to improve traffic safety in line with NYC Vision Zero mission. He also manages the annual federal grants of $60M used for the operation and NYC capital ITS projects deployment. Additionally he directs the operation of the NYC Traffic Management Center, supervises the traffic improvements study for ITS projects, and serves as agency representative with NYC metropolitan transportation agencies. He also supervises NYC ITS strategic plan research project with NY UTRC-CUNY University and NYC Adaptive Control Research with MIT - Massachusetts Institute of Technology.

3.8.2 Robert G. Rausch, P.E., Site Deployment Lead

Mr. Rausch is a Vice President and Chief ITS Systems Engineer with JHK with more than 40 years experience in the design, development, and deployment of ITS devices and systems. He is also a Registered Professional Engineer (P.E.) in 22 states. He was the Concept Development Lead for Phase 1 of the NYC CVPD project and Technical Program Manager and Lead Designer for the deployment of ITS systems for New York City. As Chief Engineer for JHK's ITS division, Mr. Rausch is responsible for technical reviews and audits of projects and products throughout the company.

Mr. Rausch has been active in the standards arena both nationally and internationally and is currently one of the instructors for the International Road Federation. He provides technical oversight / management to a number of projects and has been participating in the "Connected Vehicle" program through JHK's role with DSRC, ISO's cooperative ITS working group (18) and active participation in USDOT sponsored workshops and standards development programs. Mr. Rausch is also active in

the development of the NTCIP standards, the Advanced Transportation Controller (ATC) Steering Committee, DSRC standards development, Traffic Management Data Dictionary, center-to-center communications, and developer and participant in ISO TC204 developing international standards for ITS and CV integration. Additionally, he was the subcontractor to various USDOT efforts including International Harmonization task Group 6 dealing with security and privacy standards for the CV infrastructure.

3.8.3 David A. Benevelli, P.E., Systems Engineering Lead

Mr. Benevelli's unique and diverse background brings the broad knowledge base necessary to successfully build and operate today's Advanced Traffic Management Systems (ATMS). This substantial experience spans the project life cycle starting with initial concept and application of the National ITS Architecture through system design and implementation concluding with system operations. It also encompasses a variety of project roles from team member to project manager including advisory roles. Because of this diverse background, he is a key contributor to JHK's ITS practice.

Mr. Benevelli is an Associate Vice President with over 38 years experience in traffic management planning, development, design, deployment, and operation and over 30 years experience with New York City's traffic signal control system. He was the lead system engineer for Phase 1 of the NYC CVPD project. In addition, he is a member of the DSRC Technical Committee, contributing to development and maintenance of the DSRC standards and a member of ISO 19091 development team, working with the DSRC technical committee updating the SAE International's J2735™ Data Dictionary standard (the basis for the 19091).

Chapter 4. Teaming Framework

This section presents the NYC CVPD project's teaming framework in place with the signed agreements, including the governance agreements associated with coordinated systems management and financial agreements signed among all stakeholders. Each agreement includes a short summary and the status of the agreement to date.

4.1 Governance Agreements

NYCDOT was awarded a contract by the FHWA to implement this Pilot Program. The Pilot is well-aligned with Mayor Bill de Blasio's Vision Zero initiative, and as such has upper-management support at the highest levels of City government. NYC DOT has brought forward strong project management resources to this effort to further establish the governance approach throughout the pilot. The administration, maintenance, and policy supporting the pilot will be led by NYCDOT. NYCDOT Legal Council is leading the development and execution of MOUs with the stakeholders.

The primary objective of the governance process is to promote consistency and shared stakeholder expectations, empower stakeholders so that they are contributors to the success of the pilot, and establish procedural processes for review and evaluation of the pilot. NYCDOT has taken the lead in all governance processes including risk management, quality control, procurement, and project implementation. NYCDOT will have responsibility for the infrastructure aspects of the system and the various stakeholders will assume responsibility for the installation of vehicle equipment, with some oversight (specification, equipment, and training) from the NYCDOT. Agreements will identify paths for problem resolution. According to Task 10 Partnership Status Summary document, the NYC CVPD project team will periodically analyze what went right, what went wrong, and what are the lessons learned for the future across all of the agreements and negotiations.

A sample draft Memorandum of Understanding (MOU) developed by the NYCDOT Legal Council is included in APPENDIX B. The draft MOU documents the stakeholders' agreement and support of their participation in the NYC CVPD. As comments are received and details are better defined, the MOUs will be finalized, although they are not at that stage currently. There is no anticipated timeline for finalizing the MOUs as the team believes a stepwise process is best and time is needed to determine each stakeholders needs for a comprehensive and agreed upon MOU.

4.2 Financial Agreements

It is anticipated that stakeholder agreements will adopt "continuous improvement" frameworks to the agreement process so that all partners are tracking performance and regularly conferring on ways to improve it. Phase 1 of the NYC CVPD did not get far enough along the path of full design to determine the definitive financial agreements needed for a fully deployed Pilot. The stakeholders' expectation is that the equipment and installation will be at no cost to them, and be supplied by NYCDOT. There are several elements that have been discussed, but not resolved during Phase 1 needed to fully define

the financial agreements with various stakeholders. The risks and concerns for the financial agreements moving forward are summarized below.

- Through various discussions with stakeholders NYCDOT has implied there is no cost to the participants in this Pilot. NYCDOT will be paying for the equipment and the installation for participants. Full costs and details cannot be defined until the system requirements, equipment purchases, and installation procedures and costs are understood.
- There is an important unknown cost of the Pilot as the USDOT will be the "owner" of the CVPD equipment that has been installed into the participant's vehicle and the end of the project retrieval of the equipment is not yet defined. Direction from the USDOT will be needed in order to define the financial agreement with each stakeholder.
- There is an important unknown cost to participating in the Pilot related to the "up time" of the CVPD equipment. Specifically, if CVPD equipment is in need of repair, the time that repair takes place is lost time for the revenue generation of that vehicle. More information will be needed to address this concern in the financial agreements.

4.3 Contracting Program

NYCDOT plans to continue with the contracting relationship established during Phase 1 of the NYC CVPD Program.

- JHK/TransCore will continue as the lead design team and system integrator. JHK has subcontracts in place for the ongoing services to be provided by:
  - Cambridge Systematics
  - Security Innovations
  - KLD
  - UTRC/NYU
- NYCDOT will be bidding contracts through requests for quotes (RFQ) for the design, supply, support, and depot maintenance for the RSU's and OBUs/ASDs as described in Task 7.
- NYCDOT will be subcontracting the installation of the in vehicle equipment as necessary utilizing existing facilities for the Taxis, and subcontracted shops for the MTA, Sanitation, and DOT fleet vehicles.
- UPS will be installing all equipment in their vehicles with some consideration from NYCDOT.

Chapter 5. Deployment Scope

This section provides an overview of the project scope including geographic boundaries, number of vehicles and devices, and RSU locations.

5.1 Geographic Boundaries

The NYC CVPD project area encompasses three distinct areas in the boroughs of Manhattan and Brooklyn. Figure 5-1 shows the general location of these areas within NYC. The following describes these deployment areas in terms of their roadway characteristics.

Source: NYCDOT, 2016

Figure 5-1. NYC CVPD Overview Map

The first area includes a 4-mile segment of Franklin D. Roosevelt (FDR) Drive from 50th Street to 90th Street in the Upper East Side and East Harlem neighborhoods of Manhattan. There are seven entrance/exit points within this area of the FDR Drive. The second area includes four one-way corridors of 1st Avenue, 2nd Avenue, and 5th Avenue from 14th Street to 67th Street and 6th Avenue from 14th Street to 59th Street in Midtown and Upper East Side neighborhoods of Manhattan. The segment lengths are 2.6 miles for 1st, 2nd, and 5th Avenues and 2.2 miles for 6th Avenue, respectively. The third area covers a 1.6-mile segment of Flatbush Avenue in Brooklyn from Tillary Street on the north and Grand Army Plaza near Prospect Park to the south. While FDR Drive is a freeway without signalized intersections, the four avenues in Manhattan include 202 signalized intersections and Flatbush Avenue in Brooklyn includes 28 signalized intersections. In addition to the five avenues in Manhattan and Brooklyn, the fourth area encompasses the following two-way cross-town streets in Manhattan: 14th, 23rd, 34th, 42nd, and 57th streets. RSUs will be installed at designated intersections on these five streets between 3rd Avenue and 10th Avenue. The geographic areas for the RSUs are depicted in Figure 5-2 below.

Source: NYCDOT, 2016

Figure 5-2. Infrastructure Deployment Map

Another set of RSUs will be installed at other strategic locations throughout the City such as river crossings, the airports (NYCDOT has made arrangements with Port Authority of New York and New Jersey (PANYNJ)), and at the vehicle "barns" (bus, taxi, and fleet depots). These units are positioned to have longer contact with the equipped vehicles in support of system management functions such as parameter configuration and event data collection.

5.2 Numbers of Vehicles/Devices/Roadside Equipment

The project's primary goal is to deploy the CV technology in a significant vehicle population to enable frequent encounters of similarly equipped vehicles. The City is planning to install the CV technology in approximately 8,000 vehicles which frequent the streets of Manhattan and Brooklyn as shown in Table 5-1. The current fleet size estimate is slightly reduced from the ConOps due to a number of factors such as: a) historical taxi retirement rate, b) installation time scheduling, and c) budget constraints. This equipped fleet provides an opportunity to experience a significant density of DSRC-based vehicle interactions. These vehicle's V2V safety applications will operate anywhere they encounter another DSRC equipped vehicle.

Table 5-1. Vehicle Fleet

Fleet Owner	Equipped Vehicles (Est.)
Taxi Companies	5,850
MTA	1,250
UPS	400
NYCDOT	250
DSNY	250

The City will also be installing approximately 310 RSUs at signalized intersections in midtown and lower Manhattan and along Flatbush Avenue in Brooklyn. In addition, the City will be installing a number of RSU's along portions of FDR Drive. The vehicle's V2I safety applications will function where they encounter RSUs along these streets. The geographic areas for this technology deployment are summarized in Table 5-2 below.

Table 5-2. RSU Quantity by Location

Location	RSU Quantity (Est.)
Manhattan arterials	202
Manhattan cross streets	79
Flatbush Ave	28
FDR	8
Support locations	36
Total	353

Another set of RSUs will be installed at other strategic locations throughout the City such as river crossings, the airports, and at the vehicle "barns" (bus, taxi, and fleet depots). These units are positioned to have longer contact with the equipped vehicles in support of system management functions such as parameter configuration and event data collection.

Chapter 6. Risk Assessment

This section describes the key technical risks including equipment acquisition and key institutional risks including roles and responsibilities of the partners and stakeholders for Phase 2 deployment and Phase 3 operations. Successful execution of our deployment plan depends on a number of external factors. Each of these assumptions represents a risk to the project that will affect the ability to meet the schedule and/or performance goals. Following each assumption/risk is the team's approach to mitigating that potential impact/risk.

6.1 Key Technical Risks

The technical risks that have been identified and their mitigation approaches are listed below.

(a.) The New York City signal system needs to revert to an earlier version, interrupting development and testing.

Mitigation: Any upgrades related to the signal controllers or their software will be thoroughly tested before deployment, so that traffic is not disturbed. This is inherently on the critical path and not part of the open procurement, so this work can start sooner to avoid delays.

(b.) The number of makes and models in any category is more than anticipated, so extra time and effort is required to adapt and install the ASDs.

Mitigation: As fleets and companies are enrolled, the number of makes and models and the corresponding number of unique installations will be recorded so that adequate resources can be planned. This work is being started under Phase 1 to reduce impacts on the Phase 2 schedule.

(c.) Security system is not available for testing as scheduled, or handling certificates is more complicated than anticipated. These risks could delay testing or degrade performance.

Mitigation: This is a critical risk with dependencies outside the project and relying on the Security Credential Management System still under development. Testing will be unrealistic without a working security system, and deployment cannot begin without it.

(d.) ASD hardware modules cannot accommodate all of the safety applications and event recording applications. This could degrade performance or restrict the number of applications that are deployed.

Mitigation: The Request for Expression of Interest (RFEI) was an advanced step in assessing the ASD capabilities, and capacity will be scrutinized throughout the acquisition and deployment.

(e.) RSUs or backhaul systems cannot handle the volume of data in event uploads, causing at worst data to be lost.

Mitigation: The systems will be designed to accommodate peak demand. Should capacity be regularly exceeded, the simplest mitigation is to trim the amount of recording time before

and after the event trigger, using configurable parameters. The extreme mitigation is to install additional RSUs on routes leading to distressed RSUs to relieve the demand.

(f.) Vehicles need hardware upgrades but cannot be located.

Mitigation: If a vehicle is known to be reporting irregular performance data and its hardware cannot be replaced, the performance data will be intercepted before the obfuscation step and discarded. If a vehicle becomes a "bad actor" or is unavailable for an extended time, its security certificate will be revoked and it will be removed from the deployment.

(g.) Installation teams cannot be formed quickly enough to equip all of the vehicles for deployment.

Mitigation: Part of the fleet enrollment process will be to determine the ability of their maintenance staff (or contractor) to provide the necessary labor. Temporary labor may be an option in some cases, as is moving maintenance to other providers. Fleets' existing maintenance agreements will preclude those options in other cases.

(h.) Location accuracy elements within the RSU/ASD do not function adequately for the applications.

Mitigation: The City continues to explore alternatives that could improve the location accuracy. We are also working with our Vendors and collected data during the RFEI that suggests that the vendors are fully aware of the problem and are developing solutions including inertial navigation support, map matching, RSU signal use, and ultra-wideband (UWB) accuracy enhancing systems. The project will utilize Wide Area Augmentation System (WAAS) for improving the location accuracy through computing the Global Positioning System (GPS) positions and transmitting the GPS correction information.

6.2 Key Institutional Risks

The institutional risks on how the NYC CVPD will be operated and maintained and their mitigation strategies are listed below.

(a.) The *Security Credential Management System* version 1.1 will need to be available and stable by November 1, 2016. The USDOT will need to define the specific protocols for all users to incorporate and the certification processes required to ensure equipment meets the standards for security and interoperability.

The protocols (for security authentication and encryption/decryption) and their implementation will need to be able to handle messages at the rate needed for the traffic density in New York City. The response times for the Security Credential Management System (SCMS) will have an impact on the system design as to whether credentials need to be managed as store and forward due to the demands for service. Note that this is an important consideration based on the future of the use of the SCMS.

This is a deployment with actual **users in revenue service**; the security must be in place before testing moves to drivers outside the project team.

Mitigation: There is no mitigation for this risk; the project schedule will slip and costs will increase since the BAA explicitly told us to use the SCMS, we did not design or make provisions for the absence of a working SCMS. The only alternative is to run without security and for such a deployment this is far more risky.

(b.) How well the DSRC and Global Navigation Satellite System (GNSS) will perform in the urban canyon. The team already knows some of the issues from prior projects and preliminary testing. The early acquisition of ASDs will enable continued testing and development throughout Phase 2.

It is also clear that the location "tracking" mechanism needs to continue in an active mode in the urban environment where possible – or many of the freeway applications will be turned off along FDR drive. There are large areas of NYC where there is "something" overhead – it would be unfortunate if every time Global Positioning System (GPS), "lock" is lost, they all became inactive?

Mitigation: We believe this can be solved, and during the RFEI demonstrations, this was discussed with each of the vendors. One of the reasons we had them drive Manhattan and collect GPS "bread crumbs" was to make sure they understood the situation. Each vendor indicated they had been developing alternatives including data from the CAN bus, accelerometers, and even RSU triangulation. We plan to require perspective vendors to demonstrate prior to award of the procurement contract and will include extensive testing for this specific problem.

(c.) The Schedule will be met by the selected ASD and RSU vendors. The demands on the hardware and the complexity of the software will be unprecedented for CV equipment. The team will work with vendors to establish realistic schedules and enable as much parallel work as possible. After development is complete, manufacturing and installing the units will take time.

Mitigation: We plan on awarding to two (2) vendors and evaluating prototypes early in the project (See the schedule). With two vendors, we can fall back to a single vendor and disqualify the non performing vendor and continue with the performing vendor for the full complement of units. All vendors interviewed during the RFEI indicated they could meet the schedule.

(d.) Vendor start at risk. The implementation plan is also highly dependent on the ASD/RSU vendors being motivated to initiate their activities after receiving a Notice to Proceed at Risk and before the completion of contracting. The contracting delays and schedule will require that the vendors start much of their work "at risk"; if the City takes 6 months after announcement of award, the vendors will need to proceed with the development and hardware design "at risk" in order to even come close to meeting the proposed schedule. That is – much of the development, certification, and testing must, of necessity, begin before the City issues a billable contract. It is also likely that the prototypes will be delivered and installed before the contract is issued! Will all of the vendors accept such conditions? We have some initial indications that this will not be a problem.

Mitigation: During the RFEI, all vendors were interviewed and this specific issue was addressed. All vendors will be required to agree to this provision when preparing their bid and all vendors indicated this would not be a problem

(e.) Review & approval by USDOT of all aspects of the Phase 2 work must be done very quickly and the existing "approvals" of the Phase 1 ConOps, SMOC, Performance Measurement and Evaluation Support Plan, and SyRS documents will be used to jump start the development and procurement specifications. Delays in the review and approval of such documents and completion of promised resources may extend the project schedule and budget.

Mitigation: We have allowed the 10 day approval by USDOT in our project schedule, and have encouraged the USDOT to instruct the Independent Evaluator (IE) to work alongside

NYCDOT during the early phases of the deployment to ensure that our data collection would meet their needs.

(f.) Data collection in the "Before" period begins May 2018 at the start of Phase 3, i.e., formal data collection of any type of data collected using the deployed CV devices or that could be influenced by the CV deployment or other confounding factors will not start until Phase 3. . If the IE has issues with the type of data being collected and the processing, then the changes may be requested [by USDOT] and such changes may extend the project schedule and budget.

Mitigation: Knowing this, we will make the raw data available at NYCDOT Traffic Management Center (TMC) for the IE's evaluation and testing prior to Phase 3. If the IE works side-by-side with the real raw data, the risk that the data being collected is reduced or eliminated and we can adjust both the expectations and software early in the project.

(g.) There is inadequate time [schedule] and budget to deal with a vendor pre-qualification phase and bake-off. We will rely on the responses to the RFEI; the vendor(s) chosen may not be the low bid as we will require further demonstrations prior to award. However, once the vendors have been chosen, the project is at significant risk until the completion of the 100 ASD/10 RSU pre-pilot installation and testing program is successfully completed; if the vendor is ultimately unable to complete this phase successfully, the schedule is at serious risk because of the time required to start with an additional vendor.

Mitigation: If we move forward with 2 vendors, the risk is mitigated, but the development costs and integration costs may double. We have assumed two bidders and two awards in our cost model.

(h.) USDOT completes its promised tools and utilities – especially for the development of the Map Data Message (MAP) message (including pedestrian (PED) crossings) by the end of 2016. Delays in the delivery of such tools may delay the project schedule.

Mitigation: We can hire this to be done but at a considerably higher cost than shown in our budget.

(i.) The Federal Communications Commission (FCC) does not change the spectrum use for the DSRC band – as this could necessitate a re-design and re-engineering of both the hardware and software – and jeopardize the funding since this project is intended to lead to permanent deployment.

Mitigation: There is no mitigation strategy. Our solutions are dependent on the use of DSRC, and changes to the channel availability and use will increase costs and cause project delays. It is up to USDOT to strongly support the current channel allocation and to ensure that any channel sharing is done in a manner that does not compromise the current channel allocations and usage. Further mitigation would mean redesign of the radios and channel usage plans and reliance on alternate media – which could delay the project.

(j.) Continued support from the stakeholders is paramount to this project. We will continue to increase the participation throughout the initial phases of the project.

Mitigation: We will continue to increase the participation throughout the initial phases of the project. We will stand by the privacy provisions of our data collection and are now launching a "sales" campaign with the stakeholder community to "sell" the benefits of this technology and the value of the opportunity to be early adopters at no cost to them!

(k.) The initial Institutional Review Board (IRB) approval from Phase 1 is assumed to form the basis for the IRB of Record (Phase 2) based on the interaction of both IRBs during Phase 1.

Mitigation: We are transitioning and involving the IRB of Record now, and expect early acceptance to continue the past IRB recommendations; the PED applications will be delayed, with no impact to the schedule and NYU is being given a much greater role in the PED subject selection, recruitment letters etc.

(l.) The petition to FCC that it "must immediately prohibit use of DSRC until it adopts service rules protecting the cybersecurity and privacy of DSRC users – and DSRC operators demonstrate compliance with those rules" may delay full deployment and operation of NYC CVPD. Granting of this stay could prevent the project from using any deployed DSRC communications equipment. Although the equipment may be deployed, the DSRC messages may not be able to be transmitted until the FCC ruling is lifted.

Mitigation: An attorney may need to be consulted. The NYC CVPD team could encourage DSRC users to respond to the FCC ruling during the comment period and proceed with the project until the stay is either granted or denied. At that time, the situation would need to be reassessed with USDOT.

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3.	Galgano, S., Talas, M., Benevelli, D., Rausch, R., Sim, S., Opie, K., Jensen, M., Stanley, C., Connected Vehicle Pilot Deployment Program Phase 1, Concept of Operations (ConOps) - New York City, April 8, 2016 FHWA-JPO-16-299.
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9.	University of Arizona, University of California PATH Program, Savari Networks, Inc., SCSC, Econolite, Multi-Modal Intelligent Traffic Signal System: System Design. Version 1.0.
10.	*USDOT Broad Agency Announcement with New York City*, New York City Department of Transportation, September, 2015

APPENDIX A. List of Acronyms

Acronym / Abbreviation	Definition
ASD	Aftermarket Safety Device
ASTC	Advanced Solid-State Traffic Controller
ATC	Advanced Transportation Controller
ATMS	Advanced Traffic Management Systems
BAA	Broad Agency Announcement
BSM	Basic Safety Message
BSW	Blind Spot Warning
ConOps	Concept of Operations
COTS	Commercial Off the Shelf
CSPD-COMP	Curve Speed Compliance
CV	Connected Vehicle
CVPD	Connected Vehicle Pilot Deployment
CVRIA	Connected Vehicle Reference Implementation Architecture
DMS	Dynamic Message Sign
DSRC	Dedicated Short Range Communications
EEBL	Emergency Electronic Brake Lights
FCC	Federal Communications Commission
FCW	Forward Crash Warning
FHWA	Federal Highway Administration
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IE	Independent Evaluator
IEEE	Institute of Electrical and Electronics Engineers
IMA	Intersection Movement Assist
IRB	Institutional Review Board
I-SIGCVDATA	Intelligent Signal System CV Data
ISO	International Organization for Standardization
LCW	Lane Change Warning
MAP	Map Data Message
1MIM	Midtown In Motion
MMITSS	Multi-Modal Intelligent Traffic Signal System
MOU	Memorandum of Understanding

Acronym / Abbreviation	Definition
NTCIP	National Transportation Communications for Intelligent Transportation Systems Protocol
NYC	New York City
NYCDOT	New York City Department of Transportation
NYCWiN	New York City Wireless Network
OSADP	Open Source Application Development Portal
OTA	Over the Air
OVC	Oversized Vehicle Compliance
PANYNJ	Port Authority of New York and New Jersey
PASS	Pedestrians for Accessible and Safe Streets
PE	Professional Engineer
PED	Pedestrian
PEDINXWALK	Pedestrian in Signalized Crosswalk
PED-SIG	Mobile Accessible Pedestrian Signal System
PII	Personally Identifiable Information
RDE	Research Data Exchange
RFEI	Request for Expression of Interest
RFQ	Request for Quote
RLVW	Red Light Violation Warning
RSU	Roadside Unit
SAE	Society of Automotive Engineers International
SCMS	Security Credential Management System
SET-IT	System Engineering Tool for Intelligent Transportation
SPaT	Signal Phase and Timing
SPDCOMPWZ	Speed Compliance in a Work Zone
SPD-COMP	Speed Compliance
SyRS	System Requirements Specification
TIS	Traveler Information System
TMC	Traffic Management Center
USDOT	United States Department of Transportation
UWB	Ultra-Wideband
VTCS	Vehicular Traffic Computerization System
VTRW	Vehicle Turning Right in Front of a Bus Warning
V2V	Vehicle-to-Vehicle
V2I	Vehicle-to-Infrastructure

Acronym / Abbreviation	Definition
VRU	Vulnerable Road User
WAAS	Wide Area Augmentation System
WAVE	Wireless Access in Vehicular Environment
WSA	WAVE (Wireless Access in Vehicular Environments) Service Advertisement

APPENDIX B. Sample Draft Memorandum of Understanding (MOU)

MEMORANDUM OF UNDERSTANDING FOR
THE NEW YORK CITY CONNECTED VEHICLE PILOT PROGRAM
BETWEEN PARTICIPANT ENTITY NAME
AND THE NEW YORK CITY DEPARTMENT OF TRANSPORTATION

THIS MEMORANDUM OF UNDERSTANDING ("MOU") effective as of this _____ day of _____, 2016 between PARTICIPANT ENTITY NAME, located at PARTICIPANT ENTITY ADDRESS ("PARTICIPANT"), and the New York City Department of Transportation, located at 55 Water Street, New York, New York 10041 ("DOT") (together, the "Parties").

WHEREAS, PARTICIPANT operates a NATURE OF THE BUSINESS OF PARTICIPANT;

WHEREAS, DOT is participating in the Connected Vehicle Pilot Program (the "Program") in partnership with the United States DOT (USDOT) Federal Highway Administration;

WHEREAS, DOT intends to advance New York City's (NYC) Vision Zero Plan by deploying connected vehicle technology in several vehicle fleets and at selected NYC locations;

WHEREAS, pursuant to the Program DOT intends to install Aftermarket Safety Devises ("ASDs") that will record telemetry data associated with the issuance of audio tones and speech alert/warning messages or occurrence of events in roughly NUMBER OF VEHICLES vehicles that frequent the lower half of Manhattan;

WHEREAS, ASDs are not intended to release vehicle operators from their responsibility to observe applicable traffic laws, rules and regulations;

WHEREAS, DOT will also install Roadside Units (RSUs) in roughly 230 signalized intersections (along 1st, 2nd, 5th, and 6th Avenues; the FDR Drive in Manhattan; and Flatbush Avenue in Brooklyn) and at other selected locations;

WHEREAS, DOT will obtain information in an effort to measure and improve safety which may reduce the number of vehicle crashes and pedestrian injuries in support of NYC's Vision Zero Plan ("New York City Connected Vehicle Pilot Deployment Project/NYC CVPD") by recording participating vehicle telemetry data through the ASDs; and

WHEREAS, The NYC CVPD is expected to become a part of a permanent connected vehicle capability that is fully integrated into routine operational practice in the NYC area and will create a foundation for expanded and enhanced deployments.

NOW THEREFORE, PARTICIPANT and DOT hereby agree as follows:

Section 1. **Term.**

This MOU shall commence upon the signature of both Parties and shall continue through July 31, 2020. This MOU may be extended for an additional three year term upon expiration of this MOU by the mutual consent of the Parties.

Section 2. **Program Implementation and Data Collection**

DOT will install the ASDs in about 10,000 vehicles that service the lower half of Manhattan including approximately 7,500 Taxis; 1,500 MTA buses; 500 UPS vehicles; and 500 Sanitation and other City fleet vehicles. The ASDs will collect and send data on vehicle actions and communications with other connected vehicles, cyclists, pedestrians and certain infrastructure. DOT will install approximately 230 roadside units (RSU) into existing DOT infrastructure to manage the operation of the ASDs and collect data recorded to measure the benefits of the system and verify its operational status. The roadside units will also transmit environmental, road geometry, traffic signal status, and traffic conditions information, which will be used by the ASD to provide alerts/warnings to vehicle drivers/operators.

The ASDs will record information (nominally at 1/10 second intervals) from all sources available during the time surrounding an event. The definition of an event will be configurable based on DOT's needs throughout the term of this MOU. Currently, events shall consist of certain short term driver behaviors such as hard breaks, steering turns or hard accelerations, and may include any alerts presented to the driver. The ASD collected data will be encrypted on the vehicle and transmitted securely to DOT where it will be anonymized by DOT servers. DOT servers will not permanently collect or store any raw data on individual vehicles or associate any information with specific drivers.

It is envisioned that cyclists and pedestrians will use similar technology as the ASDs in the form of a mobile applications (hosted on Smartphones or similar devices) that will broadcast data about their localized position and movement information on sidewalks and crosswalks, analyze their location information, and provide alerts to those users and to participating vehicles.

The alerts/warnings that will be provided to drivers/operators may consist of the following safety warnings: potential red light violation; approaching a school/work zone; excess speed; pedestrian in roadway; potential vehicle collision; excessive curve speed; over-height warning; and restricted route approach. In addition, the ASDs are envisioned to support a number of vehicle to vehicle ("V2V") safety applications that may provide the following: forward collision warning, emergency electronic brake light warning, blind spot warning, lane change warning/assist and intersection movement assist to avoid crashes. Such V2V warning are based on connected vehicle (CV) messages received from other vehicles outfitted with the CV technology.

The transmissions between the ASD and the roadside equipment (RSE) will be authenticated to establish a trust relationship for the data which can then be used to determine the appropriate alerts/warnings to be presented to the driver. The CV technology takes a privacy-by-design approach using random vehicle ID's and rotating security certificates such that the vehicles cannot be tracked through the network. Further, DOT has stated that CV data cannot be used for enforcement of the issuance of any violations.

DOT will also collect location and speed data from the ASD to develop travel times for the various roadway segments within the City. This data is used for traffic analysis to assist DOT in optimizing the real time traffic signal timing. Any personally identifiable information or information that can be tracked

to a specific vehicle is encrypted on the vehicle and removed before it is permanently stored on any DOT server.

Section 3. **Confidentiality.**

The Parties agree to hold all vehicle specific information obtained in furtherance of this MOU confidential, subject to the conditions herein. The Parties agrees to use at least the same degree of care to avoid disclosure or dissemination of the other party's confidential information as it uses to protect its own confidential materials, but in any event, at least a reasonable degree of care. Access to confidential information shall be restricted to those persons to whom disclosure is reasonably necessary for performance under this MOU.

PARTICIPANT understands that the vehicle-specific information provided is for the exclusive use of DOT and USDOT. DOT agrees that it will not release any licensee-specific information to any parties outside of this MOU except as required by applicable law, virtue of court order, subpoena, or other validly issued administrative or judicial notice or order.

Each party shall promptly notify the other party of any unauthorized release of the other party's confidential information of which said party may become aware.

Section 4. **Installation and Equipment Maintenance**

DOT will provide resources to install or have installed and will be responsible for the maintenance of the ASDs in the vehicles. Replacement of lost, stolen or vandalized ASDs will be the responsibility of PARTICIPANT. ASDs will provide drivers with audible warnings or alerts and it is the responsibility of PARTICIPANT to alert DOT of any suspected equipment malfunction. The ASDs are the property of DOT and may not be removed from the vehicles without prior written consent from DOT. Any removed ASDs shall be returned to DOT.

Section 5. **Assumption of Risk.**

PARTICIPANT understands that participation in the CVPD is voluntary and PARTICIPANT agrees to assume any and all risks related to participation in the CVPD, which may include but not be limited to: ASD misuse or malfunction or inactivation.

Section 6. **Indemnification, Responsibility for Safety, Injuries or Damage and Insurance.**

(a) To the fullest extent permitted by law, the PARTICIPANT shall indemnify, defend and hold the City, its officials, and employees (the "Indemnitees") harmless from, all liabilities, obligations, fines, damages, penalties, claims, charges and expenses relating to alleged or actual injury (or death) to any person or damage to any property (including, without limitation, reasonable attorneys' fees and disbursements) ("Damages") that may be imposed upon, incurred by or asserted against any of the Indemnitees arising out of participation in the NYC CVPD, by reason of any defect or deterioration of the ASD or otherwise in connection with this MOU, whether or not the Damages are due to the negligence of the City, its officials, officers, agents, servants or employees. It is a condition of this MOU that the PARTICIPANT shall indemnify the Indemnitees for whatever Damages may arise from this MOU or any operations relating thereto, provided that if the facts or law relating to any of the foregoing would preclude any of the Indemnitees from being completely indemnified by the PARTICIPANT, such Indemnitees shall be partially indemnified by the PARTICIPANT to the fullest extent permitted by law.

(b) The PARTICIPANT shall be solely responsible for the safety and protection of its employees, agents, servants, contractors, and subcontractors, and for the safety and protection of the employees, agents, or servants of its contractors, subcontractors, and sublessees.

(c) The PARTICIPANT shall be solely responsible for taking all reasonable precautions to protect the persons and property of the City or others from damage, loss or injury resulting from any and all operations under this MOU.

(d) The PARTICIPANT shall be solely responsible for injuries to any and all persons, including death, and damage to any and all property arising out of or related to the operations under this MOU, whether or not due to the negligence of the PARTICIPANT, including but not limited to injuries or damages resulting from the acts or omissions of any of its employees, agents, servants, contractors, subcontractors, sublessees or any other person.

(e) The PARTICIPANT waives all rights against the City, including its officials and employees, for any damages or losses that are covered under any liability insurance required under this Section (whether or not such insurance is actually procured or claims are paid thereunder) or any other insurance applicable to the operations of the PARTICIPANT and/or its employees, agents, or servants of its contractors or subcontractors.

(f) During the entire term of this MOU, the PARTICIPANT shall maintain Commercial General Liability (CGL) insurance protecting the insureds from claims for property damage and/or bodily injury, including death, that may arise from The Work, the Structure, or any operations under this MOU, provided by a company that may lawfully issue such policy and has an A.M. Best rating of at least A-/"VII" or a Standard and Poor's rating of at least A, unless prior written approval is obtained from the City Corporation Counsel. This insurance shall be in the amount of at least Two Million Dollars ($2,000,000) per occurrence and Three Million Dollars ($3,000,000) aggregate. Coverage shall be at least as broad as that provided by the most recently issued Insurance Services Office ("ISO") Form CG 0001.

The CGL insurance shall name the City of New York, together with its officials and employees, as an Additional Insured with coverage at least as broad as the most recent edition of ISO Form CG 2026. The City's limits of coverage for the CGL insurance required shall be the greater of (i) the minimum limits set forth in this MOU or (ii) the limits provided to the PARTICIPANT under all primary, excess and umbrella policies covering operations under this MOU.

At the Commissioner's discretion, the PARTICIPANT shall maintain additional types of insurance and/or higher limits than required herein. Where appropriate, the City, together with its officials and employees, shall be named an Additional Insured thereon.

At the same time as the PARTICIPANT submits an executed version of this MOU, the PARTICIPANT shall submit proof of the required insurance in a form acceptable to the Commissioner. This shall include (i) a Certificate of Insurance certifying the issuance and effectiveness of such insurance with the specified minimum limits and the company code issued to the insurance company by the National Association of Insurance Commissioners (the NAIC number), (ii) the additional insured endorsement(s) naming the City as an additional insured, and (iii) a duly executed Certification by Insurance Broker or Agent in the form required by the Commissioner, attached hereto. In addition, prior to the expiration date of all policies, the PARTICIPANT shall submit proof satisfactory to the Commissioner of either renewals of such policies or the issuance of new policies in compliance with the requirements herein.

Acceptance by the Commissioner of a Certificate of Insurance or any other action or inaction by the Commissioner or the Department does not waive PARTICIPANT's obligation to ensure that insurance fully consistent with the requirements herein is secured and maintained, nor does it waive PARTICIPANT's liability for its failure to do so.

The PARTICIPANT shall be obligated to provide the City with a copy of any policy of insurance required hereunder upon request by the Commissioner or the New York City Law Department.

The PARTICIPANT may satisfy its insurance obligations through primary policies or a combination of primary and excess/umbrella policies, so long as all policies provide the scope of coverage required herein. At the Commissioner's sole discretion, the PARTICIPANT may satisfy its insurance obligations through a type of insurance other than Commercial General Liability insurance so long as such insurance provides materially the same level of coverage, both for PARTICIPANT and the City, as otherwise required herein.

Where notice of loss, damage, occurrence, accident, claim or suit is required under a policy maintained in accordance with this MOU, the PARTICIPANT shall notify in writing all insurance carriers that issued potentially responsive policies of any such event relating to The Work, the Structure, or any operations under this MOU (including notice to Commercial General Liability insurance carriers for events relating to the PARTICIPANT's own employees) no later than 20 days after such event. Such notice shall expressly specify that "this notice is being given on behalf of the City of New York as Insured as well as the Named Insured." Such notice shall also contain the following information: the number of the insurance policy, the name of the named insured, the date and location of the damage, occurrence, or accident, and the identity of the persons or things injured, damaged or lost. The PARTICIPANT shall simultaneously send a copy of such notice to the City of New York c/o Insurance Claims Specialist, Affirmative Litigation Division, New York City Law Department, 100 Church Street, New York, New York 10007.

In the event the PARTICIPANT receives notice, from an insurance company or other person, that any insurance policy required under this MOU shall expire or be cancelled or terminated (or has expired or been cancelled or terminated) for any reason, the PARTICIPANT shall immediately forward a copy of such notice to the Commissioner. Notwithstanding the foregoing, the PARTICIPANT shall ensure that there is no interruption in any of the insurance coverage required hereunder.

Policies of insurance required under this MOU shall be primary and non-contributing to any insurance or self-insurance maintained by the City.

Wherever this MOU requires that insurance coverage be "at least as broad" as a specified form (including all ISO forms), there is no obligation that the form itself be used, provided that the PARTICIPANT can demonstrate that the alternative form or endorsement contained in its policy provides coverage at least as broad as the specified form.

There shall be no self-insurance program or self-insured retention with regard to any insurance required under this MOU unless approved in writing by the Commissioner. Under no circumstances shall the City be responsible for the payment of any self-insured retention (or any other aspect of a self-insurance program). Further, the PARTICIPANT shall ensure that any such self-insurance program provides the City with all rights that would be provided by traditional insurance under this MOU, including but not limited to the defense and indemnification obligations that insurers are required to undertake in liability policies.

The insurance coverage required herein shall not relieve the PARTICIPANT of any liability under this MOU, nor shall it preclude the City from exercising any rights or taking such other actions as are available to it under any other provisions of this MOU or the law.

Section 7. **Entire MOU.**

This MOU sets forth the entire agreement between the Parties superseding all prior agreements and understandings, written or oral, and may be modified only through the mutual, written consent of both parties.

In accordance with the above terms and conditions, the Parties hereby execute this MOU.

_____ _____

NAME Date
TITLE
ENTITY NAME

_____ _____

NAME Date
TITLE
NYC Department of Transportation

U.S. Department of Transportation
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