Connected Vehicle Pilot Deployment Program Phase 2

System Design – New York City

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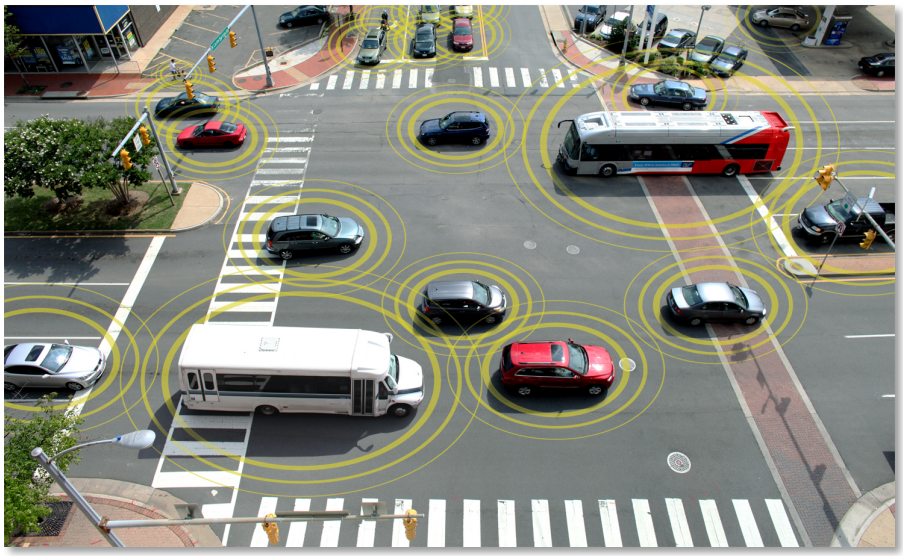

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Work performed for:
Program Manager: Kate Hartman
Agreement Officer (AO): Sarah Tarpgaard
Agreement Officer Representative (AOR): Jonathan Walker

16. Abstract

This System Design Document (SDD) describes the scope of the proposed New York City (NYC) Connected Vehicle Pilot Deployment (CVPD) system. It is a continuation of the systems engineering work based on the system architecture identified in the System Architecture Document (SAD). Its objective is to identify the subsystems and decompose them further into components. This document defines the system components and their interfaces and traces the requirements to them. Specific details on the individual system interfaces and their ITS standards are listed in the Interface Control Document (ICD).

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The New York City Department of Transportation (NYCDOT) and its pilot deployment team thanks the many fleet owners dedicated to bringing connected vehicle technology to New York City. These stakeholder organizations demonstrate their commitment towards attaining Vision Zero's goals through their participation. The various NYCDOT vehicle fleets, NYC Department of Citywide Administrative Services (DCAS) vehicle fleets, MTA/NYCT, and Pedestrians for Accessible and Safe Streets (PASS) have expended considerable resources participating in the development of the overall Concept of Operations as well as this document.

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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1 Introduction

This System Design Document (SDD) shows the detailed design of the TMC sub-system and how the other components of the system are utilized. This SDD also provides traceability of the requirements to specific design elements of the system.

1.1 Purpose of the System Design Document

This SDD describes the design of the NYC TMC component of the NYC CVPD program and the TMC interfaces to the other system components such as the ASD and RSU. It describes the components and functions that will be implemented in the NYCDOT TMC.

1.2 Assumptions

This section describes the assumptions used to derive the system design described in this SDD.

1. The NYC CVPD program requires access to the Security Credential Management System (SCMS) using the Internet. This program assumes that NYC Department of Information Technology and Telecommunications (DoITT) will configure the NYC network so that the CVPD servers can reach the Internet from the NYC TMC.
2. Availability of the production SCMS and its ability to generate the required number of certificates.
3. The design for the TMC software presented here requires the ASD and RSU devices generate the required data. The ASD and RSU devices were procured under separate contracts during the procurement phase. Those procurement documents required the generation of the data identified herein. Design changes were necessary during the deployment phase of the project, and those changes are highlighted in the As-Built Addendum – Section 7.
4. The RSU will be able to establish a network connection with the NYC TMC over the New York City's Wireless Network* (TSN) using IPv4. The current standards for the RSU and ASD call for an IPv6 communication path which is not available using the TSN.
   *Note: the initial design for the CVPD system was based on using the City's privately owned wireless network, NYCWiN. During the deployment phase of the CVPD project, the City initiated a replacement of this network which is now the Transportation Systems Network (TSN). The TSN uses AT&T FirstNet with a Sprint backup and includes wireless routers and PoE switches at each intersection to provide communications for traffic control, travel time data collection, video monitoring, and has been adapted to support the backhaul needs of the CVPD project. The current TSN usage is also constrained to IPv4, and the CVPD backhaul design is therefore based on IPv4 for the RSU to TMC and SCMS.

1.3 Constraints

The primary constraint on the NYC CVPD system is the dependence on the City's carrier based network (TSN). The TSN is currently supporting only IPv4 and does not have direct support for IPv6. The bandwidth of TSN is limited and therefore limits the amount of data that can be exchanged between the RSU and the TMC, hence, the backhaul needs to be used efficiently. It should also be noted that with the TSN, there are also usage charges based on the aggregate amount of data exchanged between the TMC and the RSUs. The design has taken steps to optimize the use of the TSN for the CV Backhaul.

1.4 Risks

There are a number of risks associated with the NYC CVPD program.

- The actual field hardware is not production hardware. While a number of vendors have produced samples and have been developing the necessary devices to support the deployment of CV technology, the number of such devices installed is very small and it is likely that the project will encounter issues associated with the deployment of this equipment.
- The system is dependent on functionality in the field hardware that is not part of a published standard, specifically the ability to define and collect events in the ASD
- Transmission of the event data is outside of the published standards

These risks are being migrated by specification of the hardware and the interfaces during the procurement cycle.

2 System Description

The high-level overview of the NYC CVPD is shown below. These items are discussed in more detail in the NYC CVPD System Architecture Document (SAD).

2.1 System Purpose

The fundamental message of the New York City (NYC) Vision Zero initiative is that death and injury on City streets is not acceptable. These tragedies happen in every community within NYC, to families from every walk of life – from the Upper East Side to the Lower East Side; from Park Slope to Edenwald. They happen to people who drive and to those who bike, but overwhelmingly, the deadly toll is highest for pedestrians – especially children and seniors. The goal of Vision Zero is to eliminate traffic deaths by 2024. The NYC CVPD project will focus on safety improvements for both motorists and non-motorists. In particular, the crash risks increase during nighttime hours when vehicle speeds tend to be higher and it becomes more difficult for vehicle drivers to see pedestrians crossing the roadway.

As the safety statistics indicate, surface improvements on city streets alone will not mitigate the number of crashes, fatalities, and severe injuries long-term. While no “Silver Bullet” will end all crashes, multiple supplemental tools are needed that can work together to attain Vision Zero’s goal. The connected vehicle (CV) technology is one of these tools and it presents a systematic approach in alerting vehicles of unsafe roadway conditions and prevents collisions with other vehicles and pedestrians. It will provide numerous safety benefits that facilitate Vision Zero's goals and initiatives.

2.2 System Scope

NYC is implementing the CV technology as another tool in its quest for Vision Zero. It is anticipated that the CV technology will reduce the number of and severity of crashes in the deployment area. In addition to deploying the technology, New York City will assess its impacts and potential for attaining the Vision Zero goal of zero crashes/fatalities/injuries.

The NYC CVPD project is one of three initial CV deployment projects that establish a base for growing a nation-wide connected vehicle system. As such, its focus is on utilizing standards to build basic infrastructure in a manner that provides a foundation for future deployments of connected vehicle technology.

The NYC CVPD project provides a real demonstration and evaluation of the benefits of the CV technology in a dense urban environment. NYC has deployed a robust infrastructure with advanced traffic controllers (ATC), an advanced adaptive traffic signal control system which currently uses travel times as part of its operational algorithms, an aggressive maintenance program, and a ubiquitous high speed wireless network (NYCWiN). By deploying Aftermarket Safety Devices (ASD) and Roadside Units (RSU), our team can bring the benefits of the CV paradigm to NYC’s Vision Zero initiative and

provide the opportunity to evaluate the benefits with a significant number of vehicles that are regularly driving in the area.

This project will also provide the Federal Highway Administration (FHWA) the opportunity to showcase the benefits of CV technology without replacing the vehicle fleet – which is likely to be the situation for many years to come. At the same time, the NYC CVPD will be used to demonstrate the benefits to vulnerable road users who suffer the most from roadway fatalities in NYC.

In the ConOps, the system needs were developed for the following users: traffic manager, fleet owners, roadway users, and system manager. They are presented using two perspectives – the NYCDOT traffic management needs and the stakeholders (i.e. fleet owners, driver/operators) needs for deploying, maintaining, and operating connected vehicle technology to be installed on their vehicles. Other needs for operating and maintaining the infrastructure (i.e. core services) are also identified. Each system need is identified with a unique number for tracing through the system development life cycle (SDLC). For each need, a set of system requirements are developed to provide the needed services for the users and stakeholders of the NYC CVPD.

The improvements provided by this project are summarized in the following list:

- Vehicle fleets equipped with ASDs for Dedicated Short Range Communications (DSRC).
- Initial intersections equipped with RSU for DSRC communications.
- Initial curves, entrance/exit ramps, and work zones equipped with RSUs.
- Fleet terminal facility areas equipped with RSU for DSRC communications.
- Significant deployment of CV safety applications.
- New applications for managing DSRC devices from over-the-air (OTA) updates to radio frequency link monitoring.

The original scope of NYC CV Pilot deployment project included deploying ASDs to 10,000 vehicles, RSUs at 300 locations, and PIDs for 100 visually-impaired pedestrian users. However, many of the initial stakeholder organizations that had expressed interest in the NYC CV pilot program did not continue their support. Hence, organizations such as TLC, taxi fleets, UPS, and DSNY ended up deciding not to participate. MTA allowed installation in eleven (11) of its buses, but ultimately it also chose to discontinue allowing further ASD installations in its buses.

This led to NYCDOT choosing NYC or DCAS fleets for partnering with other agencies to bring in more vehicles for installation. Therefore, the total number of ASD deployments became 3,000 vehicles while the number of RSU deployments increased to 450. In addition, the pedestrian application for the PID to be used by visually-impaired pedestrians encountered many issues that led to delays as well. The PID deployment number was also decreased from 100 devices to 10 prototype PIDs to be used for testing and evaluation of the technology.

Also, procuring turnkey devices proved to be challenging. This led to delays in release, testing, and validation of prototype and production devices. The amount of time and effort expended into procurement, testing, and validation has been well above the original expectations made during planning stages of the NYC CV pilot project. Additional details can be found in the As-Built Addendum section at the end of this document.

2.3 Physical System Overview

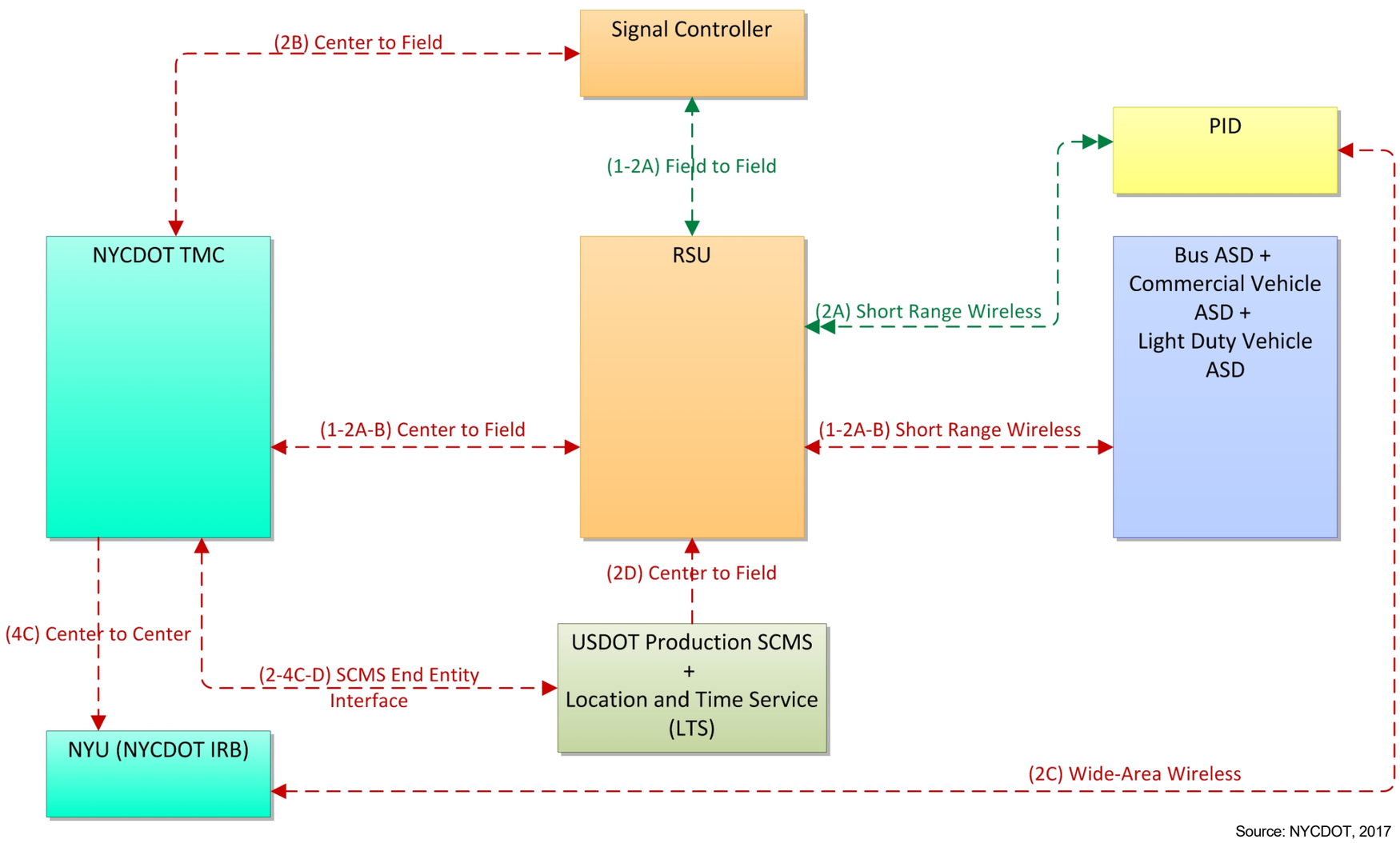
Source: NYCDOT, 2017

Figure 1 provides a simplified view of the NYC CVPD physical architecture. It focuses on the CV devices and how they are linked to the TMC and the existing Advance Solid-state Traffic Controller (ASTC). The transfer method for the pedestrian data from the PID to NYU is also shown. NYU is the NYCDOT IRB for this project.

Source: NYCDOT, 2017

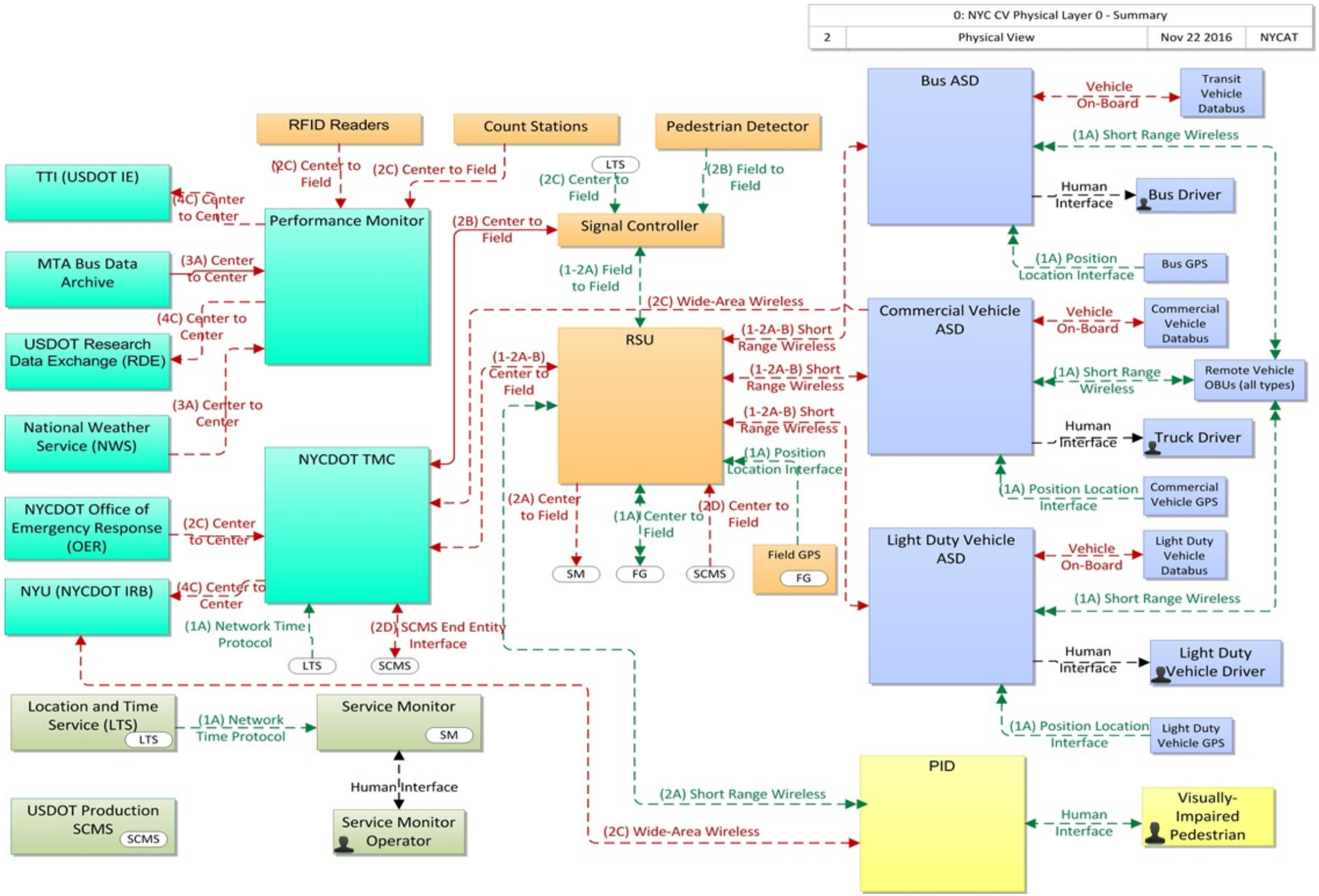
Figure 2 shows a more detailed high-level view of the physical architecture. This diagram includes the external systems that will communicate with the NYC CVPD system and additional field devices (i.e. detectors, field GPS) that will be installed and deployed.

0: NYC CV Physical Layer 0 - Summary (Simplified)			
2	Physical View	Nov 22 2016	NYCAT



Source: NYCDOT, 2017

Figure 1 NYC CV Physical Layer - Summary (Simplified)



Source: NYCDOT, 2017

Figure 2 NYC CVPD Physical View: Detailed Layer

2.4 List of Subsystems and Components

As shown in Source: NYCDOT, 2017
Figure 2 above there are 5 primary subsystems within the NYC CVPD program:

- Traffic Management Center (TMC)
- Road Side Unit (RSU)
- Aftermarket Safety Device (ASD)
- Personal Information Device (PID)
- Performance Monitor monitoring Systems

The design of the RSU, ASD and PID devices are covered in the respective procurement documents along with the ICD components detailing the data exchange.

The principle focus of this document will be the design of the TMC component along with its subcomponents.

3 Subsystems and Components

3.1 NYCDOT Traffic Management Center

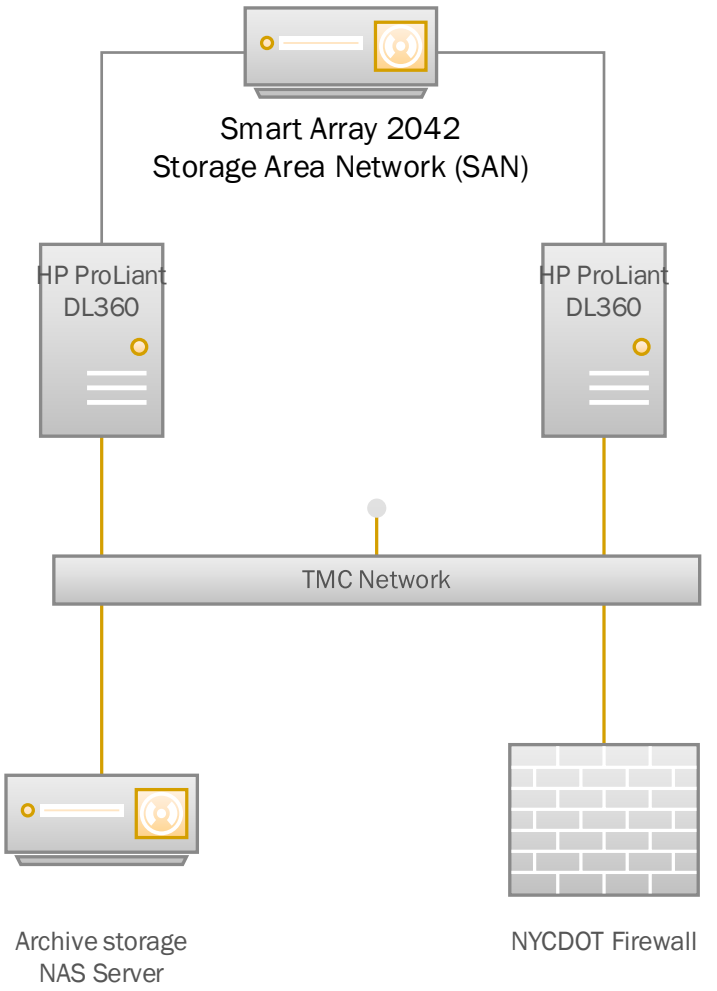
The NYCDOT TMC will be implemented as a suite of manual processes, 3rd party software packages (both commercial and open source) and custom software for the CVPD project.

3.1.1 Hardware

The NYCDOT TMC and Performance Monitor software and processes will be hosted on industry standard servers running Microsoft Windows 2016 or later based on the requirements of New York City's IT department. The hardware environment will be configured to provide redundancy and data protection and is shown below in Figure 3. The base software configuration of the TMC servers will be:

- Windows Server 2016
- Microsoft SQL Server 2016 – Standard Edition
- A virtualized server environment will be established with Microsoft's Hyper-V technology

Physical redundancy is provided by using s storage area network (SAN), the Smart Array 2042, to share data access between the 2 servers. This configuration also provides for balancing processing tasks between the servers.



Source: NYCDOT, 2017

Figure 3 NYC CVPD TMC Hardware Configuration

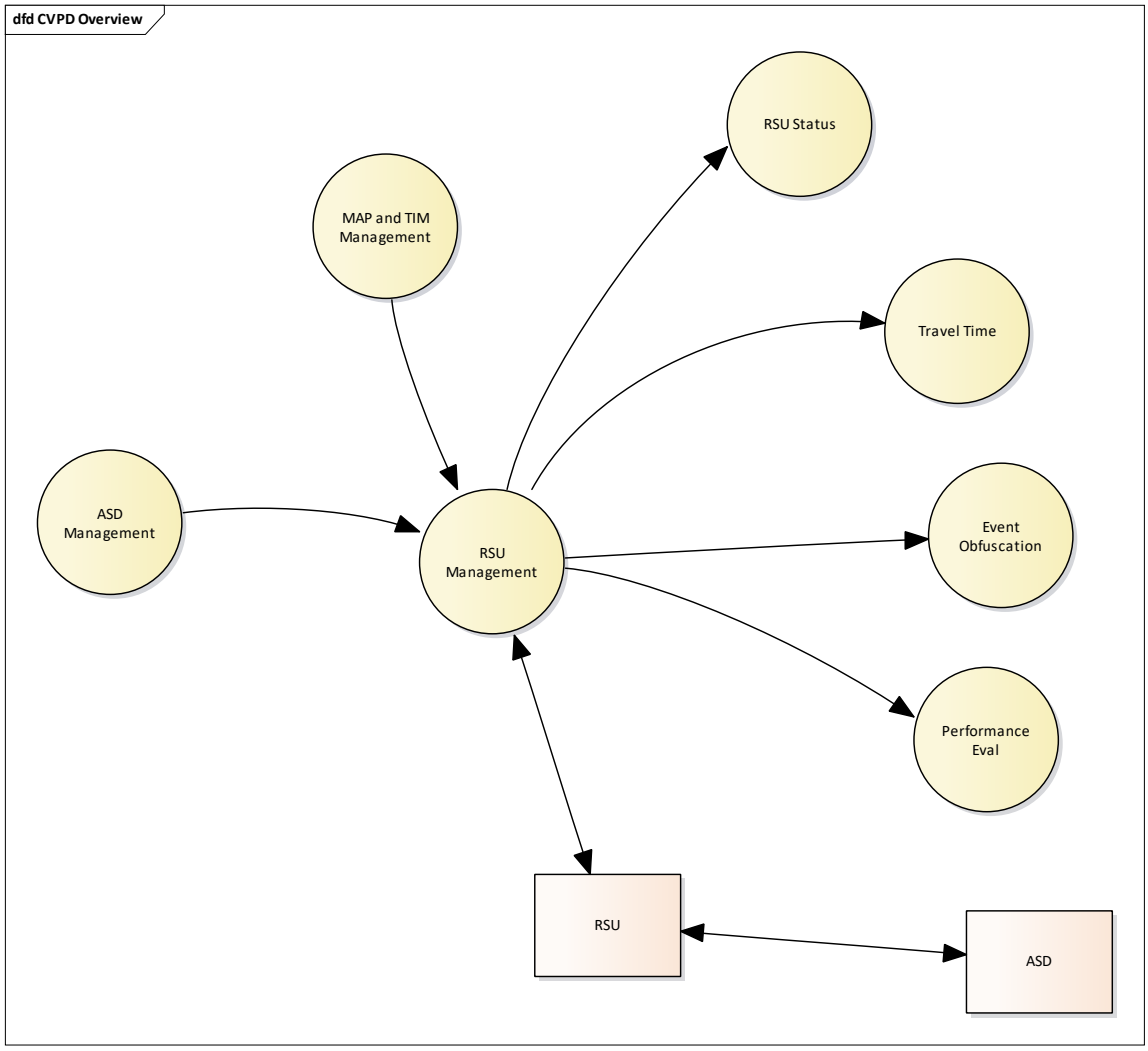
3.1.2 Software

The NYCDOT back office software has 6 major components as shown in Figure 4 below. The components are:

- ASD Management
- RSU Management
- RSU Status
- MAP and TIM Management
- Performance Evaluation
- Travel Time

Each of these components will be described in more detail in the following sections.

Many of the tables are used in multiple sections of the TMC design. The details of the database tables and the columns in those tables are documented in the subsequent figures.

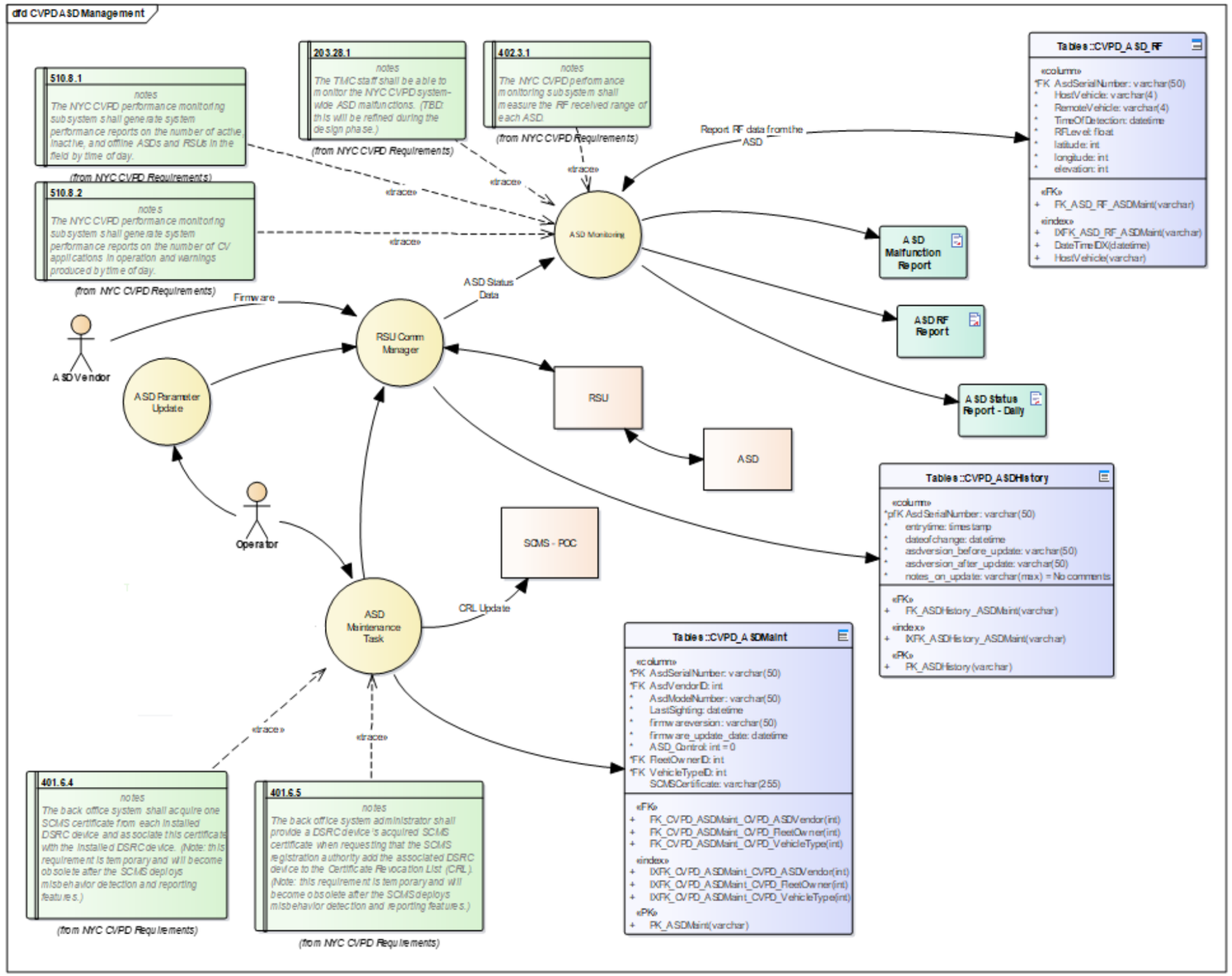


Source: NYCDOT, 2017

Figure 4 NYC CVPD Back Office Software Overview

3.1.2.1 *ASD Management*

Once the ASDs are in the field this task will monitor items such as the firmware version and parameters that are operational in the ASD.



Source: NYCDOT, 2017

Figure 5 ASD Management

3.1.2.1.1 ASD Management Processes

3.1.2.1.1.1 ASD Parameter Update

The NYC CVPD program will be tuning some of the functional parameters of the various ASD applications to evaluate and improve their performance in the dense urban environment of NYC. This process will provide the operator the tools to change the parameters for the ASD units in the field.

3.1.2.1.1.2 ASD Monitoring

This process will monitor the performance of the ASD and generate the various reports.

The ASD Monitoring process does not have direct access to the ASDs but rather will retrieve the data about ASDs from the various RSUs. The data from the ASD will be of 4 varieties:

1. Event data sets as defined in the ASD procurement specification
2. Breadcrumb data in the form of BSMs recorded by the RSU
3. RF data sets collected by the ASD as defined in the ASD procurement specification
4. ASD operations log (SSL) which provides information regarding the “health” of the ASD

Table 1 Requirements Assigned to ASD Monitor Process

REQUIREMENTS
☑ Functional. 203.28.1 The TMC staff shall be able to monitor the NYC CVPD system-wide ASD malfunctions.
☑ Functional. 402.3.1 The NYC CVPD performance monitoring subsystem shall measure the RF received range of each ASD.
☑ Functional. 510.8.1 The NYC CVPD performance monitoring subsystem shall generate system performance reports on the number of active, inactive, and offline ASDs and RSUs in the field by time of day.
☑ Functional. 510.8.2 The NYC CVPD performance monitoring subsystem shall generate system performance reports on the number of CV applications in operation and warnings produced by time of day.

3.1.2.1.1.3 ASD Maintenance Task

This process will track the specific ASDs in the field to verify which firmware version is operational along with when the device was last seen. If an ASD with an outdated version is detected the

operator will be notified. If an ASD has not been seen in a configurable amount of time the operator will be notified. If an ASD has been removed from the system, then the CRL at the SCMS will be updated.

Table 2 Requirements Assigned to ASD Maintenance Process

REQUIREMENTS
Functional. 401.6.4 The back office system shall acquire one SCMS certificate from each installed DSRC device and associate this certificate with the installed DSRC device. (Note: this requirement is temporary and will become obsolete after the SCMS deploys misbehavior detection and reporting features.)
Functional. 401.6.5 The back office system administrator shall provide a DSRC device's acquired SCMS certificate when requesting that the SCMS registration authority add the associated DSRC device to the Certificate Revocation List (CRL). (Note: this requirement is temporary and will become obsolete after the SCMS deploys misbehavior detection and reporting features.)

3.1.2.1.2 ASD Reports

3.1.2.1.2.1 ASD Malfunction Report

This will be a series of reports generated from data collected in the "ASD Operations Log" file that is uploaded from the ASDs. These reports will include as a minimum:

1. A summary of conditions captured for each ASD
2. A summary of conditions captured for all ASDs

3.1.2.1.2.2 ASD RF Report

This will be a series of reports designed to capture the RF performance of the ASD units. In order to be effective this data will maintain device unique data. The raw data will not be shared outside of the TMC. The following reports will be generated at a minimum:

1. A heat-map plot of the RSU sightings by the ASD for BSM, MAP and SPaT messages
2. A bar chart showing distance of 1st sightings for each RSU
3. A time chart showing distance of 1st sightings for each RSU
4. A heat-map showing sightings of other connected vehicles

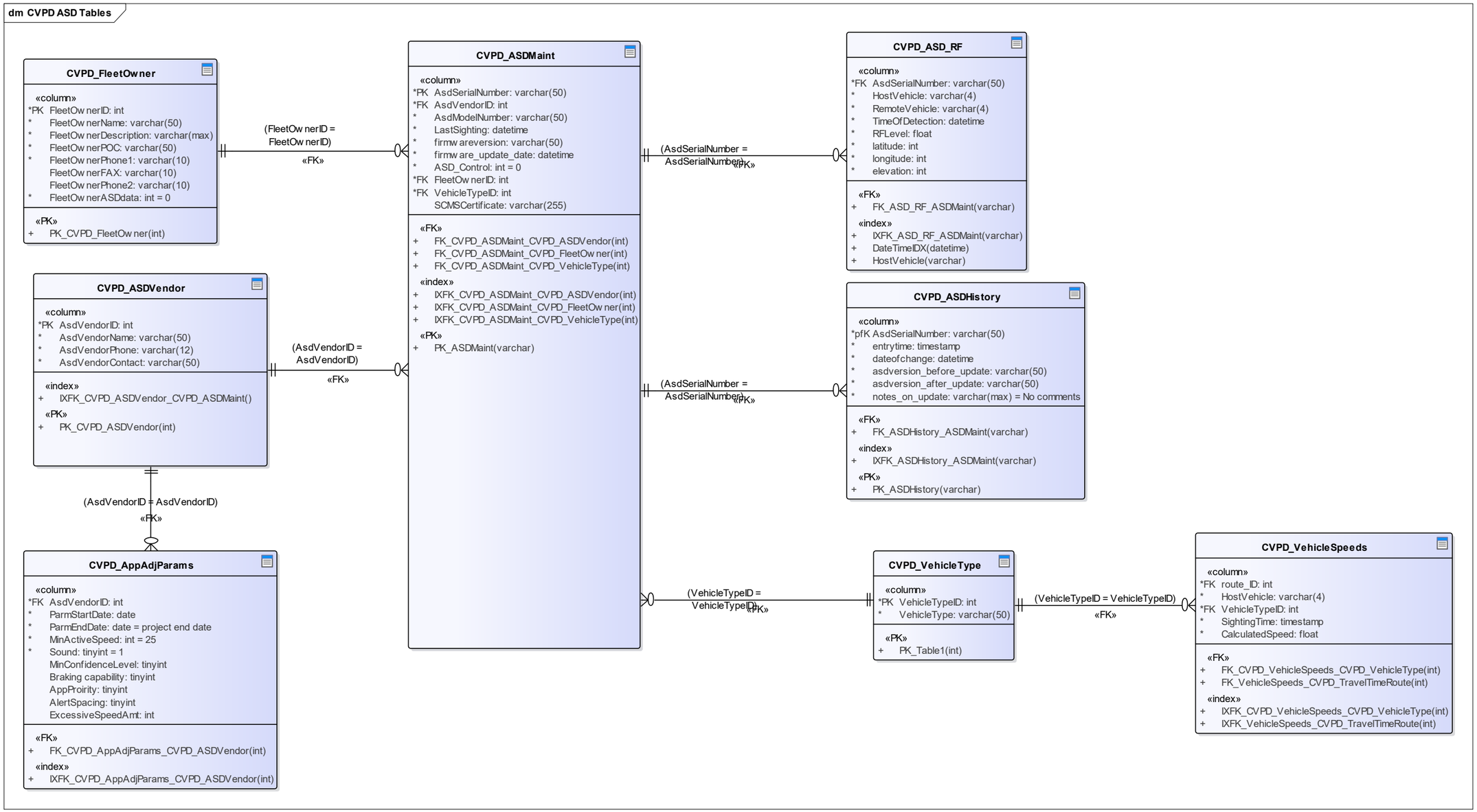
3.1.2.1.2.3 ASD Status Report - Daily

The system will generate a series of status reports for the ASD devices in the field. The following reports, at a minimum, will be generated from the collected data:

1. For a given day, the number of ASDs sighted, the number of ASDs reporting problems, the versions of firmware reported by the ASDs
2. A summary of the warnings reported by the ASDs
3. A heat-map of the warnings reported

3.1.2.1.3 ASD Tables

The ASD management is supported with the following tables. Details for the tables and the data elements are provided below in Figure 6.

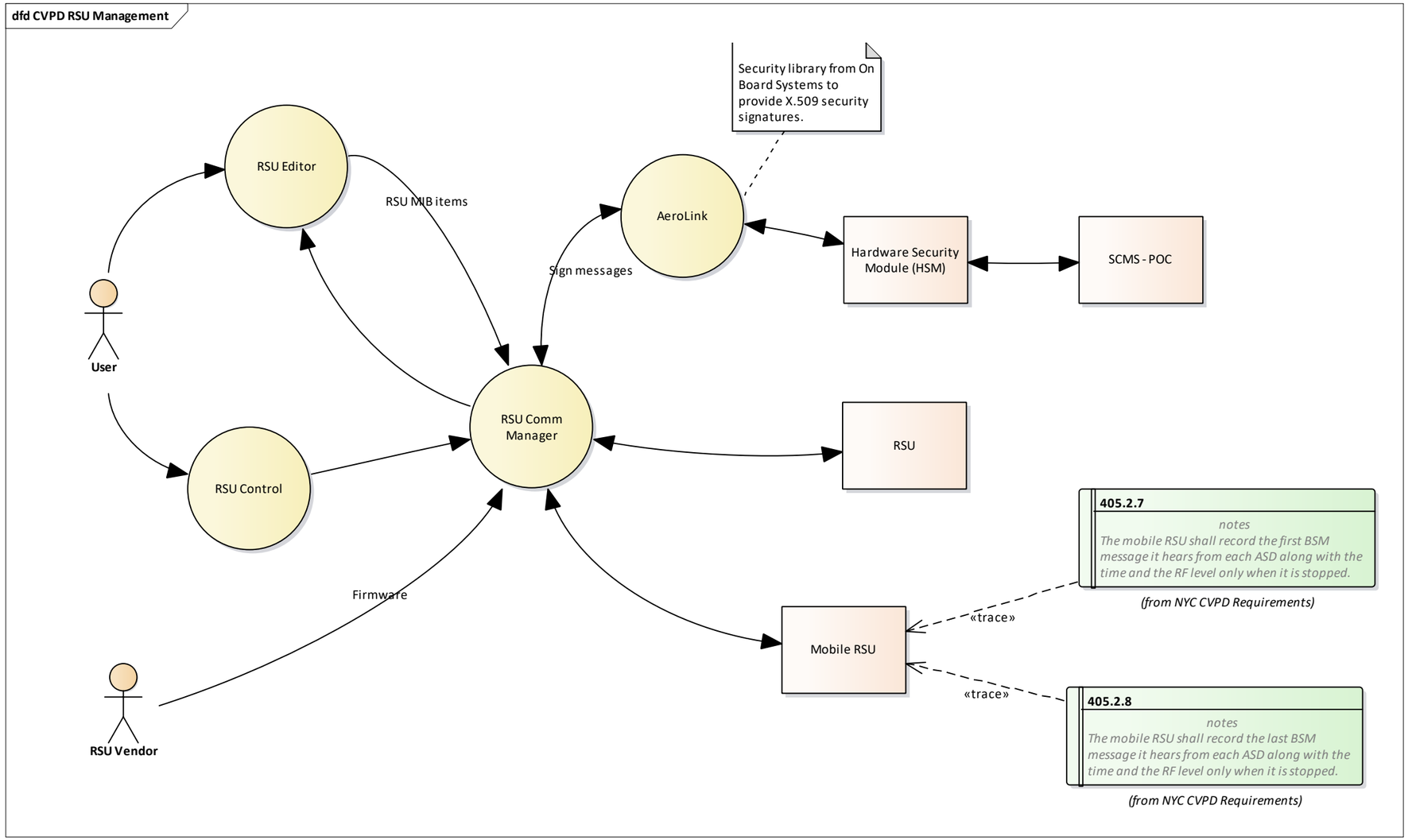


Source: NYCDOT, 2017

Figure 6 ASD Tables

3.1.2.2 *RSU Management*

The process for managing the RSU is shown in Figure 7 below.



Source: NYCDOT, 2017

Figure 7 RSU Management Data Flow

3.1.2.2.1 RSU Management Processes

3.1.2.2.1.1 RSU Editor

This will be based on TransCore's Unified Controller Manager (UCM) software and will provide for the operator to manage the internal database of the RSUs

3.1.2.2.1.2 RSU Comm Manager

The RSU Comm Manager manages all communications with the RSUs in the street. This will also include communication with the ASDs since they do not have direct communication with the TMC.

3.1.2.2.1.3 RSU Control

This process will be used by the operators at the TMC to start and stop communication with the RSU.

3.1.2.2.1.4 AeroLink

This is a security library that implements the 1609.2 security standards. The NYC CVPD software will send MAP and TIM messages to the AeroLink library to be signed with a X.509 certificate for transmittal to the RSU in the field.

3.1.2.2.1.5 HSM

The Hardware Security Module (HSM) is a FIPS 140-2 Level 3 box that will interface with the SCMS to obtain certificates to sign MAP and TIM messages in the TMC. The HCM will do the actual signing of the messages.

3.1.2.2.1.6 SCMS

Security Certificate Management System - Proof of Concept. The SCMS is provided by the USDOT and CAMP to provide security certificates for the various components of the connected vehicle program to verify the messages that are sent between the field and infrastructure devices.

3.1.2.2.1.7 Mobile RSU

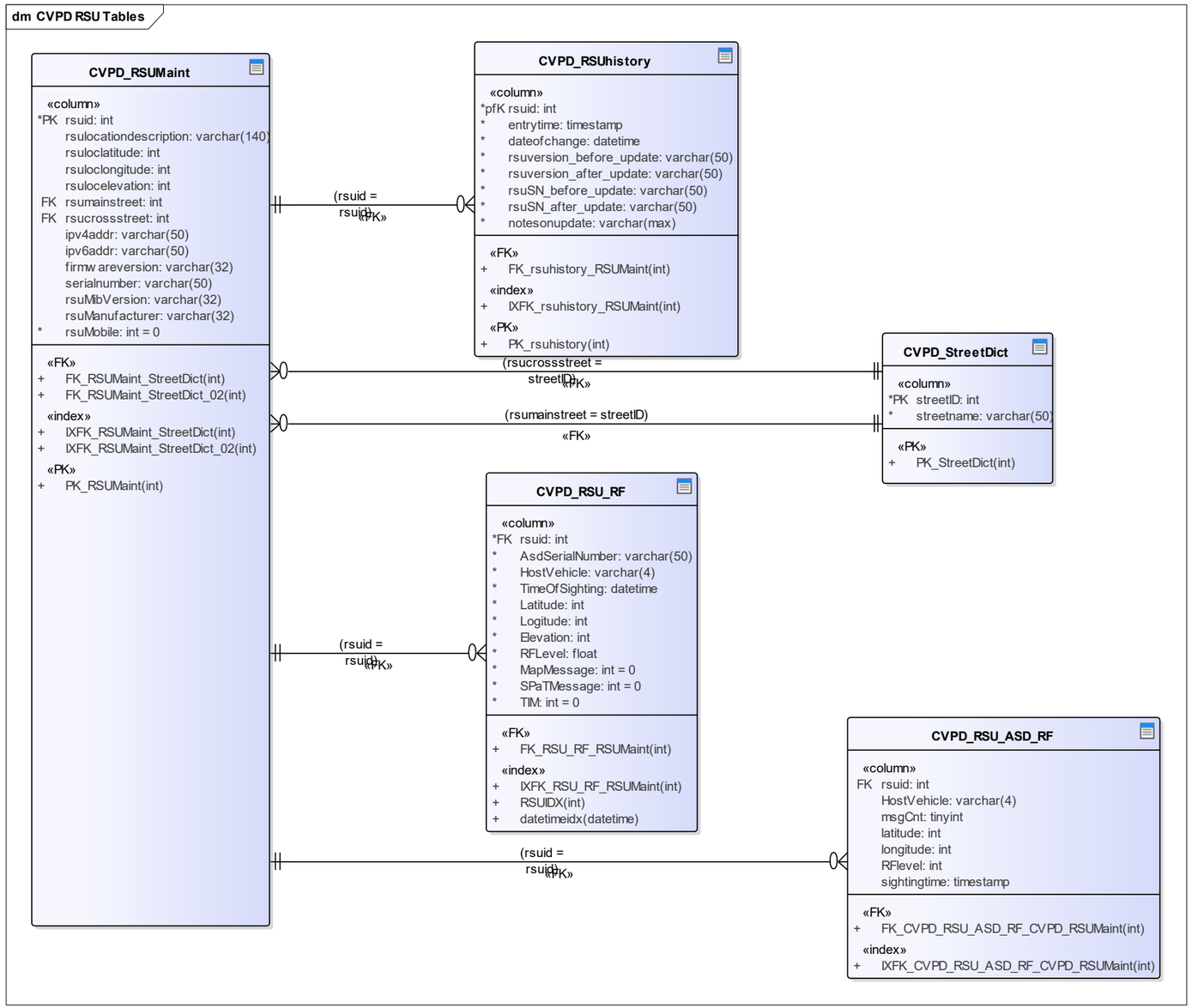
There will be some mobile RSUs that will be used to send MAP and TIM messages in moving work zones. The FCC prohibits RSU devices from transmitting while in motion. When the RSU reaches its destination and becomes static it will have to notify the TMC that it is now on-line. The TMC will have to know that the specific RSU is a mobile RSU and handle error detection appropriately.

Table 3 Requirements Assigned to Mobile RSU

REQUIREMENTS
☑ Functional. 405.2.7 The mobile RSU shall record the first BSM message it hears from each ASD along with the time and the RF level only when it is stopped.
☑ Functional. 405.2.8 The mobile RSU shall record the last BSM message it hears from each ASD along with the time and the RF level only when it is stopped.

3.1.2.2.2 RSU Tables

The RSU Maintenance task is supported by the following tables.



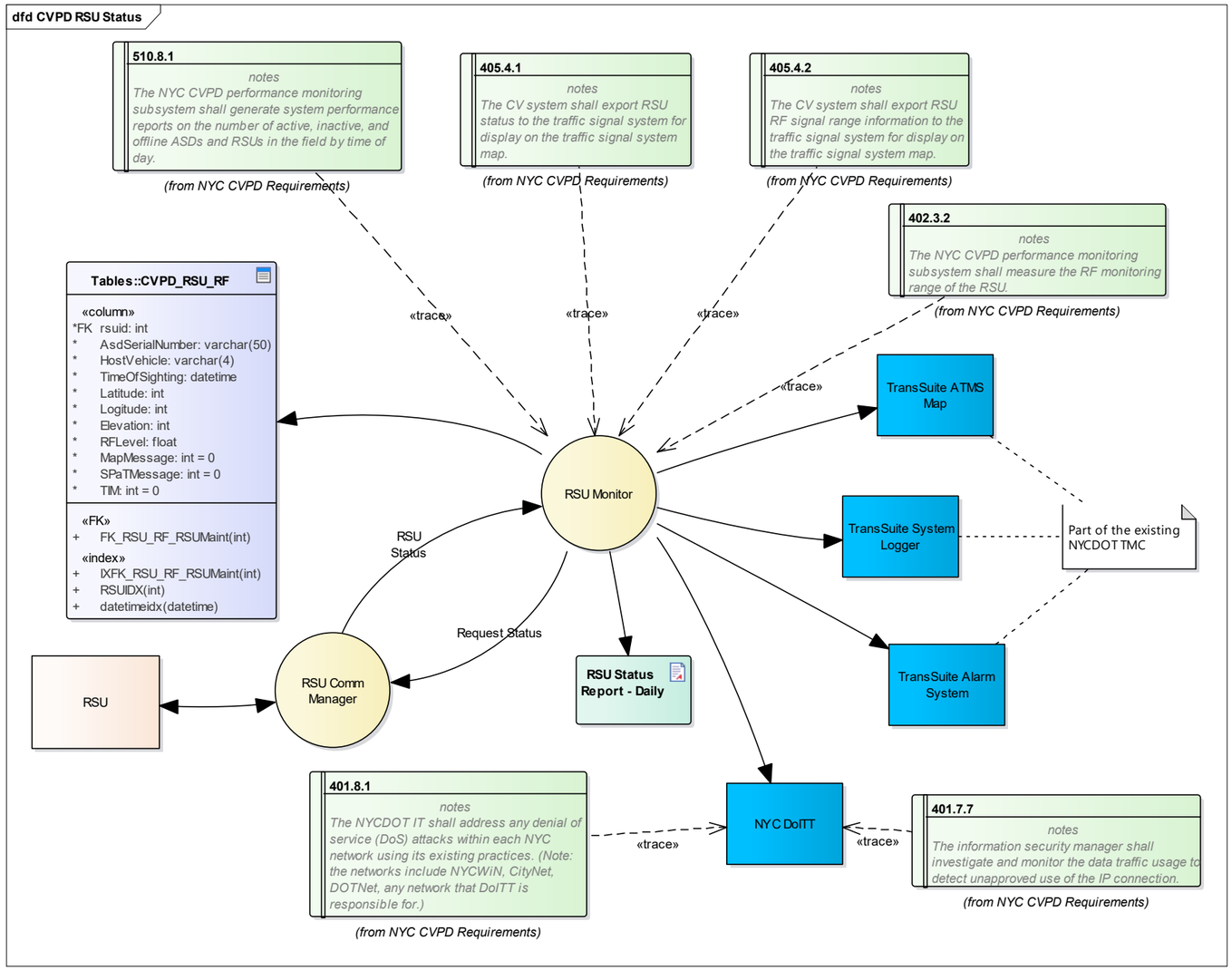
Source: NYCDOT, 2017

Figure 8 RSU tables

3.1.2.3 ***RSU Status***

The RSU status reporting process is shown in Figure 9 below.

Source: NYCDOT, 2017



Source: NYCDOT, 2017

Figure 9 RSU Status Reporting

3.1.2.3.1 RSU Status Reporting Processes

3.1.2.3.1.1 RSU Monitor

The RSU Monitor process will poll all RSUs defined in the system to determine their status and provide that information to the various TMC processes (Map, System Logger, Alarm System) for display to the operators of the system.

Table 4 Requirements Assigned to RSU Monitor Process

REQUIREMENTS
☑ Functional. 402.3.2 The NYC CVPD performance monitoring subsystem shall measure the RF monitoring range of the RSU.
☑ Functional. 405.4.1 The CV system shall export RSU status to the traffic signal system for display on the traffic signal system map.
☑ Functional. 405.4.2 The CV system shall export RSU status to the traffic signal system for display on the traffic signal system map.
☑ Functional. 510.8.1 The NYC CVPD performance monitoring subsystem shall generate system performance reports on the number of active, inactive, and offline ASDs and RSUs in the field by time of day.

3.1.2.3.1.2 RSU Comm Manager

The RSU Comm Manager manages all communications with the RSUs in the street. This will also include communication with the ASDs since they do not have direct communication with the TMC.

3.1.2.3.1.3 TransSuite ATMS Map

The TransSuite ATMS Map is an existing software component in the NYCDOT TMC. TransSuite ATMS Map provides dynamic status views of intersection controllers.

3.1.2.3.1.4 TransSuite System Logger

The TransSuite System Logger is a standard part of a TransSuite installation and is currently installed in the NYC TMC

3.1.2.3.1.5 TransSuite Alarm System

The TransSuite Alarm System can be configured to send SMS messages and email messages for specified error conditions.

3.1.2.3.1.6 NYC DoITT

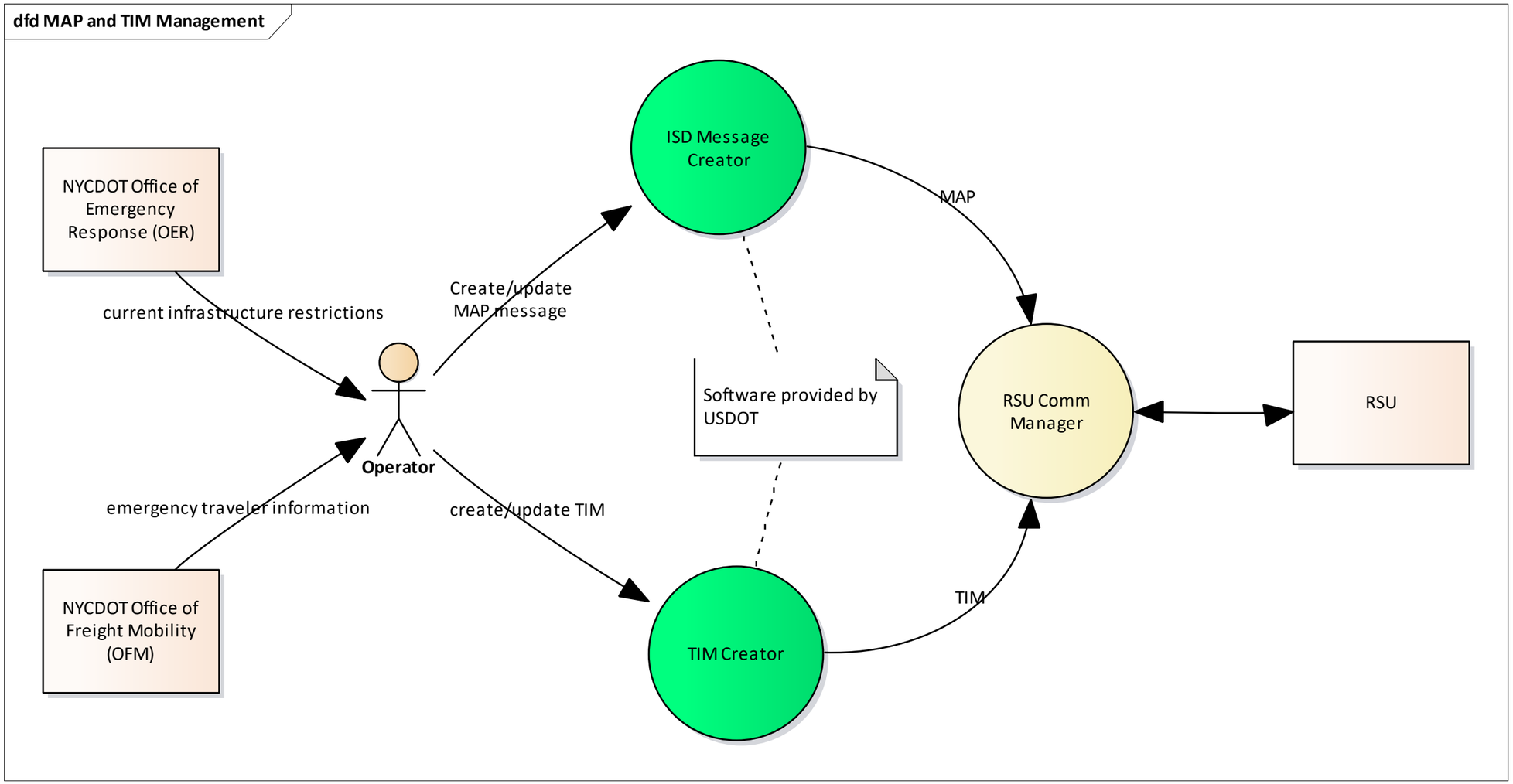
The NYC Department of Information Technology & Telecommunications (DoITT) has responsibility for managing and securing the field and TMC networks for the NYC DOT. Its Cybersecurity Requirements for Vendors & Contractors are listed on its website (https://www1.nyc.gov/site/doitt/business/it-security-requirements-vendors-contractors.page).

Table 5 Requirements Assigned to NYC DoITT

REQUIREMENTS
Functional. 401.7.7 The information security manager shall investigate and monitor the data traffic usage to detect unapproved use of the IP connection.
Functional. 401.8.1 The NYCDOT IT shall address any denial of service (DoS) attacks within each NYC network using its existing practices. (Note: the networks include NYCWiN, CityNet, DOTNet, any network that DoITT is responsible for.) .]

3.1.2.4 *MAP and TIM Management*

The MAP and TIM messages will be generated by operational personnel using the USDOT provided *ISG Message Creator* and the *TIM Creator*. The TMC personnel will received notices from the NYCDOT Office of Emergency Response and NYCDOT Office of Freight Mobility to create these messages. Once the messages are created, they are submitted to the RSU Comm Manager for signing and then delivery to the respective RSUs. The MAP and TIM message creation process is illustrated in Source: NYCDOT, 2017 Figure 10 below.

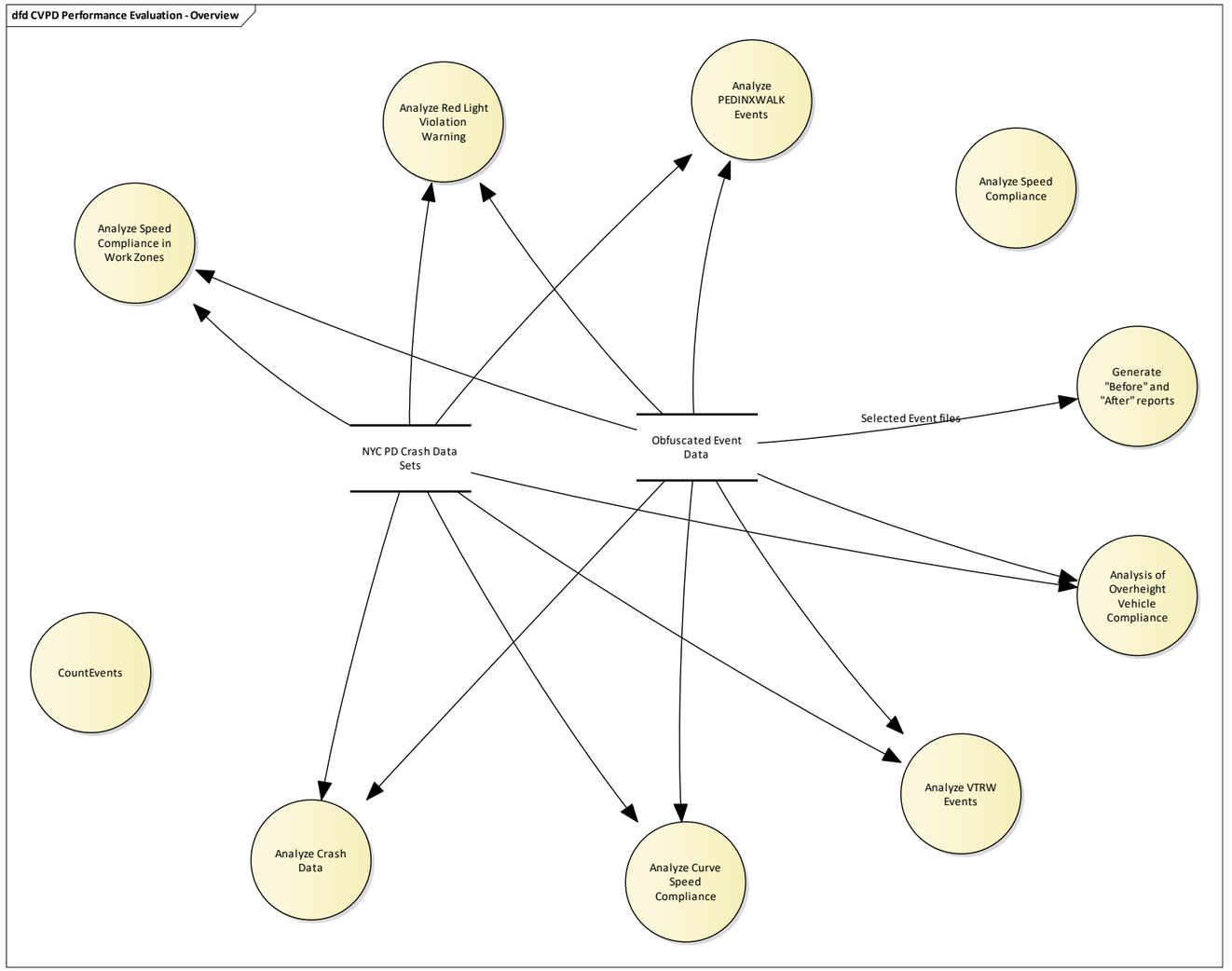


Source: NYCDOT, 2017

Figure 10 MAP & TIM Message creation

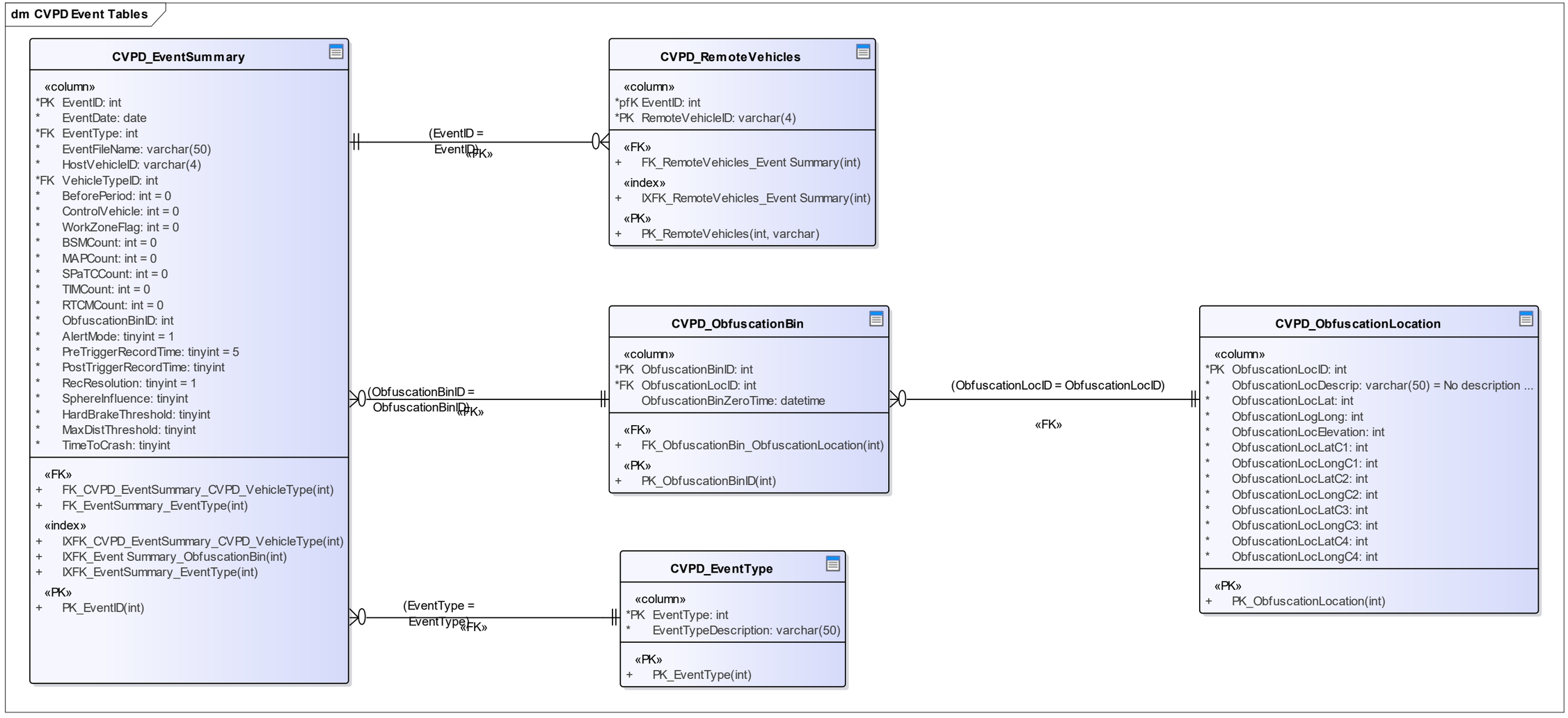
3.1.2.5 *Performance Evaluation*

The Performance Evaluation component has a number of major sub systems as shown in the following sections. An overview of the performance processes is shown below in Source: NYCDOT, 2017
Figure 11. These processes are supported by the tables shown in Source: NYCDOT, 2017
Figure 12 below.



Source: NYCDOT, 2017

Figure 11 Performance Evaluation – Overview

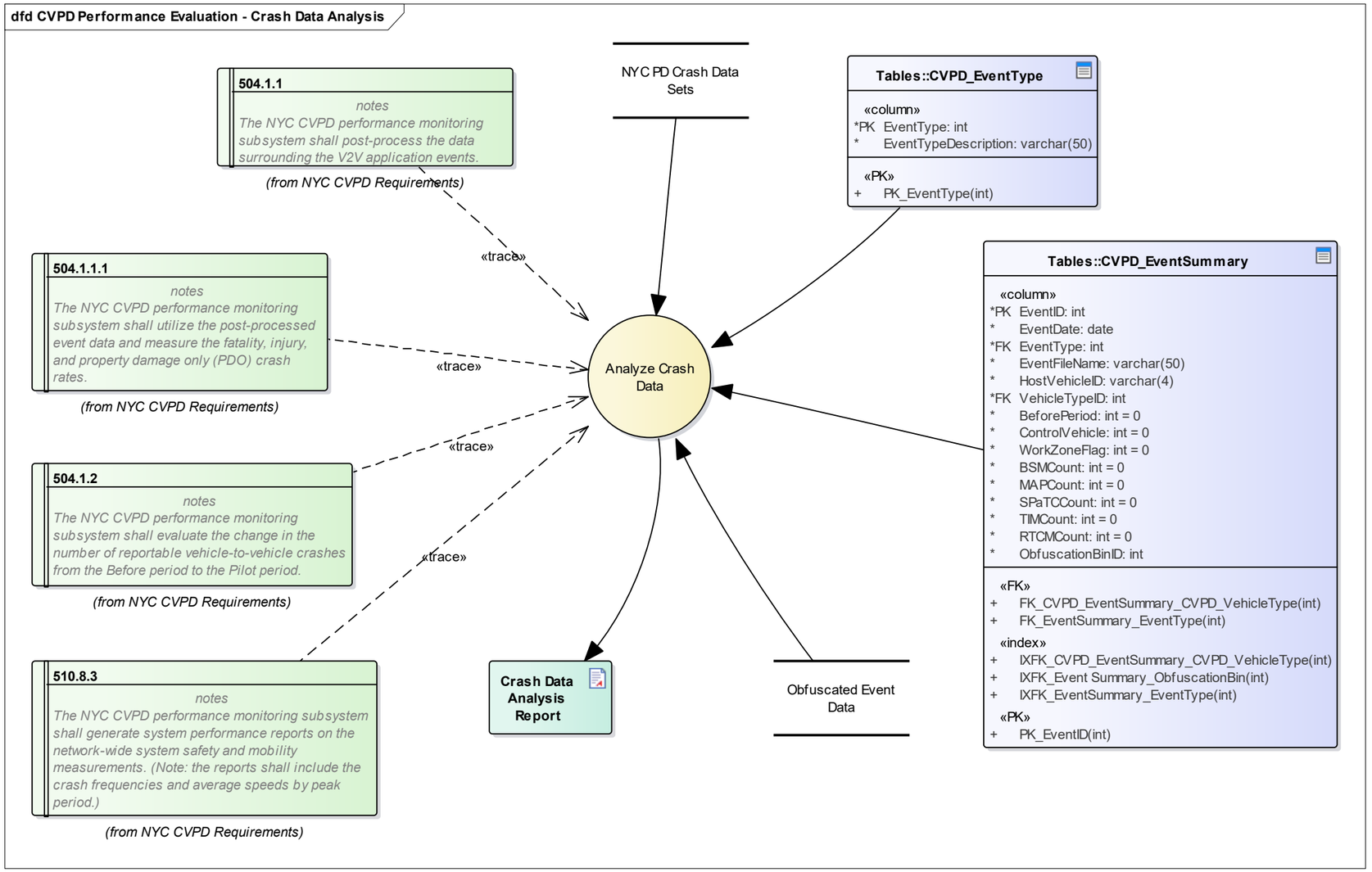


Source: NYCDOT, 2017

Figure 12 Event Tables

3.1.2.5.1 Performance Evaluation – Crash Data Analysis

The performance evaluation team will use data from the NYCPD and correlate it with the data from the CV to determine any effect of the CVPD on vehicle accidents within NYC. Source: NYCDOT, 2017
Figure 13 below shows this evaluation process.



Source: NYCDOT, 2017

Figure 13 Performance Evaluation - Crash Data Analysis Flow

3.1.2.5.1.1 Analyze Crash Data

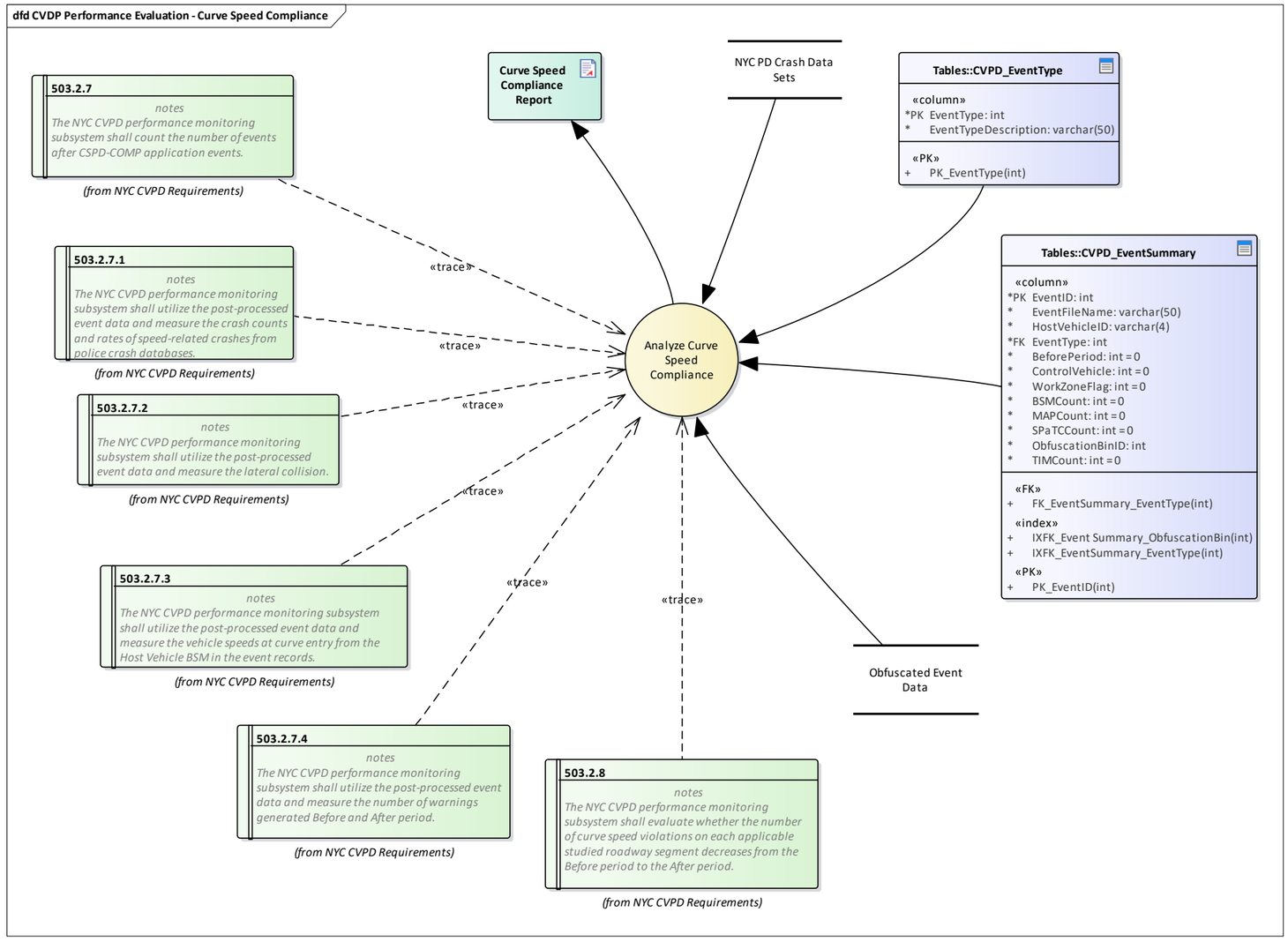
This task will combine the event data recorded by the ASD with the NYC PD Crash Data Sets to evaluate the effects of the CV program on crash data.

Table 6 Requirements Assigned to Analyze Crash Data Process

REQUIREMENTS
☑ Functional. 504.1.1 The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the V2V application events.
☑ Functional. 504.1.1.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the fatality, injury, and property damage only (PDO) crash rates.
☑ Functional. 504.1.2 The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reportable vehicle-to-vehicle crashes from the Before period to the Pilot period.
☑ Functional. 510.8.3 The NYC CVPD performance monitoring subsystem shall generate system performance reports on the network-wide system safety and mobility measurements. (Note: the reports shall include the crash frequencies and average speeds by peak period.)

3.1.2.5.2 Performance Evaluation – Curve Speed Compliance

The performance evaluation process for Curve Speed Compliance (CSPD-COMP) application is shown in Figure 14 below. Source: NYCDOT, 2017



Source: NYCDOT, 2017

Figure 14 Performance Evaluation - Curve Speed Analysis

3.1.2.5.2.1 Analyze Curve Speed Compliance

This task will combine the Curve Speed Compliance events recorded by the ASD with the NYC PD crash data sets to evaluate the effect of the CV program on curve speed events.

Table 7 Requirements Assigned to Analyze Curve Speed Compliance

REQUIREMENTS
☑ Functional. 503.2.7 The NYC CVPD performance monitoring subsystem shall count the number of events after CSPD-COMP application events.
☑ Functional. 503.2.7.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the crash counts and rates of speed-related crashes from police crash databases.
☑ Functional. 503.2.7.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the crash counts and rates of speed-related crashes from police crash databases.
☑ Functional. 503.2.7.3 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the vehicle speeds at curve entry from the Host Vehicle BSM in the event records.
☑ Functional. 503.2.7.4 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the number of warnings generated Before and After period.
☑ Functional. 503.2.8 The NYC CVPD performance monitoring subsystem shall evaluate whether the number of curve speed violations on each applicable studied roadway segment decreases from the Before period to the After period.

Some of the system reports to be generated by the curve speed compliance analysis are listed below:

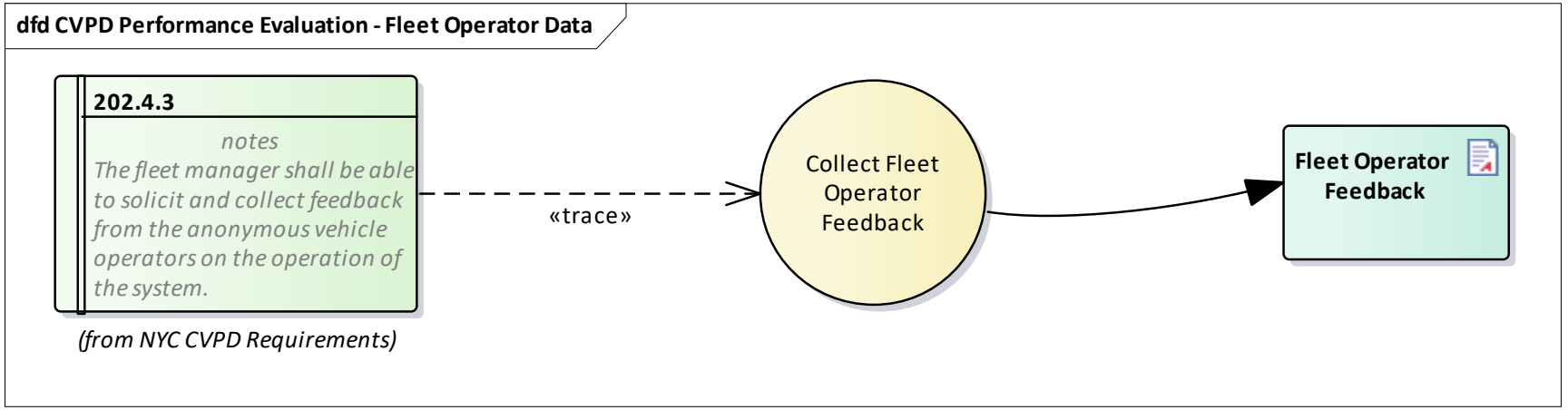
Table 8 Curve Speed Compliance Reports

Reports
Before After Comparsion Day of Week 1. Retrieve number of curve speed warnings by day of week during the quite period 2. Retrieve number of curve speed warnings by day of week during the active period 3. Calculate the number of curve speed warnings / vehicle by day of week during the quiet period 4. Calculate the number of curve speed warnings / vehicle by day of week during the active period 5. Generate a bar chart with the number of curve speed warnings / vehicle for day of week with both quiet period and active period
Before After comparsion 1. Retreive count of curve speed warnings during the Quiet period (before) 2. Calculate the number of curve speed warnings / day / vehicle for the Quiet period 3. Retrieve the count of curve speed warnings during the Active period (after) 4. Calculate the number of curve speed warnings / day /vehicle for the Active Period
Trend chart for curve speed warnings 1. Retrieve number of curve speed warnings by week for quiet period 2. Retrieve number of curve speed warnings by week for active period 3. Generate trend chart for number of curve speed warnings for both periods
Curve speed warnings control vs non-control 1. Retrieve count of curve speed warnings for control vehicles by week during the active period 2. Retrieve count of curve speed warnings for non-control vehicles by week during the active period 3. Calculate the curve speed warnings / vehicles for control and non-control vehicles 4. Plot a trend chart of the curve speed warnings / vehicle / week

3.1.2.5.3 Performance Evaluation – Fleet Operator Data

Source: NYCDOT, 2017

Figure 15 illustrates the process for fleet managers to get feedback on their drivers' experience with CV technology. This will be done through NYCDOT's coordination with the fleet owners/managers, who will be instructing their fleet drivers/operators to watch the driver training/CV application video and fill out the driver survey accessible on NYCDOT's NYC CV pilot website.



Source: NYCDOT, 2017

Figure 15 Collect Fleet Operator Feedback Process

3.1.2.5.3.1 Collect Fleet Operator Feedback

This process will be used by the performance evaluation team to collect operational information from the fleet operators participating in the NYC CVPD program.

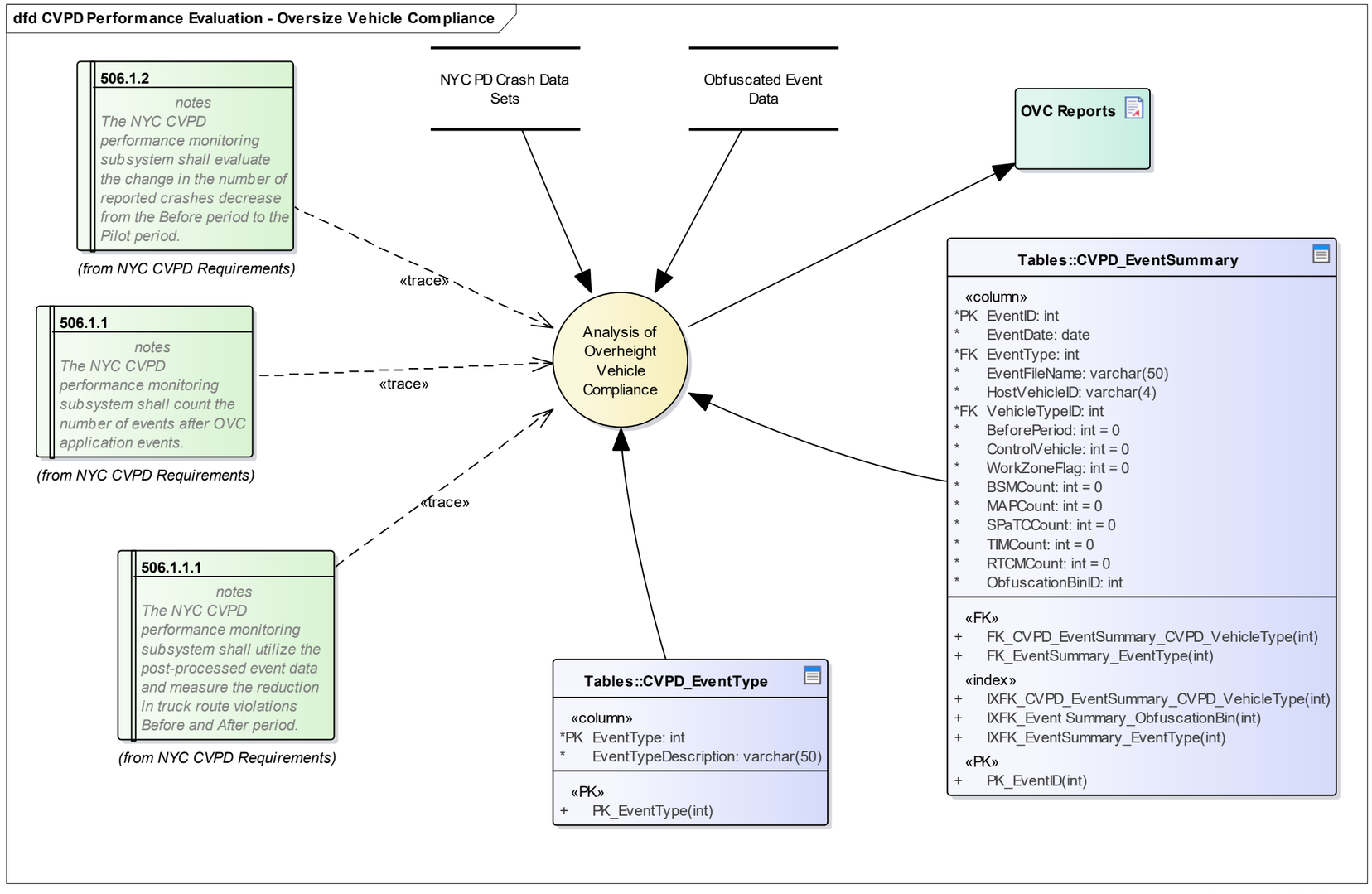
Table 9 Requirements Assigned to the Collect Fleet Operator Feedback

REQUIREMENTS
Functional. 202.4.3 The fleet manager shall be able to solicit and collect feedback from the anonymous vehicle operators on the operation of the system.

Table 10 Requirements Assigned to the Collect Fleet Operator Feedback

3.1.2.5.4 Performance Evaluation – Oversize Vehicle Compliance

The performance evaluation process for Oversize Vehicle Compliance (OVC) application is shown in Source: NYCDOT, 2017
Figure 16 below.



Source: NYCDOT, 2017

Figure 16 Process to Analyze Overheight Vehicle Compliance

3.1.2.5.4.1 Analysis of Overheight Vehicle Compliance

This task will combine the overheight vehicle events recorded by the ASD with the NYC PD Crash Data Sets to evaluate the effect of the CV program on these types of events.

Table 11 Requirements Assigned to Analysis of Overheight Vehicle Compliance

REQUIREMENTS
Functional. 506.1.1 The NYC CVPD performance monitoring subsystem shall count the number of events after OVC application events.
Functional. 506.1.1.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the reduction in truck route violations Before and After period.
Functional. 506.1.2 The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reported crashes decrease from the Before period to the Pilot period.

Some of the system reports to be generated for Overheight Vehicle Compliance are listed below:

Table 12 Overheight Vehicle Compliance Reports

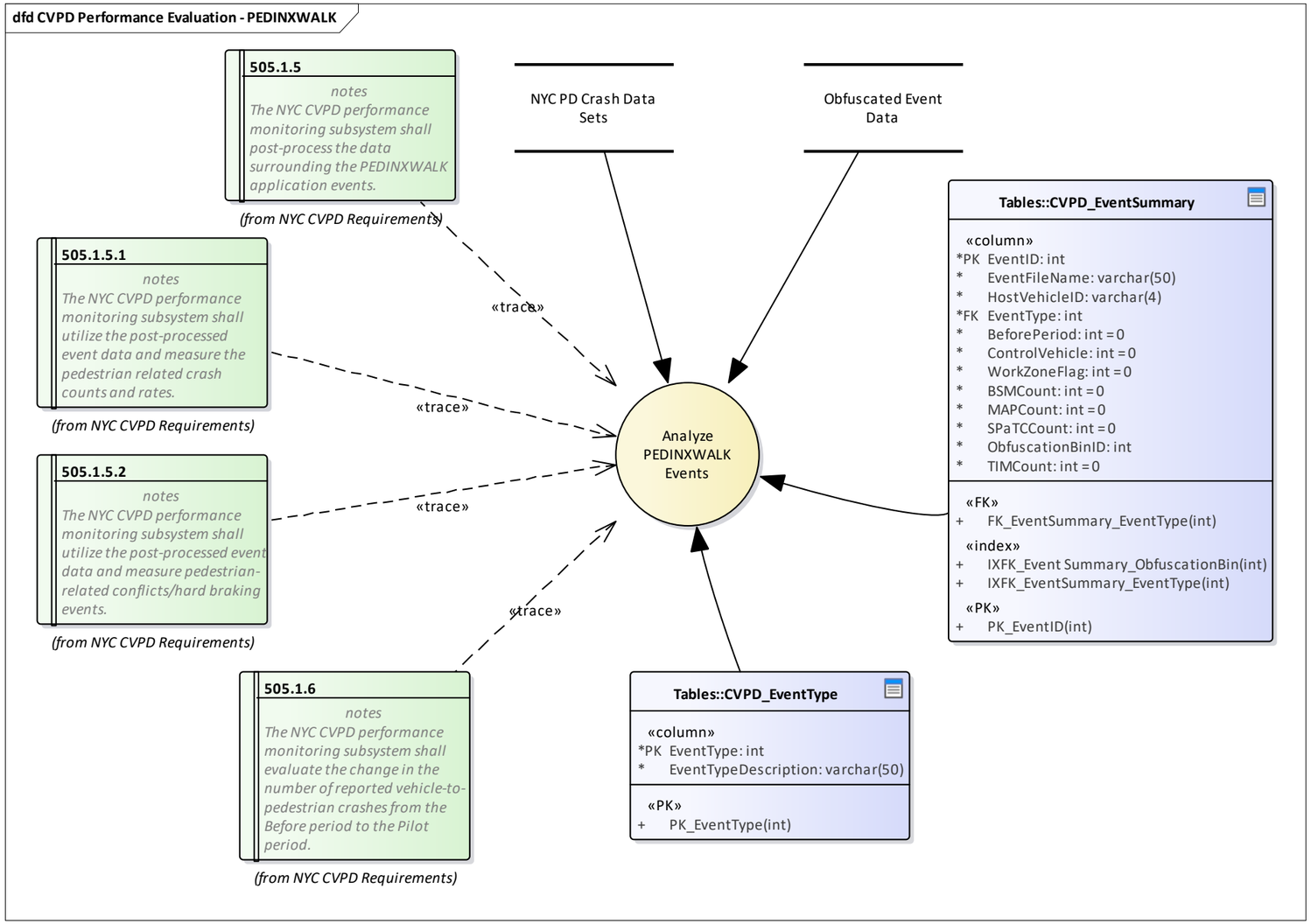
Reports
OVC Control vs Non-control 1. Count the number of OVC Events for control vehicles during the active period by week 2. Count the number of OVC Events for non-control vehicles during the active period by week 3. Plot a trend line of OVC events for both types of vehicles
OVC Trend chart 1. Count the number of OVC events / week / vehicle during the quiet period 2. Count the number of OVC events / week / vehicle during the active period 3. Plot trend lines for both periods

Reports
OVC Before and After 1. Count the number of OVC Events during the quiet period 2. Count the number of OVC Events during the active period 3. Calculate the number of OVC Events / day / vehicle for both periods

Table 13 Overheight Vehicle Compliance Reports

3.1.2.5.5 Performance Evaluation – Pedestrian in Signalized Crosswalk (PEDINXWALK)

The performance evaluation process for Pedestrian in Signalized Crosswalk (PEDINXWALK) application is shown in Source: NYCDOT, 2017
Figure 17 below.



Source: NYCDOT, 2017

Figure 17 Performance Evaluation – PEDINXWALK

3.1.2.5.5.1 Analyze PEDINXWALK Events

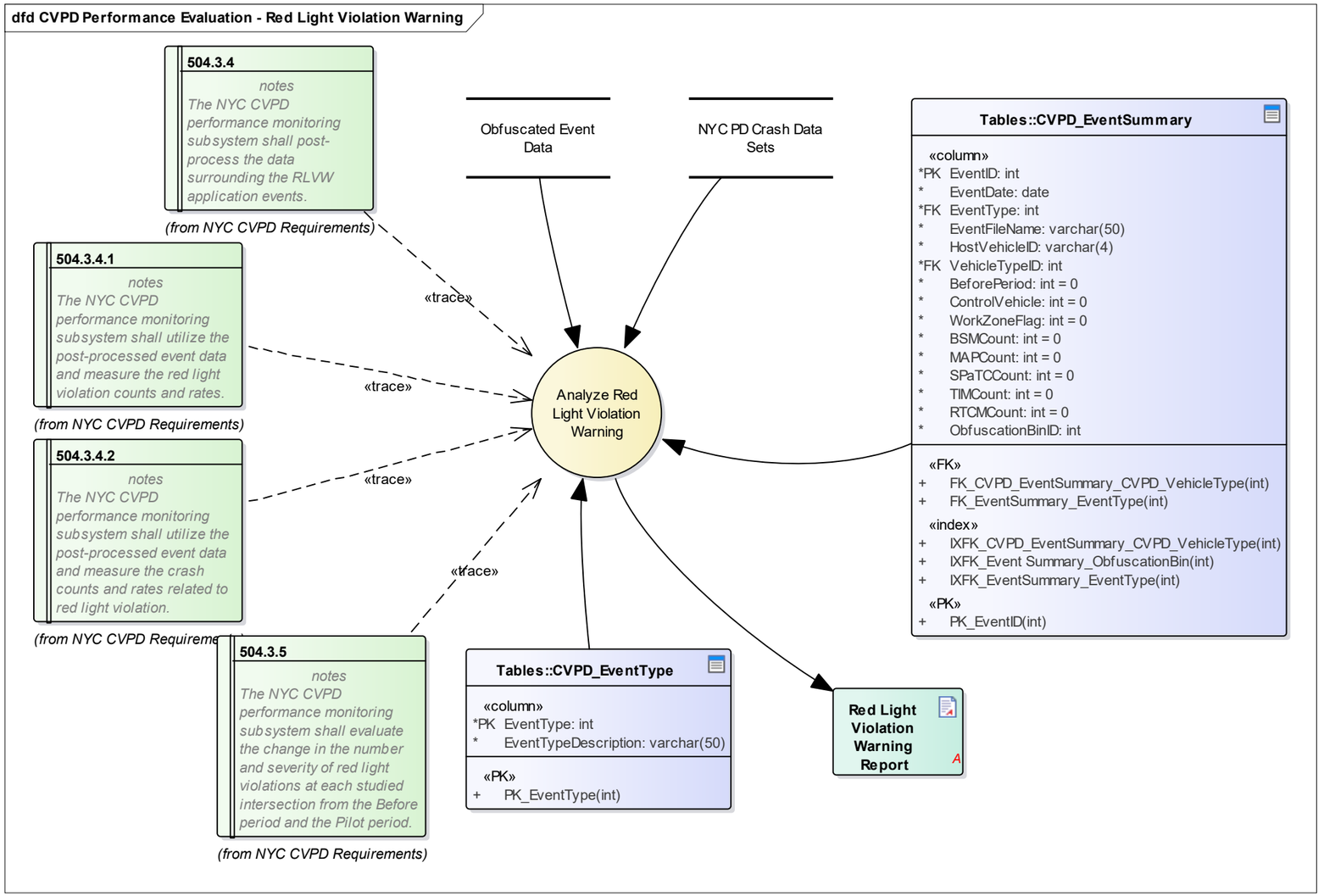
This process will combine the PEDINXWALK events recorded by the ASD with the NYC PD Crash Data Sets to evaluate the effects of the CV program.

Table 14 Requirements Assigned to Analyze PEDINXWALK Events

REQUIREMENTS
☑ Functional. 505.1.5 The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the PEDINXWALK application events.
☑ Functional. 505.1.5.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the pedestrian related crash counts and rates.
☑ Functional. 505.1.5.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure pedestrian-related conflicts/hard braking events.
☑ Functional. 505.1.6 The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reported vehicle-to-pedestrian crashes from the Before period to the Pilot period.

3.1.2.5.6 Performance Evaluation – Red Light Violation Warning

The performance evaluation process for Red Light Violation Warning (RLVW) application is shown in Figure 18 below. Source: NYCDOT, 2017



Source: NYCDOT, 2017

Figure 18 Performance Evaluation - Red Light Violation Warning

3.1.2.5.6.1 Analyze Red Light Violation Warning

This task will combine the red light warning events recorded by the ASD with the NYC PD Crash Data Sets to evaluate the effect of the CV program on these types of events.

Table 15 Requirements Assigned to Analyze Red Light Violation Warning

REQUIREMENTS
Functional. 504.3.4 The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the RLVW application events.
Functional. 504.3.4.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the red light violation counts and rates.
Functional. 504.3.4.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the crash counts and rates related to red light violation.
Functional. 504.3.5 The NYC CVPD performance monitoring subsystem shall evaluate the change in the number and severity of red light violations at each studied intersection from the Before period and the Pilot period.

Some of the reports included for the Red Light Violation Warning are shown below.

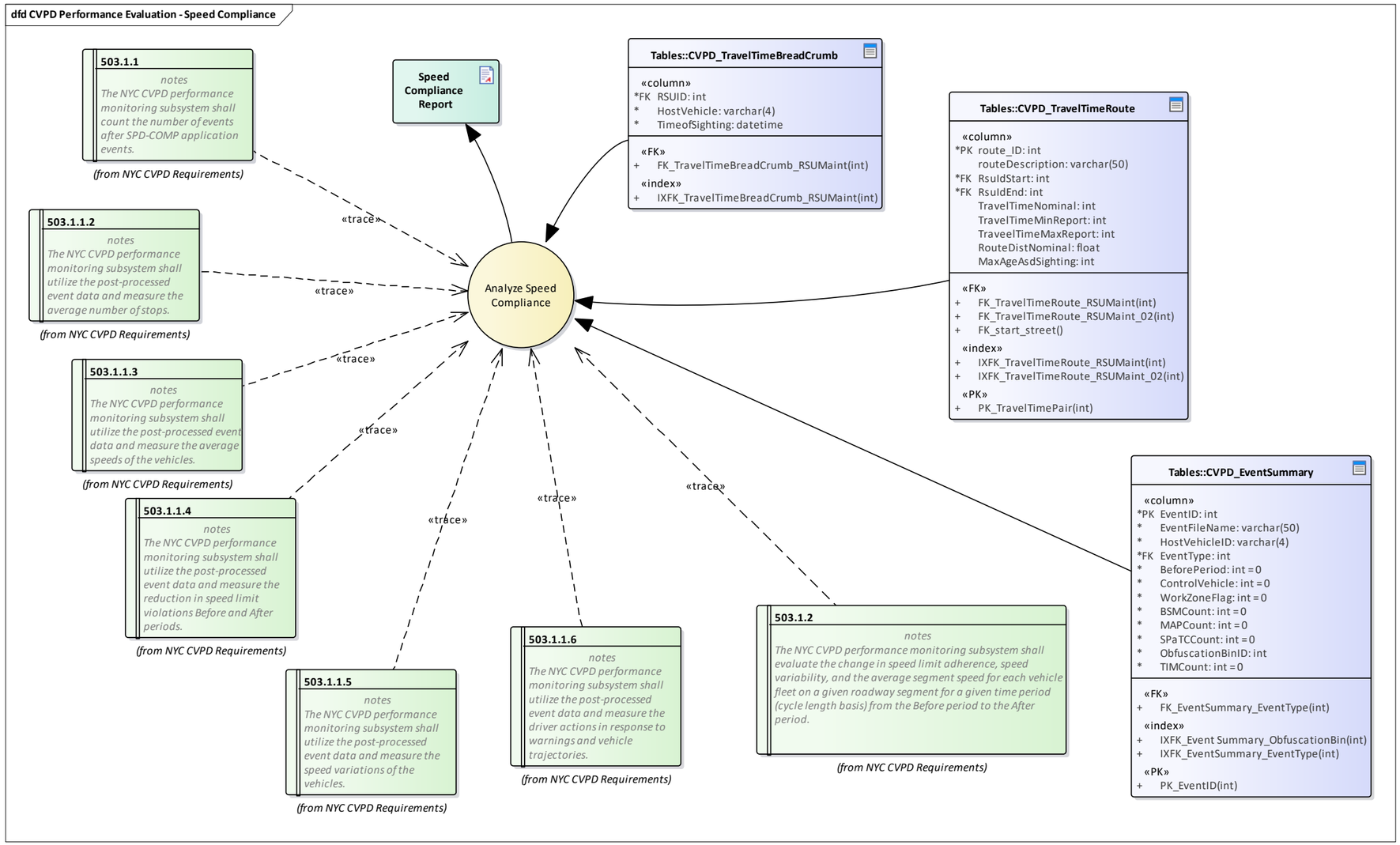
Table 16 Red Light Violation Warning - Reports

Reports
RLVW Trend Analysis 1. Count RLVW events by week / vehicle during the silent period 2. Count RLVW events by week / vehicle during the active period 3. Count RLVW events by week / vehicle for control vehicles during the active period 4. Count RLVW events by week / vehicle for non-control vehicles during the active period 5. Generate trend charts

3.1.2.5.7 Performance Evaluation – Speed Compliance

The performance evaluation process for Speed Compliance (SPDCOMP) application is shown in Figure 19 below.

Source: NYCDOT, 2017



Source: NYCDOT, 2017

Figure 19 Performance Evaluation - Speed Compliance

3.1.2.5.7.1 Analyze Speed Compliance

This process will evaluate the effect of the CV program on speed compliance.

Table 17 Requirements Assigned to Analyze Speed Compliance

REQUIREMENTS
☑ Functional. 503.1.1 The NYC CVPD performance monitoring subsystem shall count the number of events after SPD-COMP application events.
☑ Functional. 503.1.1.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average number of stops.
☑ Functional. 503.1.1.3 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average speeds of the vehicles.
☑ Functional. 503.1.1.4 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the reduction in speed limit violations Before and After periods.
☑ Functional. 503.1.1.5 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the speed variations of the vehicles.
☑ Functional. 503.1.1.6 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the driver actions in response to warnings and vehicle trajectories.
☑ Functional. 503.1.2 The NYC CVPD performance monitoring subsystem shall evaluate the change in speed limit adherence, speed variability, and the average segment speed for each vehicle fleet on a given roadway segment for a given time period (cycle length basis) from the Before period to the After period.

3.1.2.5.7.2 Speed Compliance Report

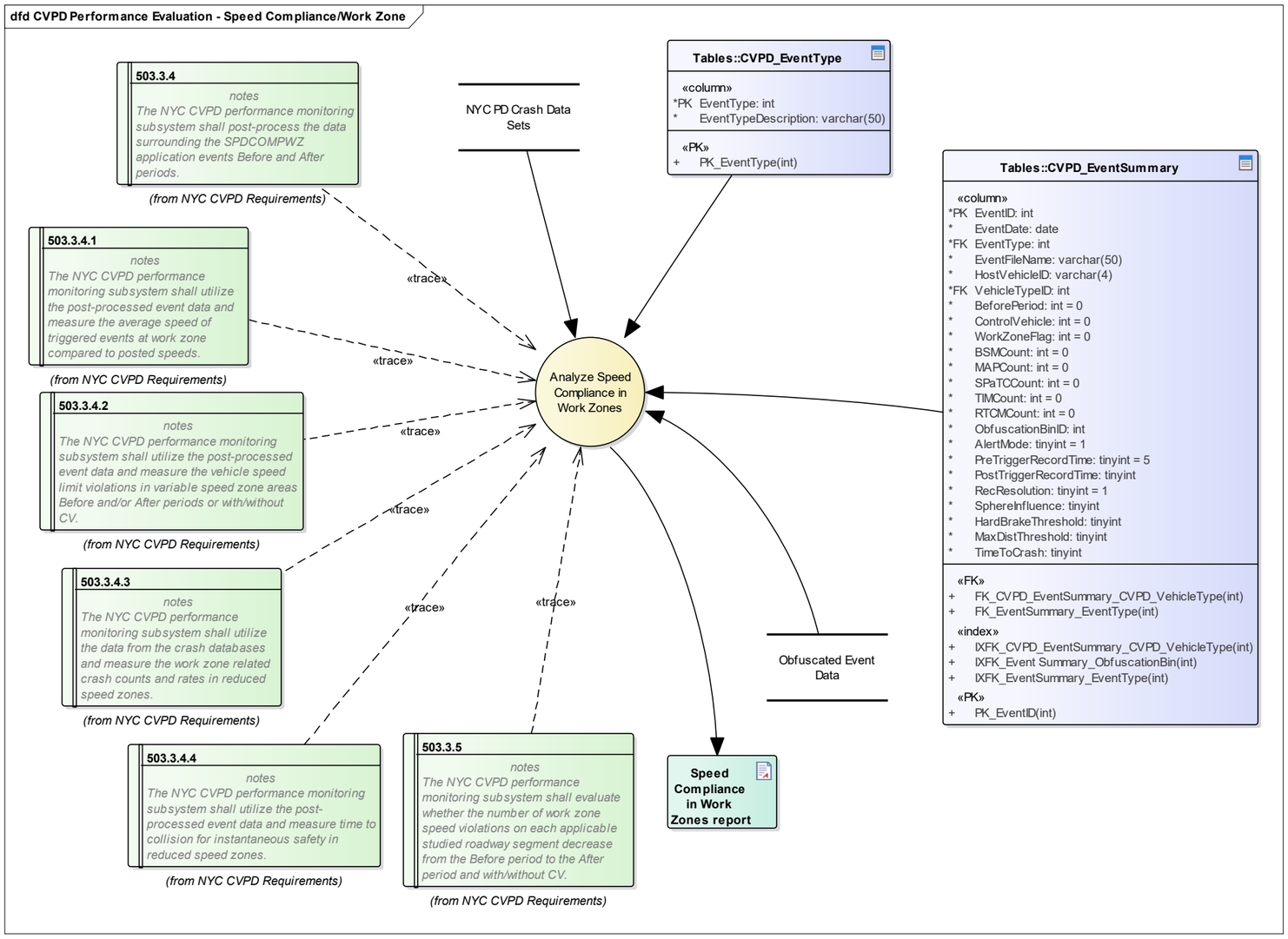
A number of reports will be generated for the Speed Compliance evaluation. Some of these reports can be generated automatically from the data collected from the ASD. Other reports will require the inclusion of data from outside the CVPD program.

Table 18 Speed Compliance - Reports

Reports
Basic Path. Automated Reports Automated reports can be generated directly from the data collected by the NYC CVPD. 1. Generate report comparing speed compliance during silent period to active period 2. Generate report comparing speed compliance between control and non-control vehicles during the active period 3. Generate report comparing speed compliance between control and non-control vehciles during the active period by vehicle type

3.1.2.5.8 Performance Evaluation – Speed Compliance / Work Zone

The performance evaluation process for Speed Compliance / Work Zone (SPDCOMPWZ) application is shown in Figure 20 below. Source: NYCDOT, 2017



Source: NYCDOT, 2017

Figure 20 Performance Evaluation - Speed Compliance in Work Zones

3.1.2.5.8.1 Analyze Speed Compliance in Work Zones

This task will combine the vehicle speed compliance in work zone events recorded by the ASD with the NYC PD Crash Data Sets to evaluate the effect of the CV program on these types of events.

Table 19 Requirements Assigned to Analyze Speed Compliance in Work Zones

REQUIREMENTS
☑ Functional. 503.3.4 The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the SPDCOMPWZ application events Before and After periods.
☑ Functional. 503.3.4.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average speed of triggered events at work zone compared to posted speeds.
☑ Functional. 503.3.4.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the vehicle speed limit violations in variable speed zone areas Before and/or After periods or with/without CV.
☑ Functional. 503.3.4.3 The NYC CVPD performance monitoring subsystem shall utilize the data from the crash databases and measure the work zone related crash counts and rates in reduced speed zones.
☑ Functional. 503.3.4.4 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure time to collision for instantaneous safety in reduced speed zones.
☑ Functional. 503.5 The NYC CVPD performance monitoring subsystem shall evaluate whether the number of work zone speed violations on each applicable studied roadway segment decrease from the Before period to the After period and with/without CV.

3.1.2.5.8.2 Speed Compliance in Work Zones report

The following reports will be generated for the Speed Compliance in Work Zone evaluation:

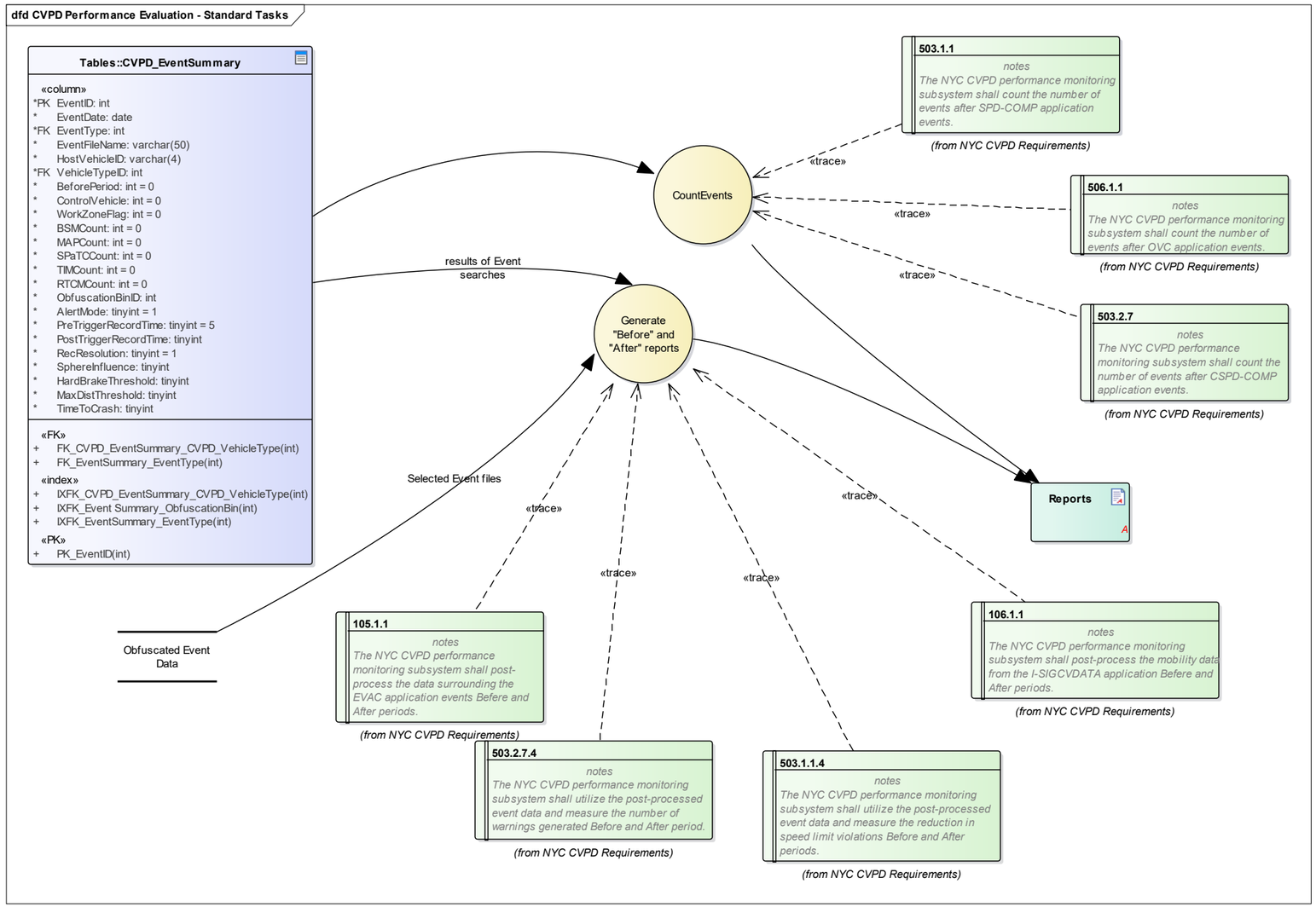
Table 20 Speed Compliance in Work Zones - Reports

Reports
Basic Path. Automated Reports The automated reports can be generated directly from the data collected by the NYC CVPD devices 1. Generate report comparing speed violations in work zones between the silent and active periods 2. Generate report comparing speed violations in work zones between control and non-control vehicles 3. Generate percentile chart showing speed over the speed limit of triggered events
Alternate. Evaluation Reports The evaluation reports require comparison of data from outside the NYC CVPD program with the data collected by the vehicles. 1. Compare events with NYC Police crash data sets during the silent period and the active period

3.1.2.5.9 Performance Evaluation – Standard Tasks

The high-level, standard tasks for performance evaluation process are highlighted in Figure 21 below.

Source: NYCDOT, 2017



Source: NYCDOT, 2017

Figure 21 Performance Evaluation - Standard Tasks

3.1.2.5.9.1 CountEvents

This process will read through the events recorded by the ASD and generate reports for the number of events of a given type during the "quiet" period versus the number of events after the "go live" time.

Table 21 Requirements Assigned to Count Events Process

REQUIREMENTS
☑ Functional. 503.1.1 The NYC CVPD performance monitoring subsystem shall count the number of events after SPD-COMP application events.
☑ Functional. 503.2.7 The NYC CVPD performance monitoring subsystem shall count the number of events after CSPD-COMP application events.
☑ Functional. 503.2.7.4 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the number of warnings generated Before and After period.
☑ Functional. 506.1.1 The NYC CVPD performance monitoring subsystem shall count the number of events after OVC application events.

3.1.2.5.9.2 Generate "Before" and "After" reports

This process will generate a series of reports for specific event types from before the ASDs send notices to the drivers and after.

Table 22 Requirements Assigned to Generate Before and After Reports Process

REQUIREMENTS
☑ Functional. 105.1.2 The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the EVAC application events Befere and After periods.

REQUIREMENTS
Functional. 106.1.1 The NYC CVPD performance monitoring subsystem shall post-process the mobility data from the I-SIGCVDATA application Befere and After periods.
Functional. 503.1.1.4 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the reduction in speed limit violations Before and After periods.
Functional. 503.2.7.4 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the number of warnings generated Before and After period.

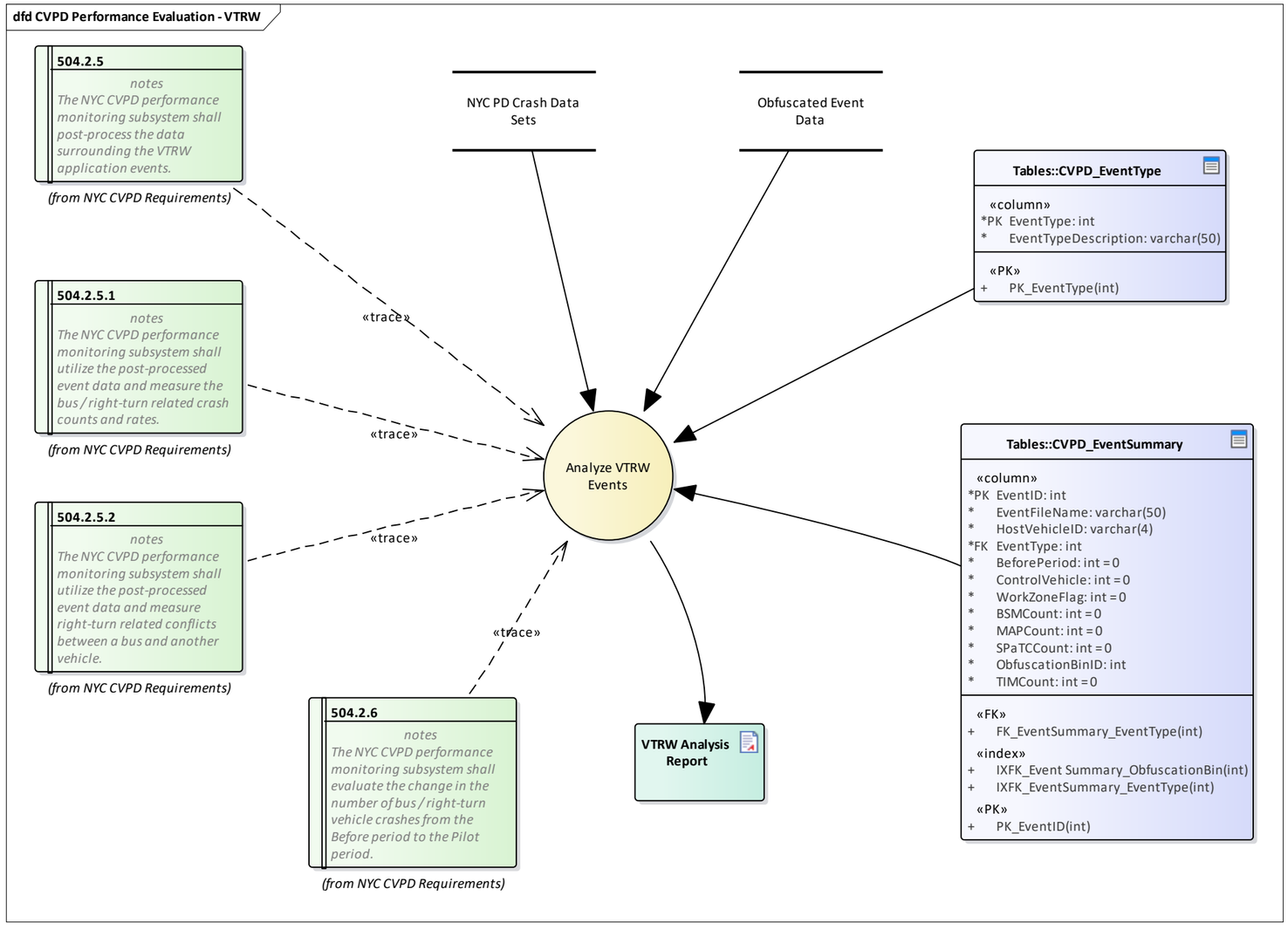
The following set of automated reports will be generated for performance evaluation:

Table 23 General Set of Reports for Performance Evaluation

Reports
Basic Path. Automated Reports 1. Report comparing various types of events from the silent period with the active period 2. Report comparing various types of events during the active period between control and non-control vehicles 3. Report comparing various types of events by day of week during the active period between control and non-control vehicles 4. Generate heat maps for various types of events

3.1.2.5.10 Performance Evaluation – VTRW

The performance evaluation process for Vehicle Turning Right in front of Bus (VTRW) application is shown in Source: NYCDOT, 2017
Figure 22 below.



Source: NYCDOT, 2017

Figure 22 Performance Evaluation - Vehicle Turn Right on Transit Vehicle

3.1.2.5.10.1 Analyze VTRW Events

This task will combine the vehicle turning right in front of a transit vehicle events recorded by the ASD with the NYC PD Crash Data Sets to evaluate the effect of the CV program on these types of events.

Table 24 Requirements Assigned to Analyze VTRW Events

REQUIREMENTS
Functional. 504.2.5 The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the VTRW application events.
Functional. 504.2.5.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the bus / right-turn related crash counts and rates.
Functional. 504.2.5.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the bus / right-turn related crash counts and rates.
Functional. 504.2.5.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure right-turn related conflicts between a bus and another vehicle.
Functional. 504.2.6 The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of bus / right-turn vehicle crashes from the Before period to the Pilot period.

The following reports will be generated for the Vehicle Turning Right in front of a Bus evaluation:

Table 25 VTRW Analysis Reports

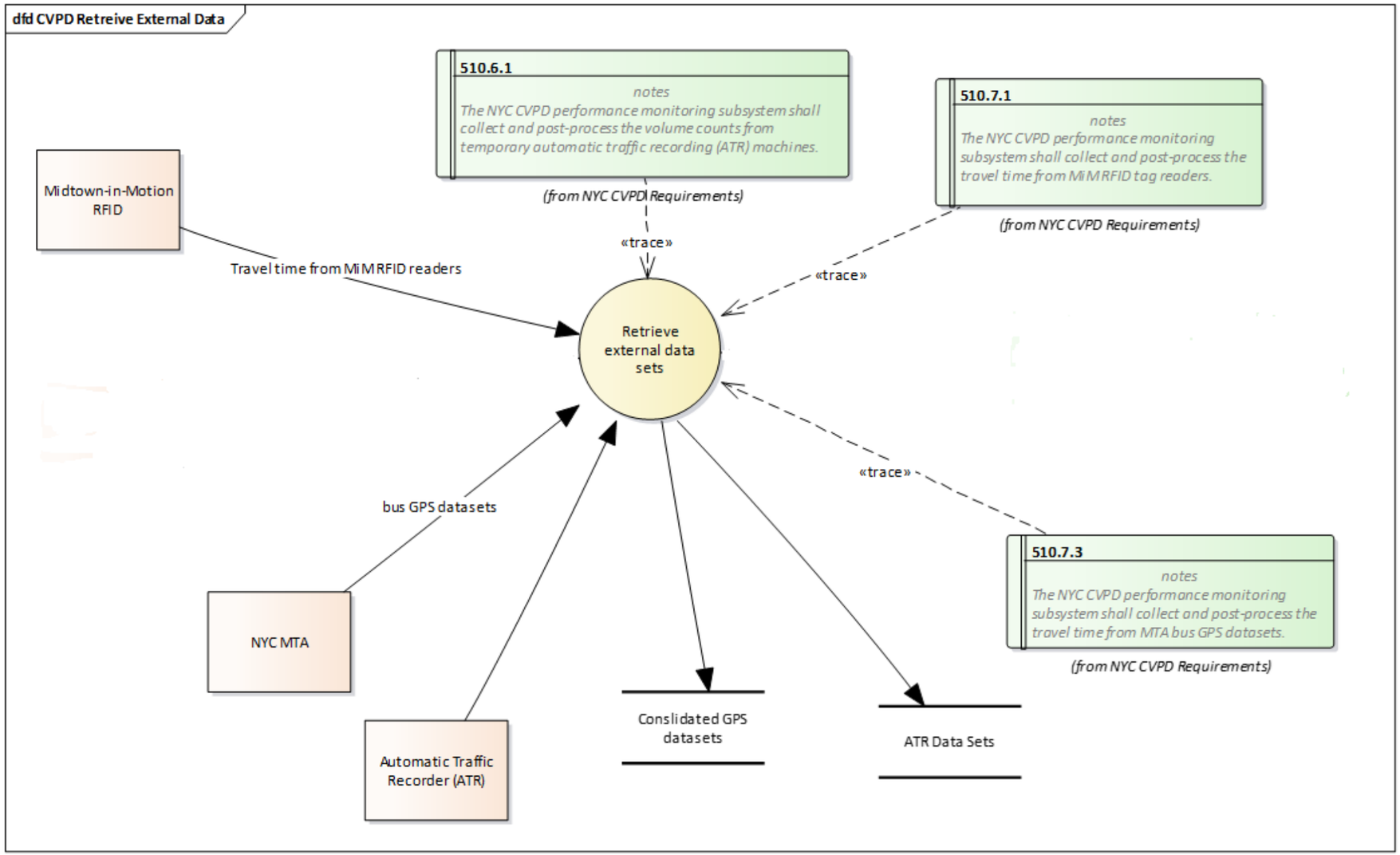
Reports
Basic Path. VTRW Event - Automated reports 1. Generate report comparing the number of VTRW Events from the silent period with the number of VTRW events during the active period

Reports
2. Generate report comparing the number of VTRW Events from the silent period with the number of VTRW events during the active period for control vehicles 3. Generate report comparing the number of VTRW Events from the silent period with the number of VTRW events during the active period for non-control vehicles 4. Generate a heat map of VTRW events from the silent period 5. Generate a heat map of VTRW events from the active period 6. Generate a heat map of VTRW events by day of week from the silent period 7. Generate a heat map of VTRW events by day of week from the active period

3.1.2.5.11 Retrieve External Data Sets

Source: NYCDOT, 2017

Figure 23 describes the process for retrieving the external data sets required to complete the performance evaluation of NYC CVPD system. Table 26 lists the requirements that trace to the external data set retrieval process.



Source: NYCDOT, 2017

Figure 23 Retrieval of External Data Sets

Table 26 Requirements Assigned to Retrieve External Data Sets Process

REQUIREMENTS
☑ Functional. 510.6.1 The NYC CVPD performance monitoring subsystem shall collect and post-process the volume counts from temporary automatic traffic recording (ATR) machines. [Proposed, Medium difficulty.]
☑ Functional. 510.7.1 The NYC CVPD performance monitoring subsystem shall collect and post-process the travel time from MiM RFID tag readers. [Approved, Medium difficulty.]
☑ Functional. 510.7.3 The NYC CVPD performance monitoring subsystem shall collect and post-process the travel time from MTA bus GPS datasets. [Approved, Medium difficulty.]

3.1.2.6 *Event Data Obfuscation*

The NYC CVPD event data obfuscation process is shown in Figure 24 below.

Source: NYCDOT, 2017

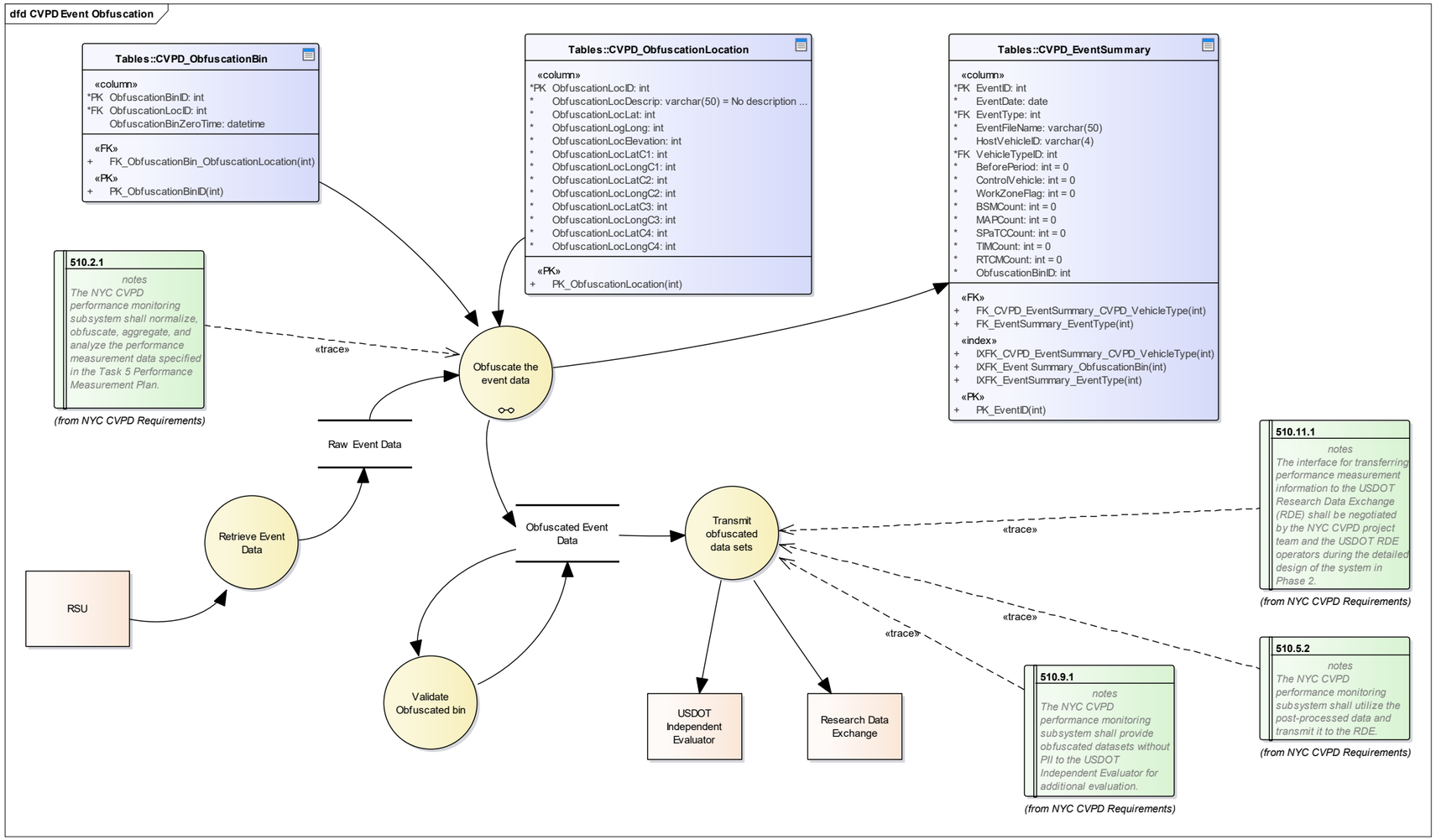


Figure 24 CVPD - Event Obfuscation

3.1.2.6.1.1 Transmit obfuscated data sets

This process will transmit the obfuscated data sets to all external users.

Table 27 Requirements Assigned to Transmit Obfuscated Data Sets Process

REQUIREMENTS
☑ Functional. 510.11.1 The interface for transferring performance measurement information to the USDOT Research Data Exchange (RDE) shall be negotiated by the NYC CVPD project team and the USDOT RDE operators during the detailed design of the system in Phase 2.
☑ Functional. 510.5.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed data and transmit it to the RDE.
☑ Functional. 510.9.1 The NYC CVPD performance monitoring subsystem shall provide obfuscated datasets without PII to the USDOT Independent Evaluator for additional evaluation.

3.1.2.6.1.2 Obfuscate the event data

This process will obfuscate the ASD recorded events to prevent upstream processors of the data from identifying a specific vehicle. As the data is post-processed in the NYCDOT TMC's back-office performance monitoring center, all PII and location breadcrumb information will be eliminated. Also, the time and location information in the event records will be binned, purged, and obfuscated. This will be done for preventing the ability to trace back to the exact location of a particular event. After the data obfuscation process is complete, the data may be submitted to the USDOT for further evaluation. More information on event data obfuscation can be found Section 3.4.3 of the NYC CVPD System Architecture Document (FHWA-JPO-17-451).

Table 28 Requirements Assigned to Obfuscate the Event Data Process

REQUIREMENTS
☑ Functional. 510.2.1 The NYC CVPD performance monitoring subsystem shall generate system performance reports on the number of CV applications in operation and warnings produced by time of day.

The basic procedure for obfuscating the data are shown below.

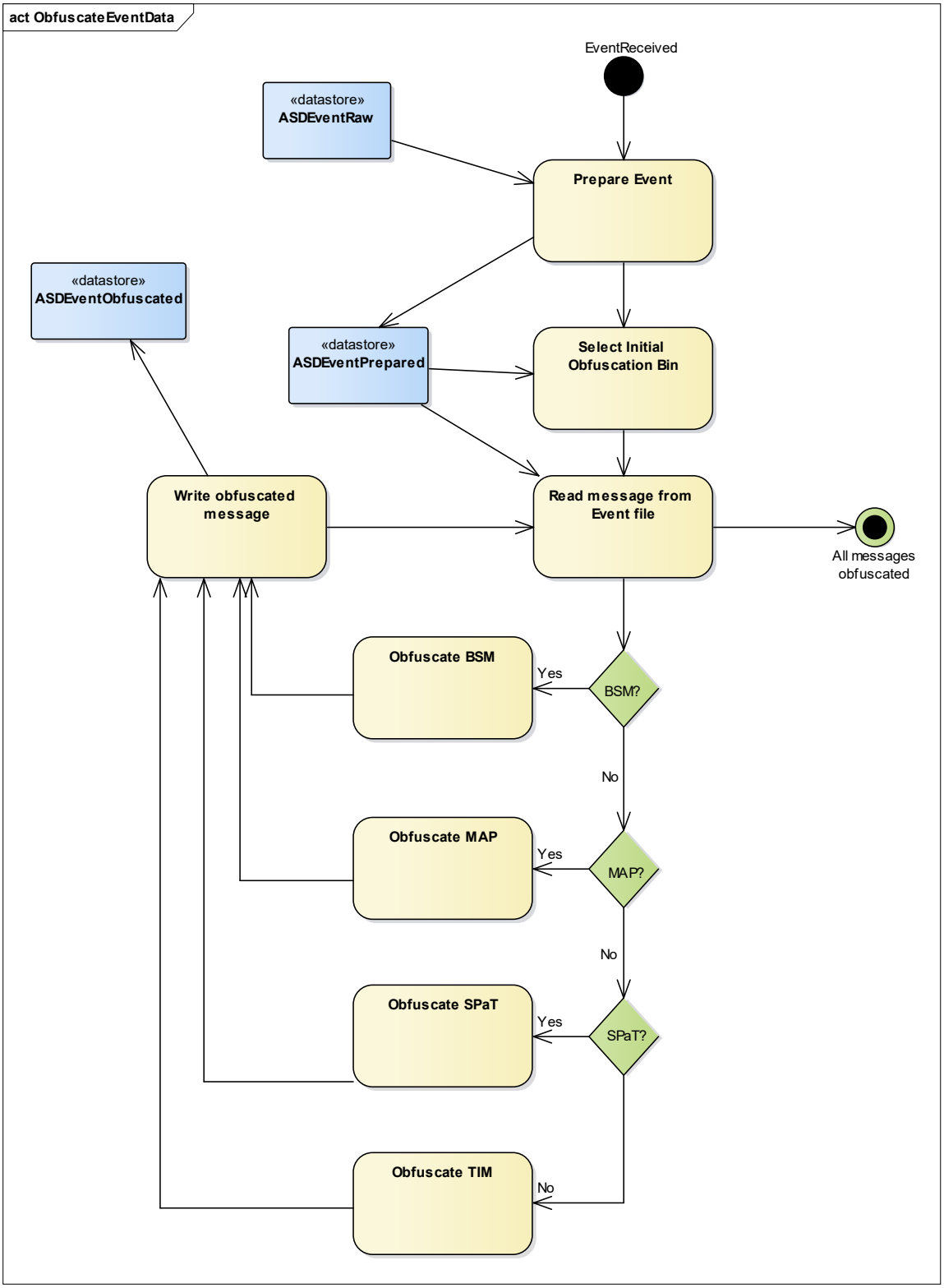
Table 29 Data Obfuscation - Basic Procedure

Data Obfuscation – Basic Procedure
Basic Path. Basic Path 1. Select an obfuscation bin. The bin will be selected based on the location and time of the event. 2. Once the obfuscation bin has been selected; read the BSMs from the event. The actual time and location of the 1st BSM will become the 0 point for all subsequent BSMs. 3. Reset the time and location of the 1st BSM to the location and time of the obfuscation bin 4. For each subsequent BSM reset the time and location relative from the original time and location to relative to the 0 time and location of the 1st BSM 5. Read the MAP messages from the event. Using the time from the 1st BSM reset the MAP messages relative to the new 0 time and remove the identifying intersection information. 6. Read the SPaT messages from the event. Using the time from the 1st BSM reset the SPaT message relative to the new 0 time and remove the identifying intersection information. 7. Read any TIM messages from the event. using the time from the 1st BSM reset the TIM message relative to the new 0 time.

3.1.2.6.1.2.1 Event Data Obfuscation – Detailed Description

The detailed procedure for the Event Data obfuscation is shown in Figure 25 below. A description of the activities is provided in the paragraphs following the diagram.

Source: NYCDOT, 2017



Source: NYCDOT, 2017

Figure 25 Event Obfuscation - Activity Diagram

3.1.2.6.1.2.1.1 Prepare Event

This activity takes the event and starts the obfuscation process.

SCENARIOS

Basic Path. Basic Path

1. Obtain an EventID for this event from the EventSummary table
2. Read each message from the event and prepend the eventID to each message
3. Read the event header and set appropriate values in the EventSummary for this event
4. Write each message to a new file
5. Set the event date in EventSummary
6. Set the BeforePeriod as appropriate
7. Set the event "Control" flag in EventSummary
8. Set the event "WorkZoneFlag" in EventSummary
9. Set the Event Type in EventSummary
10. Set the vehicle type in EventSummary
11. Update counts for message types in the event: BSM, MAP, TIM, SPaT

3.1.2.6.1.2.1.1.1 Select Initial Obfuscation Bin

The system will read the 1st host vehicle BSM and extract the lat/long of the Event.

SCENARIOS

Basic Path. Basic Path

1. Read the lat/long from the 1st host vehicle BSM
2. Determine which ObfuscationLocation geofence includes the event location
3. Read the time of the event from the Event header record
4. Determine which ObfuscationBin for the selected location ID has a time that occurs before the event time.
5. Set the ObfuscationBinID in the Event Summary table

3.1.2.6.1.2.1.2 ASDEventRaw

This file contains the messages of the ASDEvent. The expected records in this file include:

- Event header
- BSM
- MAP
- TIM
- SPaT

This file will be deleted after the *Prepare Event* activity.

3.1.2.6.1.2.1.3 ASDEventPrepared

This file contains the messages of the ASDEvent with the EventID prepended to each message. The expected records in this file include:

- Event header
- BSM
- MAP
- TIM
- SPaT

Once the Obfuscation Bins are refined these files will be deleted after the obfuscation process.

3.1.2.6.1.2.1.4 Read message from Event file

Read a message from the ASDEventPrepared file and send it to the message specific obfuscation process. Once all messages have been process, exit.

3.1.2.6.1.2.1.5 Obfuscate BSM

A BSM will be obfuscated by adjusting its location relative to the Obfuscation Bin.

SCENARIOS

Basic Path. Obfuscate BSM

1. Use actual lat/long from first BSM in the event.
2. Write the 1st BSM to the obfuscated event file changing the lat/long to the lat/long of the obfuscation bin
3. Read the next BSM.
4. Determine the relative position of the BSM lat/long to the 1st BSM lat/long
5. Calculate the new lat/long for the BSM with the same relative position to the lat/long of the obfuscation bin
6. Write the BSM to the obfuscated event file.

3.1.2.6.1.2.1.6 Obfuscate MAP

This will obfuscate a MAP message associated with an event.

3.1.2.6.1.2.1.7 Obfuscate SPaT

This will obfuscate a SPaT message associated with an event. The obfuscation will be accomplished by setting various fields (ex. DescriptiveName, IntersectionReferenceID) to values for the obfuscation bin. The time within each SPaT will be set relative to the start time of the bin.

SCENARIOS

Basic Path. Basic Path

1. Read SPaT message
2. Remove descriptive name from the SPaT message
3. Remove intersection ID from the SPaT message
4. Reset the time on the SPaT message to be relative to the 1st BSM in the event

3.1.2.6.1.2.1.8 Obfuscate TIM

The obfuscate TIM will reset the location information in the TIM to the location of the obfuscation bin with an offset to the 1st BSM message. The time of the TIM message will be change to have an offset from the retimed BSM message

3.1.2.6.1.2.1.9 Write obfuscated message

This activity will write the obfuscated messages out to the ASDEventObfuscated data file.

3.1.2.6.1.2.1.10 ASDEventObfuscated

This file contains the messages from the ASD Event after they have been through the obfuscation process. The file will contain a header record with sufficient meta data to identify the event for the performance evaluation but also prevent anyone from Association this event with an actual physical event or vehicle.

This file will contain:

- BSM (multiple)
- MAP (0-multiple) - Map messages will only be available if the event occurred near an RSU
- TIM (0-multiple)
- SPaT (0-multiple) - SPaT messages will only be available if the event occurred near an intersection with an RSU

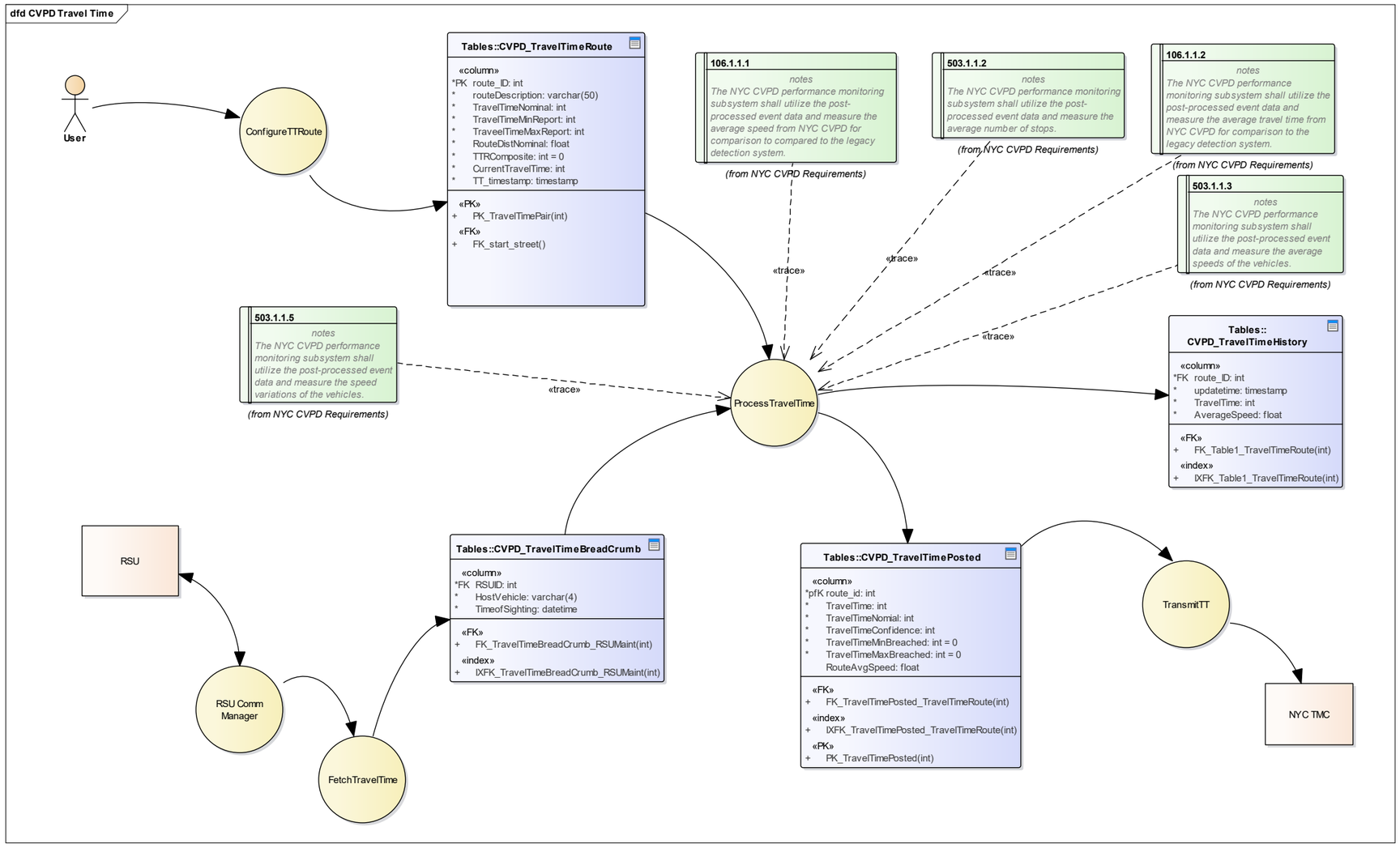
3.1.2.6.1.3 Retrieve Event Data

This process will connect to all of the RSU devices via the RSU Comm manager and retrieve the ASD event information.

3.1.2.7 *Travel Time*

Source: NYCDOT, 2017

Figure 26 illustrates the data flow diagram for collecting and processing the NYC CV travel time data.



Source: NYCDOT, 2017

Figure 26 Travel Time Data Flow Diagram (DFD)

3.1.2.7.1 Travel Time Processes

The Travel Time component is implemented with the processes shown in the data flow diagram in Figure 26 above.

Source: NYCDOT, 2017

3.1.2.7.1.1 RSU Comm Manager

The RSU Comm Manager manages all communications with the RSUs in the street. This will also include communication with the ASDs since they do not have direct communication with the TMC.

3.1.2.7.1.2 FetchTravelTime

This process collects the Bread Crumb data from the RSUs in the system and stores the data in the NYC CVPD database for processing.

At a system defined interval the FetchTravelTime process will check each RSU to determine if any bread crumb data has been captured. If there is bread crumb data it will be uploaded to the TMC and removed from the RSU

Note that the “breadcrumb” data is collected by the RSU based on the configuration of “zones” which are configured for each intersection and stored at the RSU; the RSU then captures a single BSM from each vehicle as it enters (or passes through) the configured zone. This provides a vehicle “sighting” at each intersection which is then uploaded as described above. This is the mechanism provided by the RSU vendor to satisfy the project requirements.

3.1.2.7.1.3 ProcessTravelTime

This is the core process for this activity. This process will take the bread crumb data and look for matches in the temporary ID of vehicles. When the same temporary ID is found for a route, the system will then calculate the speed and travel time for the specific vehicle. As multiple matches are found an average travel time for a route for a time period will be calculated and saved.

Table 30 Requirements Assigned to Travel Time Process

REQUIREMENTS
☑ Functional. 106.1.1.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average speed from NYC CVPD for comparison to compared to the legacy detection system.
☑ Functional. 106.1.1.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average travel time from NYC CVPD for comparison to the legacy detection system.

REQUIREMENTS
☑ Functional. 503.1.1.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average number of stops.
☑ Functional. 503.1.1.3 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average speeds of the vehicles.
☑ Functional. 503.1.1.5 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the speed variations of the vehicles.

3.1.2.7.1.3.1 Process Travel Time Activities

The travel time calculations require a number of processing activities that are shown below in Source: NYCDOT, 2017

Figure 27 Process Travel Time Activities

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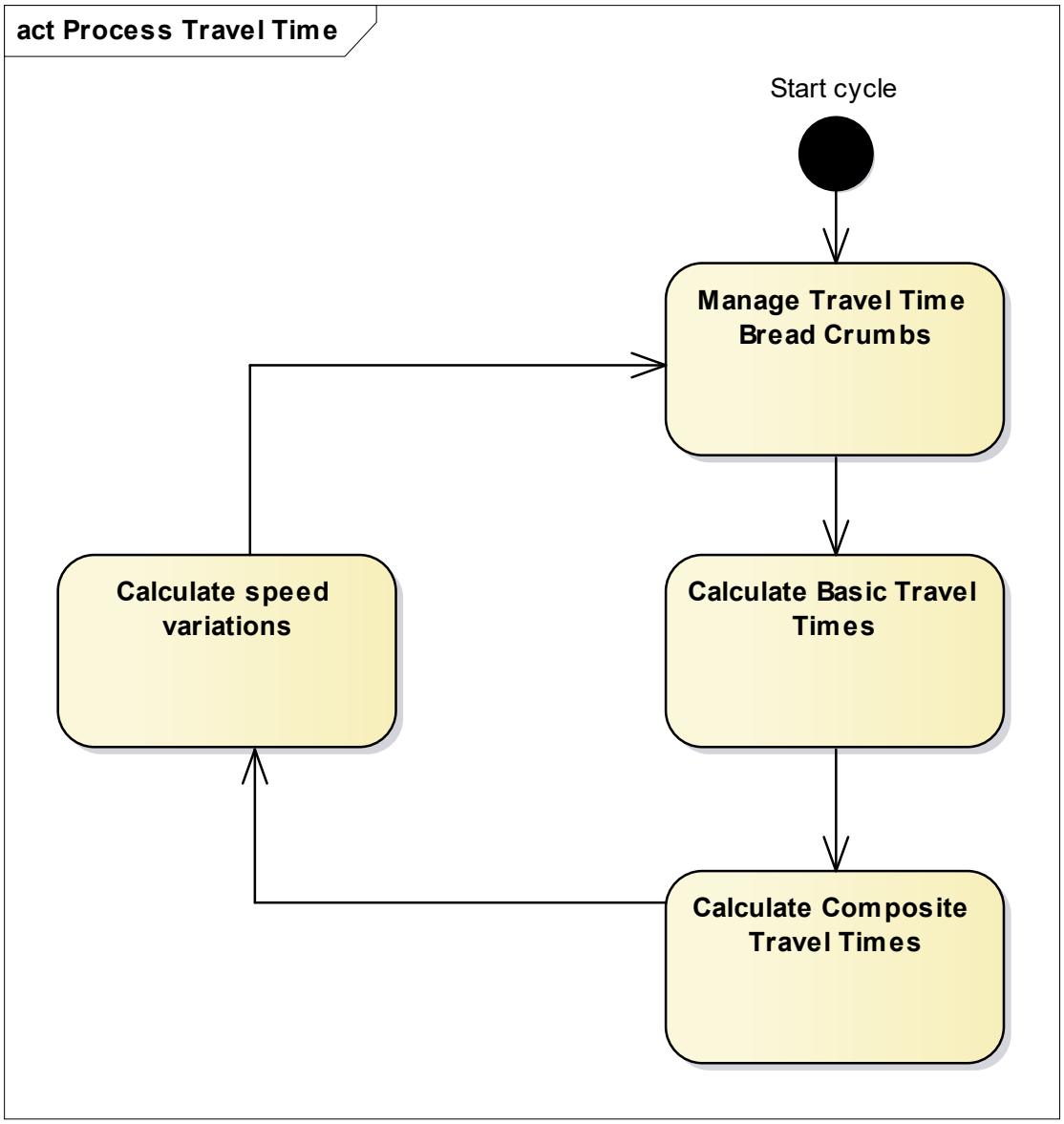


Source: NYCDOT, 2017

Figure 27 Process Travel Time Activities

These activities are described in more detail below.

3.1.2.7.1.3.2 Manage Travel Time Bread Crumbs

This activity removes the ASD sightings that have been in the system past the aging time.

SCENARIOS
Basic Path. Purge Bread Crumbs

SCENARIOS
1. Sort bread crumbs by TimeOfSighting 2. Determine purgeTime = currentTime - maxDuration 3. Delete all records older than purgeTime 4. Log number of records deleted

3.1.2.7.1.3.3 Calculate Basic Travel Times

This activity will calculate new travel times and update the posted travel times for the system.

SCENARIOS
Basic Path. Calculate Travel Time 1. Read through the Travel Time Bread Crumb table looking for matches and defined Travel Time routes 2. Calculate the travel time for each match on a specific route 3. Calculate the mean, standard deviation and confidence interval 4. Set the travel time for the route and the confidence level. The confidence level will be based on the width of the confidence interval 5. check and set if min or max travel time is broached for this route
Alternate. No matches 1. Set travel time for the route to -1

3.1.2.7.1.3.4 Calculate Composite Travel Times

This activity will combine 2 or more basic travel time routes (measured) into a single travel time route for display and posting.

SCENARIOS
Basic Path. Calculate Composite Travel Time 1. Collect travel times for all segments of the route 2. sum the segment travel times 3. Set the travel time confidence based on the least confident component

3.1.2.7.1.3.5 Calculate speed variations

This activity will calculate the various speed variations between vehicles

SCENARIOS
Basic Path. Speed variation between vehicles 1. Convert Travel Time for each match along a basic route to a speed

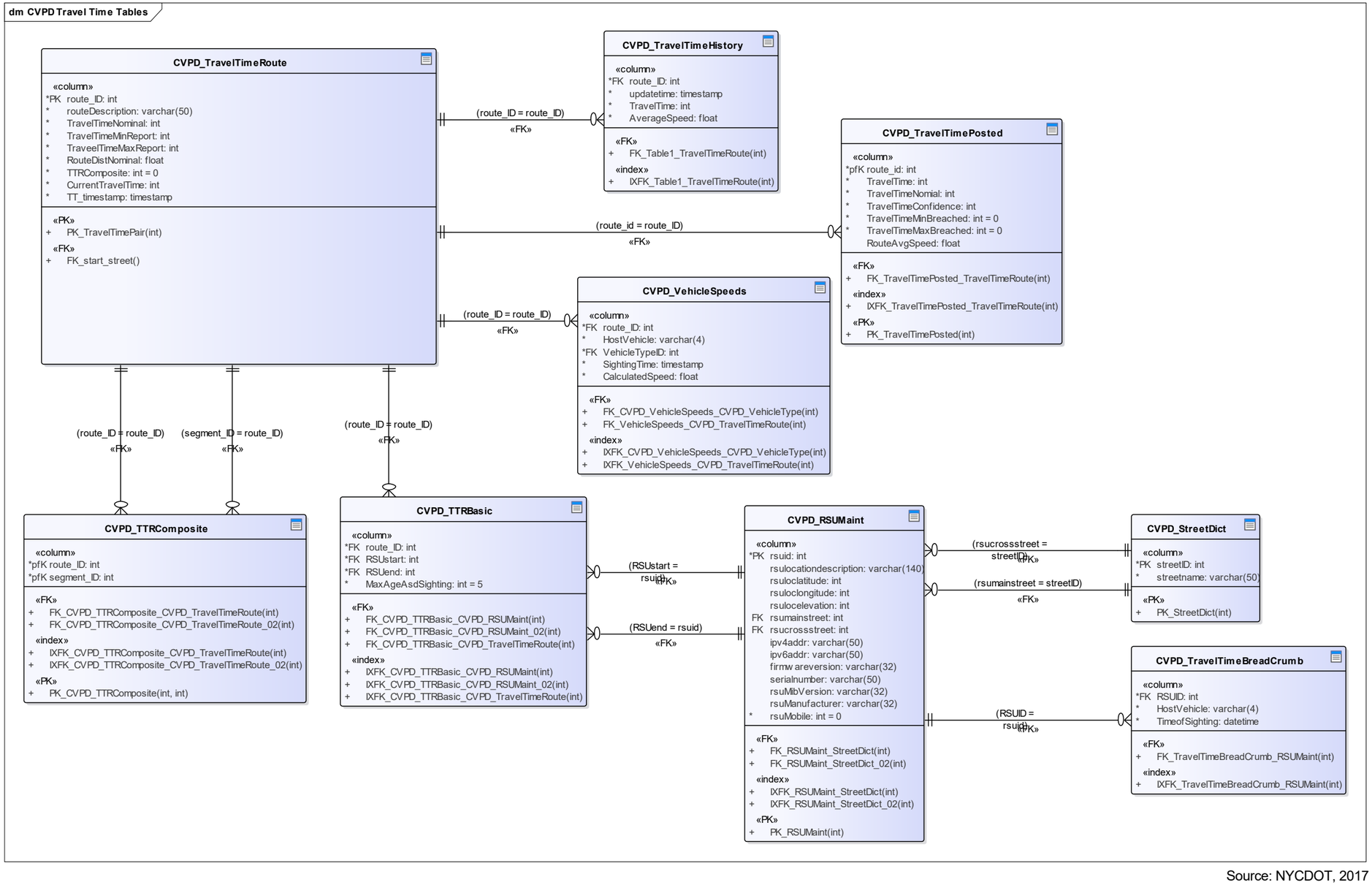
SCENARIOS
2. Generate a scatter chart with the individual speeds along a route 3. Generate a report for each route with the number of vehicles, average speed, mean speed, median speed, minimum speed, maximum speed, standard deviation 4. Generate a percentile chart of the speeds

3.1.2.7.1.4 ConfigureTTRoute

A user interface that allows an operator to configure the travel time routes in the system.

3.1.2.7.1.5 TransmitTT

This process will send the calculated travel time to the various consumers for posting.



Source: NYCDOT, 2017

Figure 28 Travel Time Database Tables

3.1.2.8 *Database*

This section documents the various tables used in the NYC CVPD TMC.

3.1.2.8.1 CVPD.CVPD_AppAdjParams

This table will track the adjustable parameters for the ASD applications.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
AsdVendorID	int	True	This will link into the ASD Vendor table. Since the parameters may vary with the different ASD vendors.
ParmStartDate	date	True	This will be the date that this set of parameters becomes effective.
ParmEndDate	date	True	Initial value: project end date This will be the date that these parameters are superseded. The initial value for this field will be the projected end of the project. It will be updated when new parameters are supplied.
MinActiveSpeed	int	True	Initial value: 25 The minimum speed at which the applications will be active in MPH
Sound	tinyint	True	Initial value: 1 A flag indicating if sound is to be generated. 0 = No 1 = Yes **NOTE**: if the vehicle is a control vehicle this value will be ignored.
MinConfidenceLevel	tinyint	False	
Braking capability	tinyint	False	

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
AppProirity	tinyint	False	
AlertSpacing	tinyint	False	
ExcessiveSpeedAmt	int	False	

3.1.2.8.2 CVPD.CVPD_ASDHistory

This table stores the ASD History with respect to the firmware updates applied to a specific ASD.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
AsdSerialNumber	varchar(50)	True	The vendor provided serial number for the unit
entrytime	timestamp	True	The time this entry was made. Not user editable. The time will be the local system time (not UTC)
dateofchange	datetime	True	the date the change took place
asdversion_before_update	varchar(50)	True	The version of the ASD firmware before the update
asdversion_after_update	varchar(50)	True	The ASD firmware version after the update
notes_on_update	varchar(max)	True	Initial value: No comments This is a free text entry area for the user making this record to record any comments.

3.1.2.8.3 CVPD.CVPD_ASDMaint

This table will track the various ASD units in the field along with their current firmware version number and last sighting date and time.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
AsdSerialNumber	varchar(50)	True	The serial number of the ASD. This will be passed in by the ASD with certain messages.
AsdVendorID	int	True	An index into the ASD vendor table
AsdModelNumber	varchar(50)	True	The vendor supplied model number for this ASD
LastSighting	datetime	True	This will be the date and time of the most current sighting of this ASD, either by another ASD or an RSU. This field will be used to help determine when an ASD is missing from the system.
firmwareversion	varchar(50)	True	The vendor supplied version number of the firmware. This will be read from the ASD
firmware_update_date	datetime	True	The date of the last firmware update. This information will also be available out of the ASDHistory table.
ASD_Control	int	True	Initial value: 0 A flag to indicate if this specific ASD is a control ASD. A control ASD has full operational capability but will not notify the vehicle operator. FALSE:==0 TRUE:==1
FleetOwnerID	int	True	A foreign key to the fleet owner for this ASD. Within the NYC CVPD program each ASD will belong to a fleet
VehicleTypeID	int	True	This column maps into the VehicleType table to provide the type of vehicle in which this ASD is installed.
SCMSCertificate	varchar(255)	False	

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			This will be one of the ASD's BSM signing certificates and is required if we must request that an ASD be placed on the certificate revocation list (CRL). The SCMS will be able to take a BSM Signing certificate and trace back to the original certificate.

3.1.2.8.4 CVPD.CVPD_ASD_RF

This table collects the RF logs from the individual ASD to ASD sightings. And will be used to measure the relative performance of RF transmissions.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
AsdSerialNumber	varchar(50)	True	The serial number of this ASD. It must match a serial number in the ASDMaint table. This will be removed prior to release of this data outside the TMC
HostVehicle	varchar(4)	True	**Use:** This is the 4 octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. Because this value is used as a means to identify the local vehicles that are interacting during an encounter, it is used in the message set. Other devices, such as infrastructure (RSUs), may have a fixed value for the temporary ID value. See also DE_StationID which is used in other deployment regions. **ASN.1 Representation:** TemporaryID ::= OCTET STRING (SIZE(4))
RemoteVehicle	varchar(4)	True	**Use:** This is the 4 octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. Because this value is used as a means to identify the local

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			vehicles that are interacting during an encounter, it is used in the message set. Other devices, such as infrastructure (RSUs), may have a fixed value for the temporary ID value. See also DE_StationID which is used in other deployment regions. **ASN.1 Representation:** TemporaryID ::= OCTET STRING (SIZE(4))
TimeOfDetection	datetime	True	This will be the date and time of the sighting of the remote vehicle. Time will be the current local time (not UTC)
RFLevel	float	True	The recorded RF level from the remote vehicle ASD
latitude	int	True	**Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable. **ASN.1 Representation:** Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 90 degrees***
longitude	int	True	**Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 180 degrees***
elevation	int	True	**Use:** The DE_Elevation data element represents the geographic position above or below the reference ellipsoid (typically WGS-84). The number has a resolution of 1 decimeter and represents an asymmetric range of

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			positive and negative values. Any elevation higher than +6143.9 meters is represented as +61439. Any elevation lower than -409.5 meters is represented as -4095. If the sending device does not know its elevation, it shall encode the Elevation data element with -4096. **ASN.1 Representation:** Elevation ::= INTEGER (-4096..61439) -- In units of 10 cm steps above or below the reference ellipsoid -- Providing a range of -409.5 to + 6143.9 meters -- The value -4096 shall be used when Unknown is to be sent

3.1.2.8.5 CVPD.CVPD_ASDVendor

This table contains the contact information for the various ASD vendors

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
AsdVendorID	int	True	This will provide the index into this table to find an ASD Vendor
AsdVendorName	varchar(50)	True	
AsdVendorPhone	varchar(12)	True	The phone number for the vendor nnn-nnn-nnnn
AsdVendorContact	varchar(50)	True	The name of the primary contact for the ASD vendor

3.1.2.8.6 CVPD.CVPD_EventRecParams

This table contains the parameters to tell the ASD how long to record data.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
PreTriggerRecTime	int	True	Initial value: 5 Units - Seconds

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			The time period prior to the trigger from which DSRC messages (BSM, MAP, SPaT, TIM), application parameters, and vehicle performance data are to be incorporated into the event record as specified for the Safety Applications.
PostTriggerRecTime	int	True	Initial value: 5 Units = seconds The time period after the trigger from which DSRC messages (BSM, MAP, SPaT, TIM), application parameters, and vehicle performance data are to be incorporated into the event record as specified for the Safety Applications
RecResolution	int	True	Units - seconds Period used to record BSM. Use either 0.1, 1, or 5 seconds. The applications have differing needs for recording the BSM information due to the driver response. Some applications need short time periods while others need longer time periods to verify driver reaction. Examples of applications with short period needs are Red Light Violation Warning. Examples of applications with long period needs are Oversize Vehicle Compliance and Speed Compliance / Work Zones.
SphereInfluence	int	True	Units - meters The range around the connected vehicle in which the events from application triggers are recorded
HardBrakeThreshold	int	True	Units - meters/second^2 The deceleration rate of 0.4g as defined in J2945/1, section 3.1, which is considered to be the threat vehicle in the application

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			Used by EEBL. The vehicle that generates the BMS indicating an EEBL has exceeded the hard braking threshold (decal > 0.4g). The threat vehicle transmits the hard breaking via BSM and the host vehicles that react to it are in the same or adjacent lane to the threat vehicle and behind the threat vehicle
MaxDistThreshold	int	True	Units - feet The maximum distance allowed from a host vehicle to the threat vehicle for generating an EEBL alert Used by EEBL, FCW. This limits the host vehicle's generation of a trigger to within this distance of the threat vehicle
TimeToCrash	int	True	units - seconds The time-to-crash value calculated by the application to an accuracy of 0.01 seconds Calculated by FCW
AsdSerialNumber	varchar(50)	True	

3.1.2.8.7 CVPD.CVPD_EventSummary

This table contains a summary of the event data received from the ASD

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
EventID	int	True	A unique ID assigned to the event for identification purposes within the NYC CVPD project. Properties: AutoNum = True property = AutoNum=True;
EventDate	date	True	

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
EventType	int	True	This is the type of event that triggered the collection of this data.
EventFileName	varchar(50)	True	This will be the system file name that contains the various messages that comprise the event. These will be the obfuscated messages as received from the ASD
HostVehicleID	varchar(4)	True	**Use:** This is the 4 octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. Because this value is used as a means to identify the local vehicles that are interacting during an encounter, it is used in the message set. Other devices, such as infrastructure (RSUs), may have a fixed value for the temporary ID value. See also DE_StationID which is used in other deployment regions. **ASN.1 Representation:** TemporaryID ::= OCTET STRING (SIZE(4))
VehicleTypeID	int	True	This will be the vehicle ID extracted from the BSM and recorded here to facilitate reporting.
BeforePeriod	int	True	Initial value: 0 This flag will indicate if the event took place during the "before period" (TRUE) or in the "after period" (FALSE). From the *NYC CVPD Concept of Operations* document: • Before period: System fully deployed and operational but ***without*** user notification of ASD perceived warnings and ***without*** modification to operations of signals or other infrastructure. • After period: System fully deployed and operational but ***with*** user notification of ASD perceived warnings and ***with***

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			modification to operations of signals or other infrastructure. TRUE:==1 FALSE:==0
ControlVehicle	int	True	Initial value: 0 A flag to indicate that this vehicle is part of the control group. The control group will have fully operational ASD but will not provide any feedback to the driver. TRUE:==1 FALSE:==0
WorkZoneFlag	int	True	Initial value: 0 This indicates if the event occurred in a designated work zone based on the TIM message
BSMCount	int	True	Initial value: 0 The number of BSM messages recorded with this event.
MAPCount	int	True	Initial value: 0 The number of MAP messages recorded with this event
SPaTCCount	int	True	Initial value: 0 The number of SPaT messages recorded with this event.
TIMCount	int	True	Initial value: 0 This will be a count of the number of TIM messages associated with the event
ObfuscationBinID	int	True	The ID of the obfuscation bin to which this event has been assigned. The obfuscation bin will provide the time of the event.
AlertMode	tinyint	True	Initial value: 1 The alert mode of the ASD for this event.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			0=silent 1=activve
PreTriggerRecordTime	tinyint	True	Initial value: 5 Units = seconds The time period prior to the trigger from which DSRC messages (BSM, MAP, SPaT, TIM), application parameters, and vehicle performance data are to be incorporated into the event record as specified for the Safety Applications
PostTriggerRecordTime	tinyint	True	Units = seconds The time period after the trigger from which DSRC messages (BSM, MAP, SPaT, TIM), application parameters, and vehicle performance data are to be incorporated into the event record as specified for the Safety Applications
RecResolution	tinyint	True	Initial value: 1 units = tenths of a second Period used to record BSM. Use either 0.1, 1, or 5 seconds stored in the database as 1, 10, 50 The applications have differing needs for recording the BSM information due to the driver response. Some applications need short time periods while others need longer time periods to verify driver reaction. Examples of applications with short period needs are Red Light Violation Warning. Examples of applications with long period needs are Oversize Vehicle Compliance and Speed Compliance / Work Zones
SphereInfluence	tinyint	True	units = meters The range around the connected vehicle in which the events from application triggers are recorded

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
HardBrakeThreshold	tinyint	True	units = meters/second^2 The deceleration rate of 0.4g as defined in J2945/1, section 3.1, which is considered to be the threat vehicle in the application Used by EEBL. The vehicle that generates the BMS indicating an EEBL has exceeded the hard braking threshold (decal > 0.4g). The threat vehicle transmits the hard breaking via BSM and the host vehicles that react to it are in the same or adjacent lane to the threat vehicle and behind the threat vehicle
MaxDistThreshold	tinyint	True	units = feet The maximum distance allowed from a host vehicle to the threat vehicle for generating an EEBL alert Used by EEBL, FCW. This limits the host vehicle's generation of a trigger to within this distance of the threat vehicle
TimeToCrash	tinyint	True	units = seconds The time-to-crash value calculated by the application to an accuracy of 0.01 seconds ***Calculated by FCW***

3.1.2.8.8 CVPD.CVPD_EventType

This is a list of the event types reported by the ASD.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
EventType	int	True	An enumerated value for the event type
EventTypeDescription	varchar(50)	True	A text description of the event type. This description will be available for

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			reports, drop down lists or to unambiguously identify the event type

3.1.2.8.9 CVPD.CVPD_FleetOwner

This table tracks the owners of the various fleets that have CV equipment installed and will map the ASDs in use by this fleet owner

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
FleetOwnerID	int	True	The primary key to identify this fleet owner
FleetOwnerName	varchar(50)	True	A name for the fleet owner
FleetOwnerDescription	varchar(max)	True	A free form description/notes field for this fleet owner
FleetOwnerPOC	varchar(50)	True	The name or position to contact for this fleet owner
FleetOwnerPhone1	varchar(10)	True	The primary phone number to contact the fleet owner
FleetOwnerFAX	varchar(10)	False	A FAX phone number for the Fleet owner
FleetOwnerPhone2	varchar(10)	False	A secondary phone number for the Fleet owner
FleetOwnerASDdata	int	True	Initial value: 0 This is a flag indicating if the fleet owner has requested access to the ASD data. If TRUE then a 2nd encryption key must be provided to the ASD to encrypt the data for the fleet owner. FALSE:==0 TRUE:==1

3.1.2.8.10 CVPD.CVPD_ObfuscationBin

The obfuscation bin is a location and time that events will be placed in to prevent users of the data from identifying a specific vehicle for the event.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
ObfuscationBinID	int	True	A unique identifier for this bin
ObfuscationLocID	int	True	A pointer to the location for this bin.
ObfuscationBinZeroTime	datetime	False	The zero time for this specific bin. This will be the start time for each event placed in this event.

3.1.2.8.11 CVPD.CVPD_ObfuscationLocation

This is the geographic location of the various obfuscation bins. Each bin will define a geofence of 4 points.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
ObfuscationLocID	int	True	The ID of the location. This will be an internal ID for the NYC CVPD software
ObfuscationLocDescrip	varchar(50)	True	Initial value: No description provided A user provided description of the location.
ObfuscationLocLat	int	True	This is latitude that will be used by the obfuscation process. **Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable. **ASN.1 Representation:** Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree***

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			-- Providing a range of plus-minus 90 degrees
ObfuscationLogLong	int	True	This is the longitude that will be used by the obfuscation process **Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 180 degrees***
ObfuscationLocElevation	int	True	**Use:** The DE_Elevation data element represents the geographic position above or below the reference ellipsoid (typically WGS-84). The number has a resolution of 1 decimeter and represents an asymmetric range of positive and negative values. Any elevation higher than +6143.9 meters is represented as +61439. Any elevation lower than -409.5 meters is represented as -4095. If the sending device does not know its elevation, it shall encode the Elevation data element with -4096. **ASN.1 Representation:** Elevation ::= INTEGER (-4096..61439) -- In units of 10 cm steps above or below the reference ellipsoid -- Providing a range of -409.5 to + 6143.9 meters -- The value -4096 shall be used when Unknown is to be sent
ObfuscationLocLatC1	int	True	This is the latitude of the 1st corner of the obfuscation bin geofence **Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			ASN.1 Representation: Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 90 degrees***
ObfuscationLocLongC1	int	True	This is the longitude of the 1st corner of the obfuscation bin geofence. **Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 180 degrees***
ObfuscationLocLatC2	int	True	This is the latitude of the 2nd corner of the obfuscation bin geofence. **Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable. **ASN.1 Representation:** Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 90 degrees***
ObfuscationLocLongC2	int	True	This is the longitude of the 2nd corner of the obfuscation bin geofence. **Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree***

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			-- Providing a range of plus-minus 180 degrees
ObfuscationLocLatC3	int	True	This is the latitude of the 3rd corner of the obfuscation bin geofence. **Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable. **ASN.1 Representation:** Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 90 degrees***
ObfuscationLocLongC3	int	True	This is the longitude of the 3rd corner of the obfuscation bin geofence. **Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 180 degrees***
ObfuscationLocLatC4	int	True	This is the latitude of the 4th corner of the obfuscation bin geofence. **Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable. **ASN.1 Representation:** Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 90 degrees***

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
ObfuscationLocLongC4	int	True	This is the longitude of the 4th corner of the obfuscation bin geofence. **Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 180 degrees***

3.1.2.8.12 CVPD.CVPD_RemoteVehicles

This is a list of the remote vehicles associated with a specific event. This list will be constructed by the NYC CVPD software.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
EventID	int	True	The ID to the event to which this remote vehicle has a connection.
RemoteVehicleID	varchar(4)	True	**Use:** This is the 4 octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. Because this value is used as a means to identify the local vehicles that are interacting during an encounter, it is used in the message set. Other devices, such as infrastructure (RSUs), may have a fixed value for the temporary ID value. See also DE_StationID which is used in other deployment regions. **ASN.1 Representation:** TemporaryID ::= OCTET STRING (SIZE(4))

3.1.2.8.13 CVDP.CVPD_RSU_ASD_RF

This table tracks the 1st and last time it sees a BSM from an ASD. The ASD will be tracked by the temporary ID and thus is not subject to the obfuscation process.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
rsuid	int	False	
HostVehicle	varchar(4)	False	
msgCnt	tinyint	False	
latitude	int	False	
longitude	int	False	
RFlevel	int	False	
sightingtime	timestamp	False	

3.1.2.8.14 CVPD.CVPD_RSUMaint

This table tracks the information about the various RSU devices

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
rsuid	int	True	The ID of the affected RSU
rsulocationdescription	varchar(140)	False	A free text entry of the RSU location.
rsuloclatitude	int	False	**Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable. **ASN.1 Representation:** Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree***

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			-- Providing a range of plus-minus 90 degrees
rsuloclongitude	int	False	**Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 180 degrees***
rsulocelevation	int	False	**Use:** The DE_Elevation data element represents the geographic position above or below the reference ellipsoid (typically WGS-84). The number has a resolution of 1 decimeter and represents an asymmetric range of positive and negative values. Any elevation higher than +6143.9 meters is represented as +61439. Any elevation lower than -409.5 meters is represented as -4095. If the sending device does not know its elevation, it shall encode the Elevation data element with -4096. **ASN.1 Representation:** Elevation ::= INTEGER (-4096..61439) -- In units of 10 cm steps above or below the reference ellipsoid -- Providing a range of -409.5 to + 6143.9 meters -- The value -4096 shall be used when Unknown is to be sent
rsumainstreet	int	False	Index into the street name for the main street for this RSU
rsucrossstreet	int	False	index into the street names for the cross street of this rsu
ipv4addr	varchar(50)	False	The IPv4 address for the device
ipv6addr	varchar(50)	False	The IPv6 address for the device

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
firmwareversion	varchar(32)	False	The current firmware version running in the RSU
serialnumber	varchar(50)	False	The serial number of the RSU
rsuMibVersion	varchar(32)	False	
rsuManufacturer	varchar(32)	False	
rsuMobile	int	True	Initial value: 0 The rsuMobile flag indicates if this is a mobile or stationary RSU. The majority of RSUs will be stationary but there will be some RSUs that are used to track work zones. Per FCC regulations a RSU that is in motion may not transmit. A RSU classified as a mobile RSU will have special processing requirements: - data will only be available when it is stationary so failure notifications will be different - the RSU location must be updated when information is received instead of being constant.

3.1.2.8.15 CVPD.CVPD_RSU_RF

This table collects the RF data for each RSU as seen by the ASDs. The expectation is that an ASD will record the 1st and last time it sees a BSM, MAP or SPaT message from each RSU.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
rsuid	int	True	The ID of the reporting RSU
AsdSerialNumber	varchar(50)	True	This is the serial number of the ASD and will be used to determine the strength of different ASD. This data item will be removed prior to the RF data being released
HostVehicle	varchar(4)	True	

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			Use: This is the 4 octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. Because this value is used as a means to identify the local vehicles that are interacting during an encounter, it is used in the message set. Other devices, such as infrastructure (RSUs), may have a fixed value for the temporary ID value. See also DE_StationID which is used in other deployment regions. **ASN.1 Representation:** TemporaryID ::= OCTET STRING (SIZE(4))
TimeOfSighting	datetime	True	The time of the sighting by the vehicle. Time will be the local time of the system.
Latitude	int	True	**Use:** The geographic latitude of an object, expressed in 1/10th integer microdegrees, as a 31 bit value, and with reference to the horizontal datum then in use. The value 900000001 shall be used when unavailable. **ASN.1 Representation:** Latitude ::= INTEGER (-900000000..900000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 90 degrees***
Logitude	int	True	**Use:** The geographic longitude of an object, expressed in 1/10th integer microdegrees, as a 32-bit value, and with reference to the horizontal datum then in use. The value 1800000001 shall be used when unavailable. **ASN.1 Representation:** Longitude ::= INTEGER (-1799999999..1800000001) ***-- LSB = 1/10 micro degree*** ***-- Providing a range of plus-minus 180 degrees***
Elevation	int	True	**Use:** The DE_Elevation data element represents the geographic position

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			above or below the reference ellipsoid (typically WGS-84). The number has a resolution of 1 decimeter and represents an asymmetric range of positive and negative values. Any elevation higher than +6143.9 meters is represented as +61439. Any elevation lower than -409.5 meters is represented as -4095. If the sending device does not know its elevation, it shall encode the Elevation data element with -4096. **ASN.1 Representation:** Elevation ::= INTEGER (-4096..61439) -- In units of 10 cm steps above or below the reference ellipsoid -- Providing a range of -409.5 to + 6143.9 meters -- The value -4096 shall be used when Unknown is to be sent
RFLevel	float	True	The report RF level of the received transmission
MapMessage	int	True	Initial value: 0 A flag to indicate if this was a MAP message that was received.
SPaTMessage	int	True	Initial value: 0 A flag to indicate if this was a SPaTmessage that was received.
TIM	int	True	Initial value: 0 A flag to indicate if this was a TIM that was received.

3.1.2.8.16 CVPD.CVPD_RSUhistory

This table will track the firmware updates to the RSU devices.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
rsuid	int	True	The ID of the RSU

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
entrytime	timestamp	True	This is the timestamp when the entry is made to this table. This is a non-editable entry
dateofchange	datetime	True	The date the change was made.
rsuversion_before_update	varchar(50)	True	The version of firmware in the RSU before the update
rsuversion_after_update	varchar(50)	True	The RSU firmware version number after the update. This may stay the same if there was a hardware failure and the new RSU has the same firmware
rsuSN_before_update	varchar(50)	True	The serial number of the RSU before the update. This field is provided in the case where the physical RSU is replaced.
rsuSN_after_update	varchar(50)	True	The serial number of the RSU after the update. This field is provided in the case where the physical RSU is replaced.
notesonupdate	varchar(max)	True	This is a free text field to allow the operator to enter notes about the update.

3.1.2.8.17 CVPD_.CVPD_StreetDict

This is a dictionary of the streets to use in the travel time route

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
streetID	int	True	the primary key for the street dictionary table
streetname	varchar(50)	True	the descriptive name for the street

3.1.2.8.18 CVPD.CVPD_TravelTimeBreadCrumb

This table collects the bread crumb data from the RSUs and provides it for the travel time calculation

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
RSUID	int	True	The ID of the reporting RSU
HostVehicle	varchar(4)	True	**Use:** This is the 4 octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. Because this value is used as a means to identify the local vehicles that are interacting during an encounter, it is used in the message set. Other devices, such as infrastructure (RSUs), may have a fixed value for the temporary ID value. See also DE_StationID which is used in other deployment regions. **ASN.1 Representation:** TemporaryID ::= OCTET STRING (SIZE(4))
TimeofSighting	datetime	True	The recorded time of the sighting. This will be local time, not UTC

3.1.2.8.19 CVPD.CVPD_TravelTimeHistory

The TravelTimeHistory table will record each change in travel time for the route on a 15 minutes basis or if the travel time changes by > 10% of the current travel time.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
route_ID	int	True	The route ID for this history entry
updatetime	timestamp	True	The time at which this update is made. The time will be the local system time.
TravelTime	int	True	

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			The travel time for the route in minutes.
AverageSpeed	float	True	The average speed for this period in MPH. Average speed will be calculated using the travel time and the nominal distance of the route.

3.1.2.8.20 CVPD.CVPD_TravelTimePosted

This table provides the current travel time for each route. This table will provide the nominal travel time along with the calculated travel time, if one exists. The consuming application is responsible for determining which travel time should be displayed to the public.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
route_id	int	True	The route ID for the travel time.
TravelTime	int	True	The travel time for the route in minutes. A -1 will indicate that a calculated travel is not available.
TravelTimeNomial	int	True	The nominal travel for the selected route
TravelTimeConfidence	int	True	This is a number indicating the confidence level of the travel time value. The confidence level accounts for the number of travel time samples for the route along with the variation in the travel time samples
TravelTimeMinBreached	int	True	Initial value: 0 A flag to indicate that the calculated travel time for the route falls below the minimum travel time for the route. The consumer of the travel time must decide if the nominal travel time, no travel time or the calculated travel time should be used..
TravelTimeMaxBreached	int	True	Initial value: 0 A flag to indicate that the calculated travel time for the route exceeds the

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			maximum travel time for the route. This flag also indicates that the nominal time for the route is the travel time for the route.
RouteAvgSpeed	float	False	The average speed along the route in MPH. This will be based on the nominal distance of the route.

3.1.2.8.21 CVPD.CVPD_TravelTimeRoute

This table describes a travel time route. The user will specify the beginning and ending RSU for the route.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
route_ID	int	True	A unique identifier for the route
routeDescription	varchar(50)	True	A free text entry by the user to describe the route
TravelTimeNominal	int	True	This is the user provided nominal travel time for the route in minutes.
TravelTimeMinReport	int	True	This is the minimum travel time for the route. This will be used to flag the consumer of the travel time information that the calculated travel time is shorter then the most reasonable speed along the route will support
TraveelTimeMaxReport	int	True	This is the maximum travel time for the route. This will be used to flag the consumer of the travel time information that the calculated travel time is greater then the most reasonable speed along the route will support
RouteDistNominal	float	True	This is the nominal distance of the route in miles.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
TTRComposite	int	True	Initial value: 0 This is a flag to indicate if this is a composite route. A composite route is a combination of basic routes (i.e. measured travel time of 2 or more basic TTR) 0 == FALSE (this is a basic TTR) 1 == TRUE (this is a composite TTR)
CurrentTravelTime	int	True	The current calculated travel time for this route in minutes
TT_timestamp	timestamp	True	The time that the CurrentTravelTime was updated

3.1.2.8.22 CVPD.CVPD_TTRBasic

This table defines a basic travel time route (TTR). A basic TTR is one that has an RSU at each end and uses matches of the vehicles to calculate the travel time.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
route_ID	int	True	The route ID
RSUstart	int	True	The starting RSU for this travel time route
RSUend	int	True	The ending RSU for this travel time route
MaxAgeAsdSighting	int	True	Initial value: 5

3.1.2.8.23 CVPD.CVPD_TTRComposite

This table defines a travel time route (TTR) that is a collection of basic TTRs

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
route_ID	int	True	This is the route ID for this travel time route.
segment_ID	int	True	This is a route that is part of the composite route.

3.1.2.8.24 CVPD.CVPD_VehicleSpeeds

This table will track the speeds along a route

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
route_ID	int	True	An index into the route definition
HostVehicle	varchar(4)	True	We will use the HostVehicle ID to prevent adding the speed for a vehicle twice to a route and time period. **Use:** This is the 4 octet random device identifier, called the TemporaryID. When used for a mobile OBU device, this value will change periodically to ensure the overall anonymity of the vehicle, unlike a typical wireless or wired 802 device ID. Because this value is used as a means to identify the local vehicles that are interacting during an encounter, it is used in the message set. Other devices, such as infrastructure (RSUs), may have a fixed value for the temporary ID value. See also DE_StationID which is used in other deployment regions. **ASN.1 Representation:** TemporaryID ::= OCTET STRING (SIZE(4))
VehicleTypeID	int	True	An index into the CVPD_VehicleType table so that speeds can be classified by vehicle type.
SightingTime	timestamp	True	The time when the vehicle was at the starting RSU of the route.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
CalculatedSpeed	float	True	The calculate speed of the vehicle based on the measured travel time between the 2 RSUs on the route and the nominal distance of the route. Units = miles/hour

3.1.2.8.25 CVPD.CVPD_VehicleType

The type of Vehicle in which this ASD is installed. The vehicle type will be the type reported in the BSM

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
VehicleTypeID	int	True	Primary key field for the vehicle type
VehicleType	varchar(50)	True	**Use:** The DE_VehicleType data element is a type list (i.e., a classification list) of the vehicle in terms of overall size. The data element entries follow the definitions defined in the US DOT Highway Performance Monitoring System (HPMS). Many infrastructure roadway operators collect and classify data according to this list for regulatory reporting needs. Within the ITS industry and within the DSRC message set standards work, there are many similar lists of types for overlapping needs and uses. **ASN.1 Representation:** VehicleType ::= ENUMERATED { none (0), -- Not Equipped, Not known or unavailable unknown (1), -- Does not fit any other category special (2), -- Special use moto (3), -- Motorcycle car (4), -- Passenger car carOther (5), -- Four tire single units bus (6), -- Buses axleCnt2 (7), -- Two axle, six tire single units axleCnt3 (8), -- Three axle, single units axleCnt4 (9), -- Four or more axle, single unit

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			axleCnt4Trailer (10), -- Four or less axle, single trailer axleCnt5Trailer (11), -- Five or less axle, single trailer axleCnt6Trailer (12), -- Six or more axle, single trailer axleCnt5MultiTrailer (13), -- Five or less axle, multi-trailer axleCnt6MultiTrailer (14), -- Six axle, multi-trailer axleCnt7MultiTrailer (15), -- Seven or more axle, multi-trailer ... }

3.1.2.8.26 CVPD.CVPD_WeatherObs

The WeatherObs table will store the hourly weather observations retrieved from the National Weather Service (NWS).

The base URL is http://w1.weather.gov/xml/current_obs/

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
StationID	varchar(4)	True	The NWS station ID
Obersvation_time	datetime2(7)	True	Time of the observation as provided by the NWS data feed.
observation_time_rfc822	datetime2(7)	False	Time of the observation conformant to RFC822 as provided by the NWS data feed.
weather	varchar(50)	False	A description of the weather as provided by the NWS data feed.
temperature_string	varchar(50)	False	This is a text version of the local temperature showing temperature in F and C
temp_f	float	False	The current temperature in Fahrenheit as provided by the NWS data feed.
temp_c	float	False	

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			the current temperature in Celsius as provided by the NWS data feed.
relative_humidity	int	False	the relative humidity as provided by the NWS data feed.
wind_string	varchar(50)	False	A description of the wind as provided by the NWS data feed.
wind_dir	varchar(50)	False	The wind direction as provided by the NWS data feed.
wind_degrees	float	False	The wind heading as provided by the NWS data feed.
wind_mph	float	False	The wind speed in miles per hour as provided by the NWS data feed.
wind_kt	float	False	The wind speed in knots as provided by the NWS data feed.
pressure_string	varchar(50)	False	A description of the atmospheric pressure as provided by the NWS data feed.
pressure_mb	float	False	The atmospheric pressure in milli-bars as provided by the NWS data feed.
pressure_in	float	False	The atmospheric pressure in inches of mercury as provided by the NWS data feed.
dewpoint_string	varchar(50)	False	A description of the dew point as provided by the NWS data feed.
dewpoint_f	float	False	The current dewpoint temperature in Fahrenheit as provided by the NWS data feed.
dewpoint_c	float	False	

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
			the dew point temperature in Celsius as provided by the NWS data feed.
visibility_mi	float	False	The current visibility in miles as provided by the NWS data feed.

3.1.2.8.27 CVPD.CVPD_WeatherStation

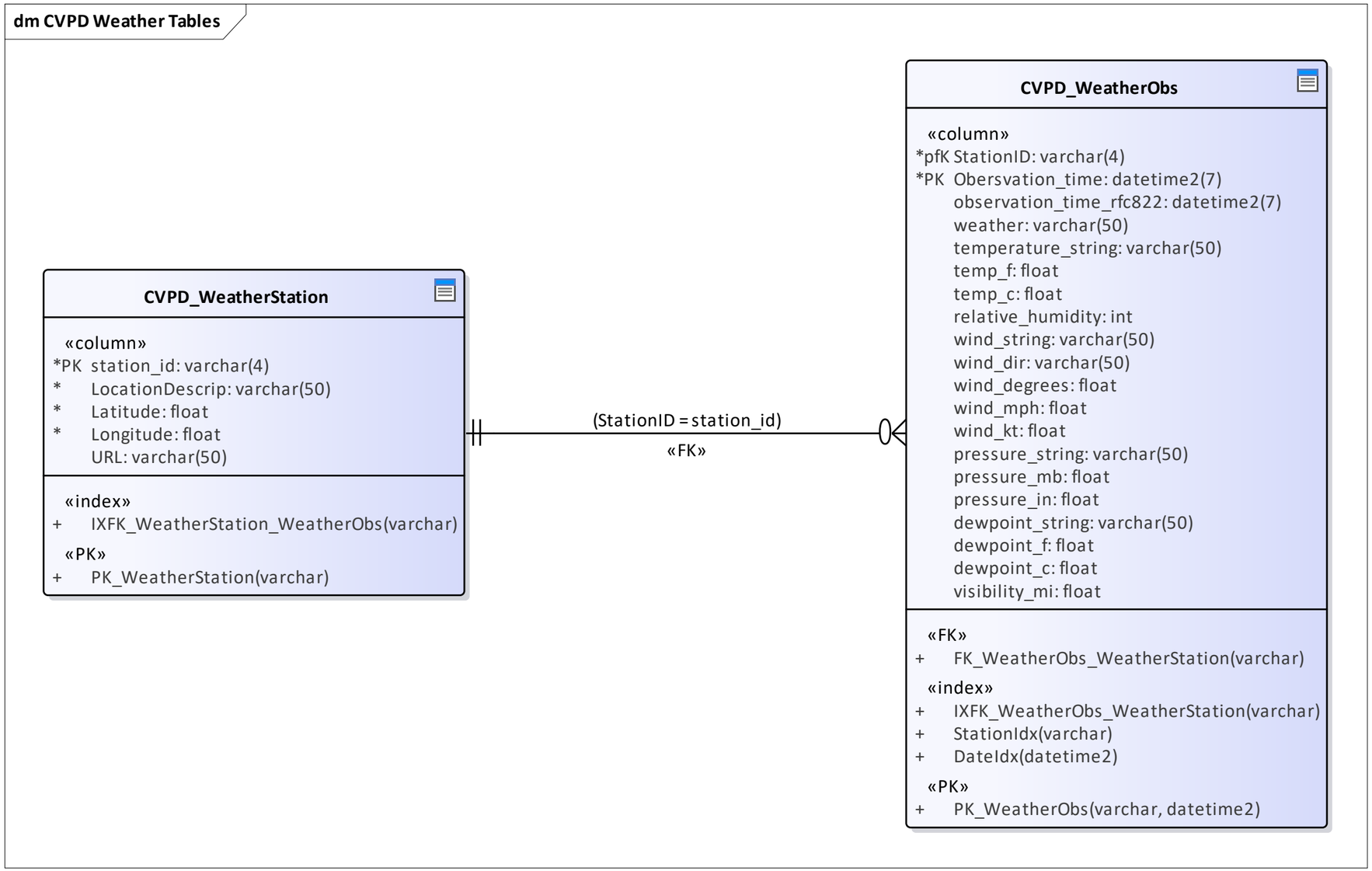
The WeatherStation table contains the baseline information for all weather stations that will be monitored for the NYC CVPD project.

COLUMN NAME	DATATYPE	NOT NULL	COMMENTS
station_id	varchar(4)	True	The NWS station ID.
LocationDescrip	varchar(50)	True	The description of the weather station as retrieved from the NWS data feed.
Latitude	float	True	Latitude of the weather station as provided by the NWS data feed.
Longitude	float	True	Longitude of the weather station as provided by the NWS data feed.
URL	varchar(50)	False	This is the URL of the XML string from the NWS. The form is "http://w1.weather.gov/xml/current_obs/KJFK.xml"

3.1.3 Interfaces

3.1.3.1 *National Weather Service*

The NYC CVPD will store the hourly weather observations from the NWS as specified for requirement 510.5.1 and 510.5.1.1.



Source: NYCDOT, 2017

Figure 29 National Weather Service

3.2 Roadside Unit (RSU)

The design of the Roadside Unit (RSU) will be completed by the successful bidder(s) for the NYC procurement for the RSUs. The specification for the RSUs are provided in the *NYC Invitation for Bids, Connected Vehicles, Roadside Unit – DOT, Bid No. 1700209*. The requirements of the RSU as identified in the *Connected Vehicle Pilot Deployment Program Phase 1, Systems Requirements Specification (SyRS) – New York City, publication number FHWA-JPO-16-303* are mapped to the procurement specification in the requirements traceability matrix (RTM) part of this document.

3.3 Aftermarket Safety Device (ASD)

The design of the Aftermarket Safety Device (ASD) will be completed by the successful bidder(s) for the NYC procurement for the ASDs. The specification for the ASDs are provided in the *5.9GHz DSRC Aftermarket Safety Device (ASD), Procurement Specification, Version 2.2 dated June 2017*. The requirements of the ASD as identified in the *Connected Vehicle Pilot Deployment Program Phase 1, Systems Requirements Specification (SyRS) – New York City, publication number FHWA-JPO-16-303* are mapped to the procurement specification in the requirements traceability matrix (RTM) part of this document.

3.4 PID

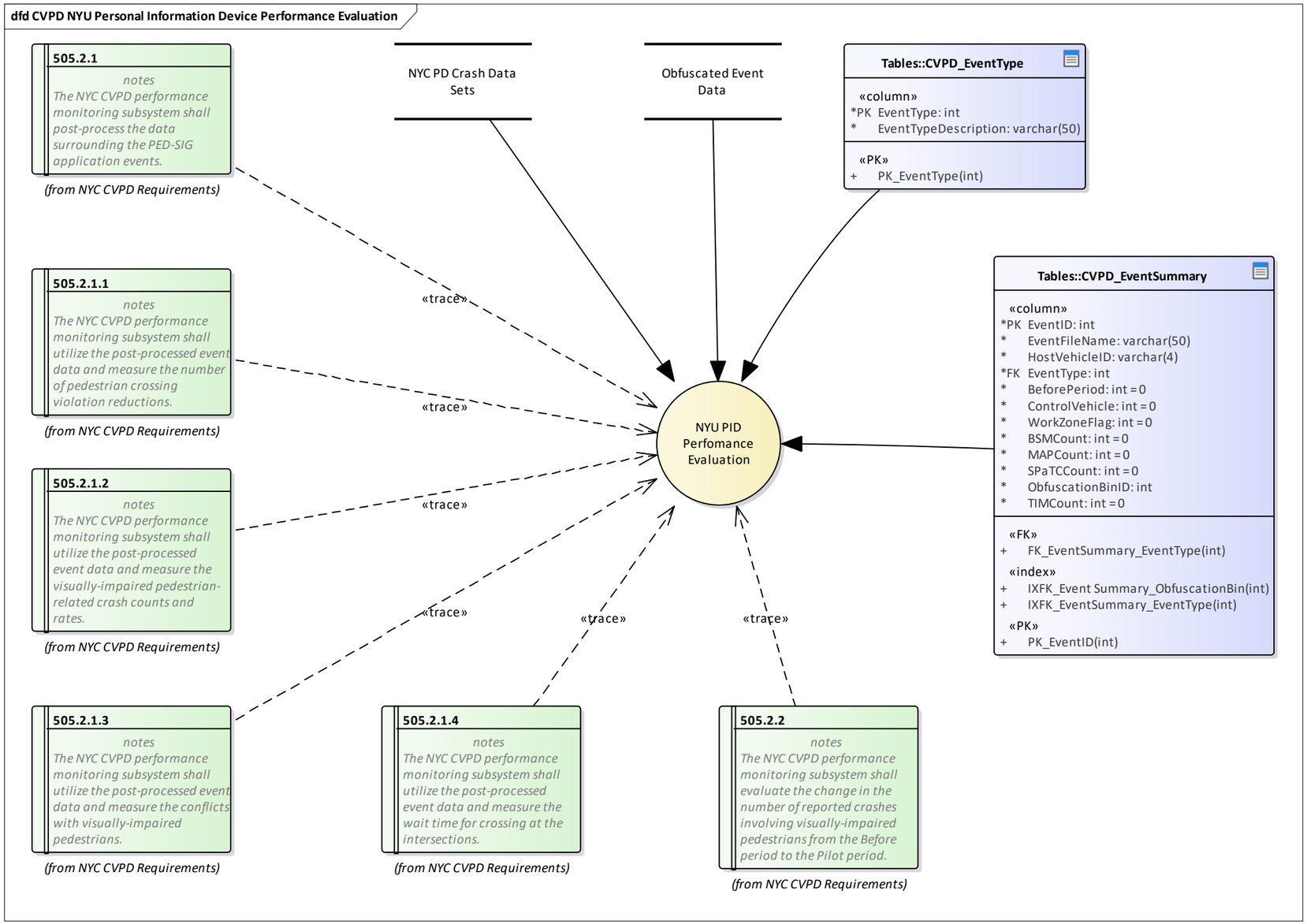
The design of the Personal Information Device (PID) will be completed by the successful bidder(s) for the NYC procurement for the PIDs. The specification for the PIDs are provided in the *Personal Information Device (PID), Procurement Specification, Version 1.A, May 2016*. The requirements of the ASD as identified in the *Connected Vehicle Pilot Deployment Program Phase 1, Systems Requirements Specification (SyRS) – New York City, publication number FHWA-JPO-16-303* are mapped to the procurement specification in the requirements traceability matrix (RTM) part of this document.

3.5 PID Performance Monitor

The performance data from the PID involves the collection of behavioral data from human subjects. Special procedures must be followed to collect and protect the human subjects and the associated data. The selection of subjects, types of data and the required protections are governed by an institutional review board (IRB). The PID Performance Monitor task will be performed by New York University (NYU) using the IRB procedures approved and monitored by NYU.

As noted in Section 2.2, the PID deployment number has changed to 10 prototypes. However, this has not impacted the performance

monitoring and evaluation process which is shown in Source: NYCDOT, 2017 Figure 30 below.



Source: NYCDOT, 2017

Figure 30 Performance Evaluation - Personal Information Device

3.5.1 Requirements

The following requirements are addressed by the NYU IRB performance evaluation.

Requirements
☑ Functional. 505.2.1 The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the PED-SIG application events. [Proposed, Medium difficulty.]
☑ Functional. 505.2.1.1 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the number of pedestrian crossing violation reductions. [Proposed, Medium difficulty.]
☑ Functional. 505.2.1.2 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the visually-impaired pedestrian-related crash counts and rates. [Proposed, Medium difficulty.]
☑ Functional. 505.2.1.3 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the conflicts with visually-impaired pedestrians. [Proposed, Medium difficulty.]
☑ Functional. 505.2.1.4 The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the wait time for crossing at the intersections. [Proposed, Medium difficulty.]
☑ Functional. 505.2.2 The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reported crashes involving visually-impaired pedestrians from the Before period to the Pilot period. [Proposed, Medium difficulty.]

3.6 Interfaces

This section provides a list of references to the sections in the ICD that pertain to this each subsystem/component listed in sections 3.1.1 and 3.1.2. It includes the unique identifiers from the merged triples spreadsheet to enable traceability.

3.6.1 Hardware

3.6.1.1 *Device Enrollment Information*

Sections 3.5.1, 3.28.1, and 3.34.1 of the ICD lists the device enrollment information triple. USDOT SCMS will be responsible for the implementation of these triples upon release of its production system.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10001	device enrollment information	Bus ASD	USDOT Prototype SCMS
			Commercial Vehicle ASD	USDOT Prototype SCMS
			Light Duty Vehicle ASD	USDOT Prototype SCMS

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10001	device enrollment information	PID	USDOT Prototype SCMS

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10001	device enrollment information	RSU	USDOT Prototype SCMS

3.6.1.2 *Device Identification*

Sections 3.2.1, 3.25.1, and 3.26.1 of the ICD list the device identification triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10015	device identification	ASD	NYCDOT TMC

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10015	device identification	PID	NYCDOT TMC

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10015	device identification	RSU	NYCDOT TMC

3.6.1.3 *Equipment Settings and Comments*

Sections 3.14.10 and 3.32.1 of the ICD list the triples regarding equipment settings and commands.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10021	equipment status	RSU	Service Monitor

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10018	equipment configuration settings	NYCDOT TMC	RSU
2	10019	equipment control commands	NYCDOT TMC	RSU
2	10020	equipment status	RSU	NYCDOT TMC

3.6.2 Software

3.6.2.1 *Intersection Geometry Information*

Sections 3.3.4, 3.30.1, and 3.14.1 of the ICD list the intersection geometry information triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10008	intersection geometry	RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10008	intersection geometry	RSU	PID

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10008	intersection geometry	NYCDOT TMC	RSU

3.6.2.2 *Location Correction*

Section 3.3.5 of the ICD lists the location correction triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10010	location correction	RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

3.6.2.3 *Pedestrian Crossing Status Information*

Section 3.33.1 of the ICD lists the pedestrian crossing status triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10011	pedestrian crossing status	Signal Controller	RSU

3.6.2.4 *Restricted Lanes Parameters*

Sections 3.3.6 and 3.14.2 of the ICD list the restricted lanes parameters triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10013		RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10013	restricted lanes parameters	NYCDOT TMC	RSU

3.6.2.5 *Speed Compliance Parameters*

Section 3.3.8 of the ICD lists the speed compliance parameters triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
1	10014	speed compliance parameters	RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

3.6.2.6 *Emergency Traveler Information*

Sections 3.11.1 and 3.3.9 of the ICD list the emergency traveler information triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10016	emergency traveler information	NYCDOT Office of Emergency Response (OER)	NYCDOT TMC

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10017	emergency traveler information	RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

3.6.2.7 *Host Vehicle Status*

Section 3.35.1 of the ICD lists the host [vehicle type] status triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10022	host [vehicle type] status	Commercial Vehicle databus	Commercial Vehicle ASD
			Transit Vehicle Databus	Bus ASD
			Commercial Vehicle databus	Commercial Vehicle ASD
			Light Duty Vehicle databus	Light Duty Vehicle ASD
			Transit Vehicle Databus	Bus ASD

3.6.2.8 *Intersection Safety and Management Application Information*

Section 3.14.5 of the ICD lists the triples regarding intersection safety and management application information.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10026	intersection management application info	NYCDOT TMC	RSU
2	10026	intersection management application status	RSU	NYCDOT TMC
2	10026	intersection safety application info	NYCDOT TMC	RSU
2	10026	intersection safety application status	RSU	NYCDOT TMC

3.6.2.9 *Intersection Status*

Sections 3.3.10 and 3.30.2 of the ICD list the intersection status triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10027	intersection status	RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10027	intersection status	RSU	PID

3.6.2.10 *Application Parameters, Information, and Status*

Section 3.14.7 of the ICD lists the triples regarding application parameters, information, and status.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10030	situation data collection parameters	NYCDOT TMC	RSU
2	10030	speed management application information	NYCDOT TMC	RSU
2	10030	traffic monitoring application info	NYCDOT TMC	RSU
2	10030	traveler information application info	NYCDOT TMC	RSU
2	10030	traffic monitoring application status	RSU	NYCDOT TMC

3.6.2.11 *Time*

Sections 3.9.1 and 3.10.1 of the ICD list the triples regarding location and time service (LTS).

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10031	time	LTS	NYCDOT TMC

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10031	time	LTS	Service Monitor

Section 3.33.4 of the ICD lists the triple regarding the time for ASTC controller.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10031	time	RSU	Signal Controller

3.6.2.12 *Speed Management Information*

Section 3.3.12 of the ICD lists the speed management information triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10033	speed management information	RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

3.6.2.13 *Vehicle Situation Data Parameters*

Section 3.3.14 of the ICD lists the vehicle situation data parameters triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10038	vehicle situation data parameters	RSU	Bus ASD
			RSU	Commercial Vehicle ASD
			RSU	Light Duty Vehicle ASD

3.6.2.14 *Personal Location*

Section 3.17.1 of the ICD lists the personal location triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
2	10032	personal location	RSU	PID

3.6.2.15 *Application Installation and Upgrade*

Section 3.14.8 of the ICD lists the triple regarding application install and upgrade.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13001	application install/upgrade	NYCDOT TMC	RSU

3.6.2.16 *Driver Updates*

Section 3.4.1 of the ICD lists the triples regarding the driver updates from the ASD sends to the driver.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13002	driver updates	Bus ASD	Bus Driver
			Commercial Vehicle ASD	Truck Driver
			Light Duty Vehicle ASD	Light Duty Vehicle Driver

3.6.2.17 *Intersection Control Status Information*

Section 3.33.3 of the ICD lists the triple regarding the intersection control status.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13003	intersection control status	Signal Controller	RSU

3.6.2.18 *Operation and Maintenance Data*

Sections 3.3.3 and 3.14.11 of the ICD list the operation and maintenance data triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13004	operation and maintenance ASD data	NYCDOT TMC	Performance Monitor
4	13004	operation and maintenance RSU data	NYCDOT TMC	Performance Monitor

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13004	operation and maintenance ASD data	RSU	NYCDOT TMC
4	13004	operation and maintenance RSU data	RSU	NYCDOT TMC

3.6.2.19 *System Monitoring*

Section 3.32.2 of the ICD lists the triple regarding the RSU subsystem monitoring.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13005	system monitoring	RSU	Service Monitor

3.6.2.20 *Vehicle Situation Data*

Section 3.3.13 of the ICD lists the vehicle situation data triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13006	vehicle situation data	Bus ASD	RSU
			Commercial Vehicle ASD	RSU
			Light Duty Vehicle ASD	RSU

3.6.2.21 *Traffic Situation Data*

Section 3.14.6 of the ICD lists the traffic situation data triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
4	13031	traffic situation data	RSU	NYCDOT TMC

3.6.2.22 *Crossing Status*

Section 3.30.3 of the ICD lists the crossing status triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13007	crossing status	RSU	PID

3.6.2.23 *Current Infrastructure Restrictions*

Section 3.12.1 of the ICD lists the current infrastructure restrictions triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13008	current infrastructure restrictions	NYCDOT Office of Freight Mobility (OFM)	NYCDOT TMC

3.6.2.24 *MTA Bus GPS Travel Time Data*

Section 3.19.1 of the ICD lists the MTA bus GPS travel time data triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13009	MTA bus GPS travel time data	MTA Bus Data Archive	Performance Monitor

3.6.2.25 *Obfuscated Data Sets*

Sections 3.23.1 and 3.24.1 of the ICD list the obfuscated data sets triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13010	obfuscated data sets	Performance Monitor	TTI (USDOT IE)

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13010	obfuscated data sets	Performance Monitor	USDOT Research Data Exchange (RDE)

3.6.2.26 *Pedestrian Presence*

Sections 3.36.1, 3.38.1, and 3.37.1 of the ICD lists the triples regarding pedestrian presence. Section 3.33.2 of the ICD lists the pedestrian crossing status triple on pedestrian presence status.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13011	pedestrian detection data	Pedestrian Detector	Signal Controller

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13013	pedestrian presence	Unequipped Pedestrian	Pedestrian Detector

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
6	13025	pedestrian presence	Visually-Impaired Pedestrian	Pedestrian Detector

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
6	13026	pedestrian crossing status	Signal Controller	RSU

3.6.2.27 *Pedestrian Performance Data*

Section 3.17.2 of the ICD lists the pedestrian performance data triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13012	pedestrian performance data	PID	NYU (NYCDOT IRB)

3.6.2.28 *Personal Input*

Section 3.27.1 of the ICD lists the personal input triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13014	personal input	Visually-Impaired Pedestrian	PID

3.6.2.29 *Personal Updates*

Section 3.27.2 of the ICD lists the triple regarding personal updates from the PID to the visually-impaired pedestrian user.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13015	personal updates	PID	Visually-Impaired Pedestrian

3.6.2.30 *PID Operational Status*

Section 3.16.1 of the ICD lists the triple regarding the PID operational status.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13016	PID operational status	NYU (NYCDOT IRB)	Performance Monitor

3.6.2.31 *Reduced Speed Warning Information*

Section 3.14 of the ICD lists the reduced speed warning information triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13017	reduced speed warning info	NYCDOT TMC	RSU

3.6.2.32 *NYC Signal Control System*

Section 3.39 of the ICD lists the signal control device configuration triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13018	signal control device configuration	NYCDOT TMC	Signal Controller

Section 3.39 of the ICD lists the signal system configuration triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13019	signal system configuration	NYCDOT TMC	Signal Controller

Section 3.39 of the ICD lists the traffic sensor control triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13020	traffic sensor control	NYCDOT TMC	Signal Controller

Section 3.39 of the ICD lists the signal control commands triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
6	13027	signal control commands	NYCDOT TMC	Signal Controller

Section 3.39 of the ICD lists the signal control plans triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
6	13028	signal control plans	NYCDOT TMC	Signal Controller

Section 3.39 of the ICD lists the signal control status triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
6	13029	signal control status	Signal Controller	NYCDOT TMC

Section 3.39 of the ICD lists the traffic flow triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
6	13030	traffic flow	Signal Controller	NYCDOT TMC

3.6.2.33 *Travel Time Records for RFID Readers*

Section 3.21.1 of the ICD lists the travel time records triple for RFID readers.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13022	travel time records	RFID Readers	Performance Monitor

3.6.2.34 *Volume Count Data*

Section 3.18.1 of the ICD lists the volume counts triple for volume counts from count stations.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	13023	volume counts	Count Stations	Performance Monitor

3.6.2.35 *Weather Information*

Section 3.20.1 of the ICD lists the weather data triple.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
5	33014	weather information	National Weather Service (NWS)	Performance Monitor

3.6.2.36 *Location and Time for GPS*

Section 3.7.1 of the ICD lists the location and time triple for the field GPS.

Interop Cat Num	Instance ID	Flow Name	Source Element	Destination Element
6	13024	location and time	Field GPS	RSU

4 Acronyms

This section defines selected project-specific acronyms used throughout this SDD. Table 31 below. lists the acronyms used in this document.

Table 31. Acronym List

Acronym / Abbreviation	Definition
AO	Agreement Officer
AOR	Agreement Officer Representative
ASD	Aftermarket Safety Devices
ASN.1	Abstract Syntax Notation One
ASTC	Advanced Solid-state Traffic Controller
ATC	Advanced Traffic Controller
BSM	Basic Safety Message
CAN	Controller Area Network
C2F	Center to Field
CAMP	Crash Avoidance Metrics Partnership
CCMS	Cooperative ITS Credentials Management System
COC	Certification Operating Council
ConOps	Concept of Operations
CV	Connected Vehicle
CVPD	Connected Vehicle Pilot Deployment
CVRIA	Connected Vehicle Reference Implementation Architecture
DATEX	Data Exchange
DDS	Data Distribution System
DOW	Day of the Week
DSNY	City of New York Department of Sanitation
DSRC	Dedicated Short Range Communications
F2F	Field to Field
FHWA	Federal Highway Administration
FOIA	Freedom of Information Act
I2V	Infrastructure-to-Vehicle
IE	Independent Evaluator
IEC	International Electrotechnical Commission
IETF	Internet Engineering Task Force
IRB	Institutional Review Board
ISO	International Organization for Standardization
ITS	Intelligent Transportation Systems

Acronym / Abbreviation	Definition
JPO	Joint Program Office
JSON	JavaScript Object Notation
LFC	Line Frequency Clock
LTS	Location and Time Service
MAP	Map Data Message
MTA	Metropolitan Transportation Authority
NMEA	National Marine Electronics Association
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
NTP	Network Time Protocol
NYC	New York City
NYC DoITT	New York City Department of Information Technology and Telecommunications
NYCDOT	New York City Department of Transportation
NYCWiN	New York City Wireless Network
O&M	Operation and Maintenance
OBE	On-Board Equipment
OBU	On-Board Unit
ODE	Operational Data Environment
OTA	Over-the-Air
PDM	Probe Data Management
PED	Pedestrian
PID	Personal Information Device
PII	Personally Identifiable Information
PVD	Probe Vehicle Data
RDE	Research Data Exchange
RFID	Radio Frequency Identification
RFQ	Request for Quote
RSE	Roadside Equipment
RSU	Roadside Unit
RTOR	Right Turn On Red
SAD	Systems Architecture Document
SAE	Society of Automotive Engineers International
SCMS	Security Credential Management System
SDD	System Design Document
SET-IT	Systems Engineering Tool for Intelligent Transportation
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SPaT	Signal Phase and Timing
SyRS	System Requirements Specification
TCS	Traffic Control System
THEA	Tampa-Hillsborough Expressway Authority
TIM	Traveler Information Message
TMC	Traffic Management Center

Acronym / Abbreviation	Definition
TOD	Time of Day
TSN	Transportation Systems Network – New York City's wireless new (2020) network
TTI	Texas Transportation Institute
UDP	User Datagram Protocol
UPS	United Parcel Service
USDOT	United States Department of Transportation
UTRC	University Transportation Research Center
V2I	Vehicle-to-Infrastructure
V2P	Vehicle-to-Pedestrian
V2V	Vehicle-to-Vehicle
VMS	Variable Message Sign
W3C	World Wide Web Consortium
WAW	Wide Area Wireless
WSMP	Wave Short Message Protocol
WWW	World Wide Web
XML	Extensible Markup Language

5 References

Table 32 below includes references to other documentation used to create this document.

Table 32. References

#	Document (Title, source, version, date, location)
1	Battelle, Integrated Vehicle-to-Infrastructure Prototype (IVP), IVP Interface Control Document (ICD), May 20, 2016.
2	Battelle, IVP Deployment Guide, Deployment of IVP at a Signalized Intersection to Send SPaT and MAP, Version 4.0, May, 2016
3	*Connected Vehicle Reference Implementation Architecture Website*, US Department of Transportation, Office of the Assistant Secretary of Transportation for Research and Technology. https://www.iteris.com/cvria
4	*Cybersecurity Requirements for Vendors & Contractors*, NYC Department of Information Technology & Telecommunications (DoITT), City of New York. https://www1.nyc.gov/site/doitt/business/it-security-requirements-vendors-contractors.page
5	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.
6	Galgano, S., Talas, M., Benevelli, D., Rausch, R., Sim, S., Opie, K., Jensen, M., Stanley, C., Stephens, D., Pape, D., Connected Vehicle Pilot Deployment Program Phase 1, System Requirements Specification (SyRS) - New York City, July 26, 2016 FHWA-JPO-16-303.
7	*IEEE 1609.2-2016 - IEEE Standard for Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages* http://standards.ieee.org/findstds/standard/1609.2-2016.html
8	*IEEE 1609.3-2016 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) - Networking Services* https://standards.ieee.org/findstds/standard/1609.3-2016.html
9	*IEEE 1609.4-2016 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Multi-Channel Operation* https://standards.ieee.org/findstds/standard/1609.4-2016.html
10	*IEEE 802.11p-2010 - IEEE Standard for Information technology-- Local and metropolitan area networks-- Specific requirements-- Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 6: Wireless Access in Vehicular Environments* https://standards.ieee.org/findstds/standard/802.11p-2010.html
11	*IETF RFC 768 - User Datagram Protocol*, Internet Engineering Task Force, August 28, 1980 https://www.ietf.org/rfc/rfc768

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12	*IETF RFC 793 - Transmission Control Protocol Darpa Internet Program Protocol Specification*, Internet Engineering Task Force, September, 1981 https://tools.ietf.org/html/rfc793
13	*IETF RFC 2460 - Internet Protocol, Version 6 (IPv6) Specification*, Internet Engineering Task Force, December, 1998 https://tools.ietf.org/html/rfc2460
14	*IETF RFC 5905 - Network Time Protocol Version 4: Protocol and Algorithms Specification*, Internet Engineering Task Force, June, 2010 https://tools.ietf.org/html/rfc5905
15	*IETF RFC 6455 - The WebSocket Protocol*, Internet Engineering Task Force, December, 2011 https://tools.ietf.org/html/rfc6455
16	*IETF RFC 7525 - Recommendatiosn for Secure Use of Transport Layer Security (TLS) and Datagram Transport Layer Security (DTLS)*, Internet Engineering Task Force, May, 2015 https://tools.ietf.org/html/rfc7525
17	*ISO 11898-1:2015 - Road vehicles - Controller area network (CAN) - Part 1: Data link layer and physical signalling*, International Organization for Standarization, December, 2016 https://www.iso.org/standard/63648.html
18	*ISO 15628:2013 - Intelligent transport systems -- Dedicated short range communication (DSRC) -- DSRC application layer*, International Standards Organization, November, 2013 https://www.iso.org/standard/59288.html
19	*ISO/TS 19091:2017 - Intelligent transport systems -- Cooperative ITS -- Using V2I and I2V communications for applications related to signalized intersections*, International Standards Organization, March, 2017 https://www.iso.org/standard/69897.html
20	*ITU-R TF 460-6: Standard-frequency and time-signal emissions,* International Telecommunication Union, February 12, 2002 https://www.itu.int/rec/R-REC-TF.460-6-200202-I/en
21	*NTCIP 1202 - NTCIP Object Definitions for ASC,* National Transportation Communications for ITS Protocol, January 30, 2007 https://www.ntcip.org/library/standards/default.asp?documents=yes&qreport=no&standard=1202
22	*NTCIP 2304 - NTCIP AP-DATEX-ASN,* National Transportation Communications for ITS Protocol, February 6, 2006 https://www.ntcip.org/library/standards/default.asp?documents=yes&standard=2304
23	*NTCIP 2306 - Application Profile for XML in ITS Center to Center Communications (AP-C2CXML),* National Transportation Communications for ITS Protocol, February 6, 2006 https://www.ntcip.org/library/standards/default.asp?documents=yes&standard=2306
24	*SAE J1939_201308 - Recommended Practice for a Serial Control & Communications Vehicle Network*, SAE International, August 14, 2013 http://standards.sae.org/j1939_201308/
25	*SAE J1939/03_201511 - On Board Diagnostics Implementation Guide*, SAE International, November 5, 2015 http://standards.sae.org/j1939/3_201511/

#	Document (Title, source, version, date, location)
26	*SAE J1939/21_201603 - Data Link Layer*, SAE International, March 3, 2016 http://standards.sae.org/j1939/21_201603/
27	*SAE J1939/71_201610 - Vehicle Application Layer*, SAE International, October 25, 2016 http://standards.sae.org/j1939/71_201610/
28	*SAE J1939/73_201601 - Application Layer - Diagnostics*, SAE International, January 22, 2016 http://standards.sae.org/j1939/73_201601/
29	*SAE J1939/74_201509 - Application - Configurable Messaging*, SAE International, September 22, 2015 http://standards.sae.org/j1939/74_201509/
30	*SAE J1939/75_201511 - Application Layer - Generator Sets and Industrial*, SAE International, November 5, 2015 http://standards.sae.org/j1939/75_201511/
31	*The SAE J1939 Communications Network: An overview of the J1939 family of standards and how they are used,* SAE International www.sae.org/misc/pdfs/J1939.pdf
32	*SAE J2735_201603 - Dedicated Short Range Communications (DSRC) Message Set Dictionary™*, SAE International, March 30, 2016 http://standards.sae.org/j2735_201603/
33	*SAE J2945/1_201603 - On-Board System Requirements for V2V Safety Communications*, SAE International, March 30, 2016 http://standards.sae.org/j2945/1_201603/
34	*SAE J3067_201408 - Candidate Improvements to Dedicated Short Range Communications (DSRC) Message Set Dictionary [SAE J2735] Using Systems Engineering Methods,* SAE International, March 30, 2016 http://standards.sae.org/j3067_201408/
35	Wyoming Department of Transportation (WYDOT), RSU Maintenance Planning for WYDOT Connected Vehicle Pilot, Version 1.1, April 11, 2017

6 Requirements Traceability Matrix

This is a table that provides traceability between the system requirements and design. It includes every requirement in the NYC CVPD SyRS (FHWA-JPO-303), and every requirement has at least one corresponding design element. Each requirement also references other documentation for the design element, including the ASD, PID, and RSU procurement for the vendors and the NYC CVPD System Architecture Document (SAD) (FHWA-JPO-451).

Table 33. NYC CVPD Requirements Traceability Matrix (RTM)

ReqID	Related Section in SyRS	RelatedNeeds	Parent Section in SyRS	Requirement Text	Verification				Subsystem of Responsibility	Rel_Arch_Elem	Rel_Dsgn_Elem
					I	A	T	D			
101.1.2	3.8.3.1 Speed Compliance	Need ID 101.1: Need to manage speed on surface streets – 25 MPH regulatory speed limit	3.8.3 V2I Application	The SPDCOMP application shall obtain regulatory speed limits from the MAP message per SAE J2735-201603 based on the host vehicle's current location.			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.1
101.1.4	3.8.3.1 Speed Compliance	Need ID 101.1: Need to manage speed on surface streets – 25 MPH regulatory speed limit	3.8.3 V2I Application	The SPD-COMP application shall trigger an alert when either the vehicle speed exceeds the recommended speed by a configured amount or for a configured period of time by time of day. (Note: configurable speed (Excessive Speed Amount Threshold), configurable time (Excessive Speed Time), and time of day are defined in Table D-1 in Appendix C)			T		ASD	NYC CVPD SAD: speed compliance parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.2
101.2.10	3.8.3.2 Curve Speed Compliance	Need ID 101.2: Need to manage speeds on curves –regulatory speed limit	3.8.3 V2I Application	The CSPD-COMP application shall determine if there is a curve with reduced speed ahead.			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.3
101.2.11	3.8.3.2 Curve Speed Compliance	Need ID 101.2: Need to manage speeds on curves –regulatory speed limit	3.8.3 V2I Application	The CSPD-COMP application shall advise the driver of a curve with reduced speed ahead.			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.4
101.2.14	3.8.3.2 Curve Speed Compliance	Need ID 101.2: Need to manage speeds on curves –regulatory speed limit	3.8.3 V2I Application	The CSPD-COMP application shall determine the difference between the posted speed on the upcoming curve and the vehicle's current speed.				D	ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.5
101.2.15	3.8.3.2 Curve Speed Compliance	Need ID 101.2: Need to manage speeds on curves –regulatory speed limit	3.8.3 V2I Application	If the vehicle speed is greater than the posted curve speed, the Vehicle CSPD-COMP Application shall advise the driver in time for the driver to reduce vehicle speed to the posted speed limit before the vehicle enters the curve.				D	ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.6
101.2.16	3.8.3.2 Curve Speed Compliance	Need ID 101.2: Need to manage speeds on curves –regulatory speed limit	3.8.3 V2I Application	While the vehicle is in the curve, the CSPD-COMP application shall trigger a driver alert when the host vehicle speed exceeds the posted speed plus the Excessive Curve Speed Amount Threshold for a time period exceeding the Excessive Curve Speed Time Threshold.			T		ASD	NYC CVPD SAD: speed compliance parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.7

101.2.17	3.8.3.2 Curve Speed Compliance	Need ID 503: Need to assess speed compliance	3.8.3 V2I Application	The CSPD-COMP application shall determine if the vehicle exceeds the Curve Posted Speed plus the Excessive Curve Speed Amount Threshold, for a period exceeding the Excessive Curve Speed Time Threshold.				D	ASD	NYC CVPD SAD: speed compliance parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.1.7
101.3.9	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	The SPDCOMPWZ application shall acquire the following from Speed Zone information for use in SPDCOMPWZ advisory and alert calculations: 1. Posted Reduced Speed Zone Speed Limit 2. Work Zone geometric information			T		ASD	NYC CVPD SAD: speed management information, restricted lanes parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.1
101.3.10	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	The SPDCOMPWZ application shall determine if there is a reduced speed zone ahead.				D	ASD	NYC CVPD SAD: speed management information, restricted lanes parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.2
101.3.11	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	The SPDCOMPWZ application shall advise the driver of a reduced speed zone ahead.				D	ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.3
101.3.13	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	The SPDCOMPWZ application shall determine the speed of the host vehicle based on accuracy and (configurable) threshold per J2945/1.				D	ASD	NYC CVPD SAD: speed compliance parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.4
101.3.14	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	The SPDCOMPWZ application shall determine the difference between the posted speed on the upcoming reduced speed zone and the vehicle's current speed.				D	ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.5
101.3.15	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	If the vehicle speed is greater than the reduced speed zone, the SPDCOMPWZ application shall advise the driver in time for the driver to reduce vehicle speed to the posted speed limit before the vehicle enters the zone.			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.6
101.3.16	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	The SPDCOMPWZ application shall determine if the vehicle exceeds the Work Zone Posted Speed plus the Excessive Zone Speed Amount Threshold, for a period exceeding the Excessive Zone Speed Time Threshold.				D	ASD	NYC CVPD SAD: speed compliance parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.7
101.3.17	3.8.3.3 Speed Compliance / Work Zone	Need ID 101.3: Need to manage speed in work zones –speed limit	3.8.3 V2I Application	While the vehicle is in the speed zone, the SPDCOMPWZ application shall trigger a driver alert when the vehicle speed exceeds the Work Zone Posted Speed plus the Excessive Zone Speed Amount Threshold, for a period exceeding the Excessive Zone Speed Time Threshold.			T		ASD	NYC CVPD SAD: speed compliance parameters (See Figure 9 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.2.8

102.1.1	3.8.2.1 Forward Crash Warning	Need 102.1: Need to reduce crashes between vehicles	3.8.2 V2V Application	The FCW safety application shall warn drivers of impending rear-end collisions with other DSRC-equipped vehicles.			T		ASD	NYC CVPD SAD: driver updates (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.1.1
102.2.1	3.8.2.2 Emergency Electronic Brake Light	Need 102.2: Need to reduce crashes between vehicles	3.8.2 V2V Application	The EEBL safety application shall warn drivers about DSRC-equipped vehicles braking.			T		ASD	NYC CVPD SAD: driver updates (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.2.1
102.3.1	3.8.2.3 Blind Spot Warning	Need 102.3: Need to reduce crashes between vehicles	3.8.2 V2V Application	The BSW safety application shall warn drivers about DSRC-equipped vehicles in their blind spots.			T		ASD	NYC CVPD SAD: driver updates (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.3.1
102.3.2	3.8.2.4 Lane Change Warning	Need 102.3: Need to reduce crashes between vehicles	3.8.2 V2V Application	The LCW safety application shall warn drivers about DSRC-equipped vehicles changing lanes in the same direction.			T		ASD	NYC CVPD SAD: driver updates (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.4.1
102.4.1	3.8.2.5 Intersection Movement Assist	Need 102.4: Need to reduce crashes between vehicles	3.8.2 V2V Application	The IMA safety application shall warn drivers about DSRC-equipped vehicles that cross the intersection.			T		ASD	NYC CVPD SAD: driver updates (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.5.1
102.5.4	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	The VTRW application shall detect whether a vehicle is turning right in front of transit vehicle via the position and heading data received in a basic safety message (from a remote vehicle) based on the PVT accuracy for positioning.				D	ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.1
102.5.5	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	The application alert mode in the VTRW application shall be active when the transit vehicle stops within a bus stop geographic zone.				D	ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.2
102.5.6	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	The application alert mode shall terminate when the transit vehicle stops within a bus stop geographic zone.				D	ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.3

102.5.7	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	The VTRW application shall only issue alerts to the driver when the transit vehicle indicates an impending crash.				D	ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.4
102.5.8	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	A VTRW application shall advise if a remote vehicle which originates directly behind the transit vehicle at a bus stop begins to pass to the left of the transit vehicle as the transit vehicle is departing a bus stop.			T		ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.5
102.5.9	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	A VTRW alert shall alert the driver if a remote vehicle which originates directly behind the transit vehicle at a bus stop passes to the left of the transit vehicle as the transit vehicle is departing a bus stop and the remote vehicle's position and heading indicates an intent to return to or cross the lane of the transit vehicle.			T		ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.6
102.5.17	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	The VTRW application shall present the alerts regardless of traffic signal status.				D	ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.7
102.5.26	3.8.2.6 Vehicle Turning Right in Front of a Transit Vehicle	Need ID 102.5: Need to reduce crashes between vehicles	3.8.2 V2V Application	The VTRW application should have access to the Transit Vehicle's gear position.				D	ASD	NYC CVPD SAD: vehicle control event, vehicle location and motion (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.20.6.8
102.5.27	4.10 Vehicle Data Bus	Need ID 102.5: Need to reduce crashes between vehicles		The ASD shall have access to the host vehicle's brake status.				D	ASD	NYC CVPD SAD: host commercial vehicle status, host transit vehicle status, host vehicle status (See Figure 8 in Section 3.2.1.1, Figures 9, 10, 11, and 13 in Section 3.2.1.2, and Figures 38 and 39 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.1
102.5.33	3.5.2.1 Functional Safety Requirements	Need ID 102.5: Need to reduce crashes between vehicles	3.5.2 System Maintenability	The ASD shall have access to Intersection IDs where the Pedestrian Detection equipment exists.				D	ASD	NYC CVPD SAD: intersection status (See Figure 13 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.16.1.1

102.6.1	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW Application shall receive the SPaT and MAP data sent by the RSUs to the vehicles deployed along the NYC CVPD corridors as per J2735.				D	ASD	NYC CVPD SAD: intersection status, intersection geometry (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.1
102.6.2	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall use the same time source as infrastructure SPaT applications.				D	ASD	NYC CVPD SAD: intersection status (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.2
102.6.9	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall acquire SPaT information, through the Host Vehicle ASD, from the intersection RSU and signal controller at a signalized intersection within RSU's DSRC range and in the vehicle's direction of travel.				D	ASD	NYC CVPD SAD: intersection status (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.5
102.6.10	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall acquire the location of the stop bars at signalized intersections at which RLVW is operating from the intersection MAP Message.				D	ASD	NYC CVPD SAD: intersection geometry (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.6
102.6.11	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall acquire the following from Intersection SPaT messages for use in RLVW advisory and alert calculations: 1. Signal Phase and Timing information of the traffic signal at the Intersection 2. Intersection status of the traffic controller	I				ASD	NYC CVPD SAD: intersection status (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.7
102.6.12	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The Vehicle RLVW Application shall be inactive if one or more of the following conditions occur: 1. Vehicle position and accuracy information is not available 2. Vehicle Speed is not available 3. Communication failure between Vehicle and Infrastructure 4. SPaT information is not available 6. MAP information is not available 7. Vehicle Heading information is not available			T		ASD	NYC CVPD SAD: intersection status, intersection geometry (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.9
102.6.13	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall calculate if a vehicle will violate the Red Light stop bar at a signalized intersection based on its current speed, heading, acceleration, location, location of stop bars, stop bar tolerance and yellow duration tolerance.			T		ASD	NYC CVPD SAD: intersection status, intersection geometry, intesection safety warning (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.10

102.6.14	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall trigger a driver alert for a vehicle approaching a signalized intersection when it determines that a stop is required and the vehicle will violate the Red Light stop bar at a signalized intersection based on its current speed, heading, acceleration, location and the location of stop bars.			T		ASD	NYC CVPD SAD: intersection status, intersection geometry, intesection safety warning (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.11
102.6.15	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall alert drivers in time for the driver to take action for a required stop at a signalized intersection.			T		ASD	NYC CVPD SAD: intersection status, intersection geometry, intesection safety warning (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.12
102.6.16	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW Application shall not alert the driver if the vehicle has safely stopped at the intersection and subsequently accelerates such that a violation occurs.				D	ASD	NYC CVPD SAD: intersection status, intersection geometry, intesection safety warning (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.13
102.6.18	3.8.3.4 Red Light Violation Warning	Need ID 102.6: Need to reduce crashes between vehicles	3.8.3 V2I Application	The RLVW application shall acquire the following from Intersection MAP messages for use in RLVW advisory and alert calculations: 1. Intersection geometric information 2. Traffic law restrictions for the intersection	I				ASD	NYC CVPD SAD: intersection status, intersection geometry, intesection safety warning (See Figure 10 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.3.14
103.1.1	3.8.3.5 Oversize Vehicle Compliance	Need ID 103: Need to warn potential violators of size-restricted roadways (e.g. bridges, overpasses or tunnels) in time for the driver to take appropriate action.	3.8.3 V2I Application	The ASD shall advise the driver of a potential crash before the bridge, overpass, or tunnel to exit the restricted roadway and find an alternate route. (Note: Advisory Distance Threshold Parameter is defined in Table E-1 in Appendix C.)				D	ASD	NYC CVPD SAD: infrastructure restriction warning info, restricted lanes parameters (See Figure 11 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.4.1

103.1.2	3.8.3.5 Oversize Vehicle Compliance	Need ID 103: Need to warn potential violators of size-restricted roadways (e.g. bridges, overpasses or tunnels) in time for the driver to take appropriate action.	3.8.3 V2I Application	The ASD shall warn the driver of an impending crash before the over-height bridge, overpass, or tunnel to stop the vehicle completely and avoid the crash. (Note: Warning Distance Threshold Parameter is defined in Table E-1 in Appendix C.)				D	ASD	NYC CVPD SAD: infrastructure restriction warning info, restricted lanes parameters (See Figure 11 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.4.2
103.2.1	3.8.3.5 Oversize Vehicle Compliance	Need ID 103: Need to warn potential violators of size-restricted roadways (e.g. bridges, overpasses or tunnels) in time for the driver to take appropriate action.	3.8.3 V2I Application	The OVC application shall calculate whether or not the vehicle is at risk of crash by comparing the vehicle's height and the height of the roadway restriction.				D	ASD	NYC CVPD SAD: infrastructure restriction warning info (See Figure 11 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.4.3
103.3.1	3.8.3.5 Oversize Vehicle Compliance	Need ID 103: Need to warn potential violators of size-restricted roadways (e.g. bridges, overpasses or tunnels) in time for the driver to take appropriate action.	3.8.3 V2I Application	The OVC application shall utilize the host vehicle's pre-established height in determining whether to alert the driver.				D	ASD	NYC CVPD SAD: infrastructure restriction warning info (See Figure 11 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.4.4
103.3.2	3.8.3.5 Oversize Vehicle Compliance	Need ID 103: Need to warn potential violators of size-restricted roadways (e.g. bridges, overpasses or tunnels) in time for the driver to take appropriate action.	3.8.3 V2I Application	The OVC application shall determine the location of the vehicle relative to the location of the size-restricted or weight restricted roadway.				D	ASD	NYC CVPD SAD: infrastructure restriction warning info, restricted lanes parameters (See Figure 11 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.4.5

103.3.3	3.8.3.5 Oversize Vehicle Compliance	Need ID 103: Need to warn potential violators of size-restricted roadways (e.g. bridges, overpasses or tunnels) in time for the driver to take appropriate action.	3.8.3 V2I Application	The RSU shall contain the roadway's clearance height and communicate it to the ASD via DSRC.				D	ASD; RSU	NYC CVPD SAD: infrastructure restriction warning info (See Figure 11 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.4.6; RSU Procurement Specification Version 1.7 § 5.1.1.2
104.1.5	3.8.3.7 Pedestrian in Signalized Intersection Warning	Need ID 104.1: Need to reduce crashes between vehicles and pedestrians / bicyclists	3.8.3 V2I Application	A PEDINXWALK alert shall be displayed if a pedestrian has been detected in a crosswalk that intersects the Transit Vehicle's planned forward, left or right turn route at the intersection.				D	ASD	NYC CVPD SAD: intersection safety warning (See Figure 13 in Section 3.2.1.2)	ASD Demonstration Procurement Specification Version 2.2 - forthcoming Addendum
104.1.7	3.8.3.7 Pedestrian in Signalized Intersection Warning	Need ID 104.1: Need to reduce crashes between vehicles and pedestrians / bicyclists	3.8.3 V2I Application	The Pedestrian Detector shall send a pedestrian detected signal when a pedestrian is present in the crosswalk it monitors.				D	ASD	NYC CVPD SAD: pedestrian detection data (See Figure 13 in Section 3.2.1.2)	NYC Bid Number 1700211: Connected Vehicles, Pedestrian Image Detection Sys
104.1.8	3.8.3.7 Pedestrian in Signalized Intersection Warning	Need ID 104.1: Need to reduce crashes between vehicles and pedestrians / bicyclists	3.8.3 V2I Application	The Pedestrian Detectors shall be pole mountable.	I				ASD		NYC Bid Number 1700211: Connected Vehicles, Pedestrian Image Detection Sys
104.1.10	3.8.3.7 Pedestrian in Signalized Intersection Warning	Need ID 104.1: Need to reduce crashes between vehicles and pedestrians / bicyclists	3.8.3 V2I Application	The PEDINXWALK System Latency for pedestrian detection shall be no more than 2 seconds from detecting pedestrian to alert.			T		ASD	NYC CVPD SAD: pedestrian detection data, pedestrian presence status, intersection safety warning (See Figure 13 in Section 3.2.1.2)	Will be added to the ASD procurement specification and Peek ICD for procurement
104.1.12	3.8.3.7 Pedestrian in Signalized Intersection Warning	Need ID 104.1: Need to reduce crashes between vehicles and pedestrians / bicyclists	3.8.3 V2I Application	The PEDINXWALK application shall receive Signal Phase and Timing for Pedestrian Lanes and Pedestrian presence detection from the SPaT message.				D	ASD	NYC CVPD SAD: intersection status (See Figure 13 in Section 3.2.1.2)	Will be added to the ASD procurement specification
104.2.3	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall correctly discern the pedestrian's position and intended crossing direction.				D	PID	NYC CVPD SAD: personal location (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.8

104.2.4	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall provide status of the walk signal in the intended direction.				D	PID	NYC CVPD SAD: intersection status (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.9
104.2.7	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall advise (via audio) the pedestrian how to use the application.				D	PID	NYC CVPD SAD: personal updates (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.10
104.3.1	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall receive intersection geometry information from the RSU based on J2735-201603.	I				PID	NYC CVPD SAD: intersection geometry (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.11
104.3.2	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall use the intersection geometry information to determine the pedestrian's orientation.	I				PID	NYC CVPD SAD: intersection geometry (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.12
104.3.3	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall use the intersection geometry information provided by the MAP message to determine the crosswalk geometry of the intended crossing.	I				PID	NYC CVPD SAD: intersection geometry (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.13
104.3.8	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG Application shall determine the intended crossing time from the intersection geographic information (distance) and the expected pedestrian travel rate (configurable).	I				PID	NYC CVPD SAD: crossing status, intersection geometry (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.15
104.3.9	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall collect data on the map error status notification. (partial, unable to detect). Note that this is intended to assist the system in troubleshooting problems; the quality of the MAP data is critical to the application and this requirements ensures that such issues are made known to the central system for corretion. This assumes that the application notifies the PED whenever it encounters a geographic computation error.	I				PID	NYC CVPD SAD: intersection geometry (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.16

104.4.6	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application on the PID shall acquire credentials from the SCMS that will allow it to authenticate the SPaT and MAP messages received.	I				PID	NYC CVPD SAD: device enrollment information (See Figure 18 in Section 3.2.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.2.1
104.4.8	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	Security and Credentials Management shall be able to set service specific permissions associated with the future support of pedestrian requests from the PID.	I				PID	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.2.2
104.4.10	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	Applications on the PID shall be able to sign messages transmitted from the RSU.	I				PID	NYC CVPD SAD: security policy and networking information (See Figure 18 in Section 3.2.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.2.8
104.4.11	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	Applications shall be capable of including a unique ID which shall remain stable (unchanged) throughout the PID's interaction with a single intersection.	I				PID	NYC CVPD SAD: device identification (See Figure 18 in Section 3.2.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.2.9
104.5.1	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall provide information to the pedestrian based on the content of the SPaT and MAP message at the nearest intersection.	I				PID	NYC CVPD SAD: personal updates (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.2.3
104.5.2	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The Application on the PID shall assist the pedestrian in determining his/her orientation. Note: Definition of orientation: to understand which street crossing the pedestrian is facing.	I				PID	NYC CVPD SAD: intersection status, intersection geometry, personal updates (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.3
104.5.3	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PID application shall provide information to the pedestrian regarding the availability of PED support services at the intersection. (It there is an RSU.)	I				PID	NYC CVPD SAD: personal updates (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.18
104.5.4	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	Application shall provide information to the pedestrian indicating the status of the pedestrian signal for the intended crossing including walk time remaining, clearance time remaining, and time until the next walk signal is expected.	I				PID	NYC CVPD SAD: intersection status, crossing status (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.19

104.5.6	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED Applications shall allow the pedestrian to configure selected parameters and characteristics such as sound volume, voice commands, and walking speeds.				D	PID	NYC CVPD SAD: personal input (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.20
104.5.8	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The application shall notify the pedestrian if there is a preemption or priority change (TSP) operation taking place which may dissrupt the signal timing.	I				PID	NYC CVPD SAD: intersection status, signal service status (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.21
104.5.10	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The Application shall calculate intersection crossing information based on pedestrians origin, destination, departure range, arrival range. (Note: this is for coordination of signal timing phase.)	I				PID	NYC CVPD SAD: crossing status, intersection geometry (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.23
104.5.11	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG Application shall collect the performance data listed in Table G-3.	I				PID	NYC CVPD SAD: pedestrian performance data (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.24
104.5.13	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The Application shall collect metadata that includes the date and time when system information was generated.	I				PID	NYC CVPD SAD: pedestrian performance data (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.26
104.5.14	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall receive signal timing and controller status from the RSU through the SPaT message.	I				PID	NYC CVPD SAD: intersection status (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.27
104.5.18	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	Every PID shall be able to change signing keys per SAE J2945/9 Section 6.6. (Note: the signing will be static during interactions with a single intersection.)	I				PID	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.12

104.6.2	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall continuously notify the user that it is operating.				D	PID	NYC CVPD SAD: personal updates (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.3.2
104.6.3	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PED-SIG application shall be able to provide requested information within 10 seconds.	I				PID	NYC CVPD SAD: personal updates (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.3.1
104.6.3.1	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	If the delay will be longer than 10 seconds, then the application shall provide information indicating how long it is expected to complete the operation.				D	PID	NYC CVPD SAD: personal updates (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.3.3
104.6.4	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The applications shall be able to measure and log the time required to provide the pedestrian the information.	I				PID	NYC CVPD SAD: pedestrian performance data (See Figure 14 in Section 3.2.1.2)	Add this requirement to the PID Procurement Spec.
104.6.11	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PID device shall be able to function in a communication-saturated environment.	I				PID	NYC CVPD SAD: pedestrian performance data (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.31
104.8.4	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PID system shall ensure geo-location information is used for PED-SIG application only.	I				PID	NYC CVPD SAD: personal location, pedestrian performance data (See Figure 14 in Section 3.2.1.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.5.2
104.8.9	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	All data transmitted between the PID and the NYU server shall be encrypted to protect any personal information.	I				PID	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.28

104.8.10	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	Data stored by the NYU server or exported for independent evaluation shall be processed to remove any personal information and any attributes including exact location and exact time such that the data cannot be associated with a particular person or event.	I				PID	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Personal Information Device (PID) Procurement version 1.7A & 5.2.1.7, 5.2.1.28
104.9.4	3.8.4.1 Mobile Accessible Pedestrian Signal System	Need ID 104.2: Need to reduce crashes between vehicles and visually / audibly-impaired pedestrians	3.8.4 I2P Application	The PID shall use the channel assignments defined in Table F-1.	I				PID	NYC CVPD SAD: intersection status, crossing status, intersection geometry (See Figure 18 in Section 3.2.2)	Personal Information Device (PID) Procurement Specification version 1.7A § 5.2.1.29
105.1.2	3.8.3.6 Emergency Communications and Evacuation Information	Need ID 105: Need to inform drivers of serious incidents	3.8.3 V2I Application	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the number of vehicles receiving emergency information Befere and After periods.				D	ASD	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.21.5.1
106.1.1	3.2.5 Performance Data Collection and Processing	Need ID 106: Need to provide mobility information in heavily congested areas	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall post-process the mobility data from the I-SIGCVDATA application Before and After periods.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.9.2
106.1.1.1	3.2.5 Performance Data Collection and Processing	Need ID 106: Need to provide mobility information in heavily congested areas	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average speed from NYC CVPD for comparison to the legacy detection system.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.7.1.3
106.1.1.2	3.2.5 Performance Data Collection and Processing	Need ID 106: Need to provide mobility information in heavily congested areas	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average travel time from NYC CVPD for comparison to the legacy detection system.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.7.1.3
110.1.1	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall function in vehicle classes in which it is to be installed in the NYC CVPD. (Note: NYC CVPD vehicles are specified in the USDOT ASD Design Specification v3.1.)				D	ASD	NYC CVPD SAD: application install/upgrade (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.1
110.1.2	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall function in weather (pavement and atmospheric) and lighting conditions anticipated for the NYC CVPD. (Note: NYC CVPD operational weather conditions are specified in the USDOT ASD Design Specification v3.1.)				D	ASD		ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.2

110.1.3	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall function on NYC CVPD roadways. (Note: NYC CVPD roadways are identified in the NYC CVPD ConOps.)				D	ASD		ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.3
110.1.4	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall obtain vehicle position data whose accuracy supports the application's calculations for issuing advisories and alerts.				D	ASD	NYC CVPD SAD: application install/upgrade (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.4
110.1.5	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall not interfere with other in-vehicle safety systems.				D	ASD		ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.5
110.1.6	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall use advisories and alerts that conform to human factors guidelines issued by the FHWA, NHTSA, and SAE.			T		ASD		ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.7
110.1.7	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall perform self-diagnostics upon power up and when the vehicle is operating. (Note: Self-Diagnostics refers to the ability of the Safety Application to determine whether it is capable of performing its intended function.)				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.8
110.1.8	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall determine the operating level/mode of operational, degraded, or failure based on the results of a self-diagnostic test.				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.9
110.1.9	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall set the operational status corresponding to the operational level mode as follows: 1. Operational – online 2. Degraded – online 3. Failure – offline				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.9
110.1.10	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall log self-diagnostic test failure which contains, at a minimum, the following information: 1. Date and time of test failure 2. Additional information to the nature of a failed test				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.10, 3.19.1.11, 3.19.1.12
110.1.11	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall maintain historical information of self-diagnostic test failures for a predetermined period in non-volatile storage. (Note: Non-volatile storage refers to storage that remains intact even when there is no power. It is left up to the implementer to determine if the retention of data is a fixed window of time, if it is based on a fixed amount of storage, or if it is until cleared.)				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.10

110.1.12	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall take itself off-line when the operating level/mode is failure.				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.11
110.1.13	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall restore or maintain itself on-line when the operating level/mode is either operational or degraded.				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.12
110.1.14	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall perform effectively for all defined NYC CVPD functional classes of roadway and levels of service (LOS) where the application is installed or is being used. (Note: NYC CVPD functional classes of roadway and levels of service are specified in the NYC CVPD ASD Specification.)				D	ASD		ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.13
110.1.15	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall be able to receive and decode messages broadcast by NYC CVPD RSU. (Note: NYC CVPD RSU is specified in the NYC CVPD RSU Specification.)				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.15
110.1.16	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The V2I Safety Application alerts shall only be issued when the current inputs to the application warrants an advisory or alert.				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.16
110.1.17	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	Safety Application Driver Training shall conform to human factors guidelines issued by the FHWA, NHTSA, and SAE.		A			ASD	Program / Policy for the Safety Application Driving Training	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.7
110.1.18	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The Safety Application shall not provide information to the driver that conflicts with infrastructure roadside signage.		A			ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.9.1.17
110.1.19	3.8.1 Common Application	Need ID 102: Need to reduce crashes	3.8 Application Requirements	The safety application shall provide its operational status (online, offline) to the ASD management system.			T		ASD	NYC CVPD SAD: equipment status (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.18
110.1.20	3.8.1 Common Application	Need ID 101.1: Need to manage speed on surface streets – 25 MPH regulatory speed limit	3.8 Application Requirements	An application shall receive intersection geometry information, e.g. Geometric Intersection Design (GID), from the closest MAP message based on the host vehicle's current location.				D	ASD	NYC CVPD SAD:intersection geometry (See Figures 10, 13, and 14 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.19

110.1.21	3.8.1 Common Application	Need ID 101.1: Need to manage speed on surface streets – 25 MPH regulatory speed limit	3.8 Application Requirements	The application shall obtain vehicle speed from one of the sources available to the ASD. These sources include the CAN interface, GNSS interface, derivation from sequential GNSS location readings.			T		ASD	NYC CVPD SAD: location and time (See Figure 15 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.20
110.2.2	3.2.1 Vehicle Performance Monitoring	Need ID 102: Need to reduce crashes	3.2 System Performance Characteristics	The ASD shall broadcast the BSM of host vehicles per SAE standards J2945/1 and J2735.			T		ASD	NYC CVPD SAD: vehicle location and motion (See Figure 8 in Section 3.2.1.1 and Figures 10 and 13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.10.2.4, 3.10.2.5
110.2.3	3.2.1 Vehicle Performance Monitoring	Need ID 102: Need to reduce crashes	3.2 System Performance Characteristics	All NYC CVPD ASDs shall utilize the same GPS time source and common accuracy configuration as the NYC CVPD Infrastructure.	I				ASD	NYC CVPD SAD: location and time (See Figure 15 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.1.1.1
110.3.1	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The safety applications listed in Table C-1 shall acquire vehicle position, position accuracy, speed, and heading from the ASD.			T		ASD	NYC CVPD SAD: vehicle location and motion (See Figure 8 in Section 3.2.1.1 and Figures 10 and 13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.21
110.3.2	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The safety applications listed in Table C-1 shall determine if the ASD position, speed and heading information provided is sufficiently accurate to support the ASD's advisory and alert calculations.			T		ASD	NYC CVPD SAD: vehicle location and motion (See Figure 8 in Section 3.2.1.1 and Figures 10 and 13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.22
110.3.3	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The safety applications listed in Table C-1 shall only issue advisories and alerts if the ASD position, speed and heading information provided is sufficiently accurate to support the ASD's advisory and alert calculations.			T		ASD	NYC CVPD SAD: vehicle location and motion (See Figure 8 in Section 3.2.1.1 and Figures 10 and 13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.23
110.3.4	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The safety applications listed in Table C-1 shall acquire roadway geometry for the roadway ahead. (Note: roadway geometry is expected to come from MAP messages acquired by the ASD from NYC CVPD DSRC Infrastructure.)			T		ASD	NYC CVPD SAD: vehicle location and motion (See Figures 9-13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.24
110.3.4.1	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The V2I safety applications listed in Table C 1 except for CSPD-COMP and SPDCOMPWZ applications shall acquire the roadway geometry information through the MAP message from the RSUs.			T		ASD	NYC CVPD SAD: vehicle location and motion (See Figures 9-13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.24

110.3.4.2	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The CSPD-COMP and SPDCOMPWZ applications listed in Table C 1 shall acquire the roadway geometry information through the TIM message from the RSUs.			T		ASD	NYC CVPD SAD: vehicle location and motion (See Figures 9-13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.24
110.3.5	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The safety applications listed in Table C-1 shall acquire the posted speed for the roadway ahead, including upcoming reduced speed zone. (Note: Posted speed information is expected to come from MAP messages acquired by the ASD from NYC CVPD DSRC Infrastructure.)			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.25
110.3.5.1	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The V2I safety applications listed in Table C 1 except for CSPD-COMP and SPDCOMPWZ applications shall acquire the posted speed information through the MAP message from the RSUs.			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.25
110.3.5.2	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The CSPD-COMP application listed in Table C 1 shall acquire the posted speed for the upcoming curved section of a roadway through the TIM message from the RSU.			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.25
110.3.5.3	3.8.1 Common Application	Need ID 101: Need to manage speed on surface streets	3.8 Application Requirements	The SPDCOMPWZ application listed in Table C 1 shall acquire the posted speed for the upcoming work zone through the TIM message from the RSU.			T		ASD	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.25
110.3.6	3.8.1 Common Application	• Need ID 101.3: Need to manage speed in work zones – speed limit	• 3.8 Application Requirements	• Issuance of the CSPD-COMP and SPDCOMPWZ application advisory of a reduced speed zone ahead to the driver shall coincide with driver visibility of reduced speed zone ahead signage. (Note: Location of roadside signage and sign visibility distances are described in the MUTCD.)	•	•	• T	•	• ASD	• NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.2.2)	• ASD Demonstration Procurement Specification Version 2.2 § 3.19.1.26
110.3.7	3.8.1 Common Application	Need ID 102.6: Need to reduce crashes between vehicles	3.8 Application Requirements	The safety application shall acquire data from the ASD which includes the following: 1. Vehicle Positioning information 2. Vehicle Position accuracy 2. Vehicle Speed 3. Vehicle Acceleration 4. Vehicle Heading			T		ASD	NYC CVPD SAD: vehicle location and motion (see Figure 8 in Section 3.2.1.1 and Figures 10 and 13 in Section 3.2.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.1

110.4.1	4.9 Foreign Dedicated Short Range Communiations Devices	Need ID 102: Need to reduce crashes		Foreign light-duty vehicles shall transmit DSRC BSM messages in accordance with the J2945/1 standard.			T		ASD		
110.4.2	4.9 Foreign Dedicated Short Range Communiations Devices	Need ID 102: Need to reduce crashes		Foreign trucks shall transmit DSRC BSM messages in accordance with the J2945/1 and shall contain the following Part II SupplementalVehicleExtensions objects: classification, and vehicleData (height and mass) as defined in J2735 Section 6.133.			T		ASD		
201.1.1	3.4 Information Management	Need ID 201: Need to have privacy		The ASD event recording shall encrypt each event record. (Clarification: this prevents vehicle identity and determination of whether the vehicle is from the control group or the treatment group.)	I				ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.19
201.2.1	3.8.1 Common Application	Need ID 201: Need to have privacy	3.8 Application Requirements	The V2V safety applications shall set the message threshold at the proper level.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.2
201.2.2	3.8.1 Common Application	Need ID 201: Need to have privacy	3.8 Application Requirements	The V2V safety applications shall formulate the decision algorithm properly to recognize the threat.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.3
201.2.3	3.8.1 Common Application	Need ID 201: Need to have privacy	3.8 Application Requirements	The V2V safety applications shall ensure that all components of the system are functioning as intended.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.4
201.3.2	3.8.1 Common Application	Need ID 201: Need to have privacy	3.8 Application Requirements	The V2I safety applications shall operate on correct, timely information.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.5
201.4.1	3.8.1 Common Application	Need ID 201: Need to have privacy	3.8 Application Requirements	The NYC CVPD safety management subsystem shall verify the initial data entry from the V2I safety applications.				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.6
201.4.2	3.5.2 System Maintenability	Need ID 203: Need to manage CV equipment maintenance	3.5 System Operations	The TMC staff shall be able to monitor the NYC CVPD system-wide RSU malfunctions.			T		RSU	NYC CVPD SAD: system monitoring (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.11.1
201.5.1	3.5.2.1 Functional Safety Requirements	Need ID 201: Need to have privacy	3.5.2 System Maintenability	The ASD shall provide the alerts to the driver without ambiguity.				D	ASD	NYC CVPD SAD: driver updates (See Figure 8 in Section 3.2.1.1)	ASD Demonstration Procurement Specification Version 2.2 § 3.16.1.2

201.5.2	3.5.2 System Maintenability	Need ID 201: Need to have privacy	3.5 System Operations	The ASD shall have configurable parameters for tuning alert thresholds.	I				ASD	NYC CVPD SAD: See Figure 41 ASD Context Diagram in Section 3.4.3.3	ASD Demonstration Procurement Specification Version 2.2 § 3.15.1.1
201.6.1	3.5.2.1 Functional Safety Requirements	Need ID 203: Need to manage CV equipment maintenance	3.5.2 System Maintenability	The RSU shall broadcast the regulatory speed information to the ASD.	I				RSU	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.2.2)	RSU Procurement Specification Version 1.7 § 4.10.1.2
202.1.3	3.8.1 Common Application	Need ID 202: Need to manage CV application for the traffic environment	3.8 Application Requirements	The safety applications listed in Table C-1 shall implement the most recent application control parameters supplied externally to the application as described in Table E-1.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.7
202.1.4	3.8.1 Common Application	Need ID 202: Need to manage CV application for the traffic environment	3.8 Application Requirements	The safety application shall allow the central system to modify the control parameters as defined in Table E-1.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.19.2.8
202.2.1	3.1.3 Adaptability	Need ID 202: Need to manage CV application for the traffic environment	3.1 Physical	The NYC CVPD applications shall have modifiable algorithms and software parameters for improving the system performance.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.6.8.1
202.3.1	3.1.3 Adaptability	Need ID 202: Need to manage CV application for the traffic environment	3.1 Physical	The ASD shall have upgradable hardware components for improving the device performance upon expansion of the NYC CVPD system.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	Personal Information Device (PID) Procurement version 1.7A & 3.5.3.2;
202.3.2	3.1.3 Adaptability	Need ID 202: Need to manage CV application for the traffic environment	3.1 Physical	The RSU shall have upgradable hardware components for improving the device performance upon expansion of the NYC CVPD system.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	

202.4.1	4.10 Vehicle Data Bus	Need ID 202: Need to manage CV application for the traffic environment		The ASD shall monitor the items in Table E-5 on the in-vehicle network.	I				ASD	NYC CVPD SAD: host commercial vehicle status, host transit vehicle status, host vehicle status (See Figure 8 in Section 3.2.1.1, Figures 9, 10, 11, and 13 in Section 3.2.1.2, and Figures 38 and 39 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.2
202.4.2	3.2.1 Vehicle Performance Monitoring	Need ID 202: Need to manage CV application for the traffic environment	3.2 System Performance Characteristics	The Vehicle Performance Monitoring application shall collect/log vehicle operational data (e.g. hard break, steering turns, accelerations based on accelerometers).	I				ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 37 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.6.5.1
202.4.3	3.2.1 Vehicle Performance Monitoring	Need ID 202: Need to manage CV application for the traffic environment	3.2 System Performance Characteristics	The fleet manager shall be able to solicit and collect feedback from the anonymous vehicle operators on the operation of the system.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.3
202.6.1	3.5.2 System Maintenability	Need ID 202: Need to manage CV application for the traffic environment Comment: to provide security for the source of the changes.	3.5 System Operations	The Parameter Control functional entity at the TMC shall sign the Parameter Control messages per IEEE 1609.2.	I				ASD	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.1.2
202.6.3	3.5.2 System Maintenability	Need ID 202: Need to manage CV application for the traffic environment	3.5 System Operations	The Parameter Control functional entity shall meet the highest security requirements for a device of the appropriate class. (Note: this shall be derived via the Confidentiality/Integrity/Availability (CIA) analysis once the application specification is developed in detail.)				D	ASD	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.1.3
202.6.5	3.5.2 System Maintenability	Need ID 202: Need to manage CV application for the traffic environment	3.5 System Operations	The Parameter Control functional entity shall update the parameter control message signatures daily.	I				ASD	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.1.4
202.6.7	3.5.2 System Maintenability	Need ID 202: Need to manage CV application for the traffic environment	3.5 System Operations	The Parameter Control message version shall be based on the message payload.	I				ASD	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 - Appendix H, Table 25

202.6.8	3.5.2 System Maintenability	Need ID 202: Need to manage CV application for the traffic environment	3.5 System Operations	The ASDs from all suppliers shall implement the same Parameter Control protocol. (Note: Parameter Control protocol will be defined by SAE or by NYC CVPD.)				D	ASD	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.1.5
202.7.1	3.2 System Performance Characteristics	Need ID 202: Need to manage CV application for the traffic environment		The ASD shall process all radio messages at a minimum rate of 10 Hz.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	
202.8.1	3.2.1 Vehicle Performance Monitoring	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.2 System Performance Characteristics	The ASD shall monitor the delivery of the audio alert and any audio instructions to the driver. (Clarification: the monitoring system [internal to the ASD] will confirm that the actual audio information [sound] was produced in the vehicle and that the audio information matches what the alert was intended to deliver. The purpose of this requirement is to detect faulty speaker wiring and damaged speakers that prevent the alert from being delivered to the driver and to ensure that the driver has not done anything to the audio system. It is not intended to be an accurate voice to text conversion system, but sufficient to determine that an alert message was delivered.)				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.6.5.2
202.9.1	3.2.1 Vehicle Performance Monitoring	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.2 System Performance Characteristics	The ASD shall include an accelerometer for each of the three axis that measure the acceleration in each direction.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.1.5
202.9.2	3.2.1 Vehicle Performance Monitoring	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.2 System Performance Characteristics	The accuracy and range of the accelerometers shall be able to determine when the vehicle experiences a sudden change of direction or speed, sudden stop, or impact [with something]. (Definition of 'Sudden change of direction or speed, sudden stop, or impact' is in Appendix D of the NYC CVPD SyRS document.)	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.6.5.5
203.1.1	3.1.2.2 Repair	Need ID 203: Need to manage CV equipment maintenance	3.1.2 Durability	The NYC CVPD maintenance personnel shall replace the ASD damaged by improper maintenance, tampering, or mishap.				D	ASD	NYC CVPD SAD: equipment status, equipment control commands (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.6.7.1

203.1.2	3.1.2.2 Repair	Need ID 203: Need to manage CV equipment maintenance	3.1.2 Durability	The NYC CVPD maintenance personnel shall replace the RSU damaged by improper maintenance, tampering, or mishap.				D	RSU	NYC CVPD SAD: equipment status, equipment control commands (See Figure 16 in Section 3.2.2)	
203.2.1	3.1.2.2 Repair	Need ID 203: Need to manage CV equipment maintenance	3.1.2 Durability	The NYC CVPD maintenance personnel shall be able to reboot the ASD after a disruptive software glitch.				D	ASD	NYC CVPD SAD: equipment status, equipment control commands (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.6.7.2
203.2.2	3.1.2.2 Repair	Need ID 203: Need to manage CV equipment maintenance	3.1.2 Durability	The NYC CVPD maintenance personnel shall be able to reboot the RSU after a disruptive software glitch.				D	RSU	NYC CVPD SAD: equipment status, equipment control commands (See Figure 16 in Section 3.2.2)	
203.4.1	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The ASD shall operate on the voltage supplied by the host vehicle.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.3
203.5.2	3.3.1 Security Management and Operations	Need ID 203: Need to manage CV equipment maintenance	3.3 System Security	If the ASD determines that it has no valid certificates, it shall cease transmission of BSMs.				D	ASD	NYC CVPD SAD: device enrollment information, security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.3. Address the issue of recording the enrollment or pseudonym certificates for the installed ASD so that this can be provided, should the vehicle need to be put on the CRL.
203.6.3	3.5.2.1 Functional Safety Requirements	Need ID 203: Need to manage CV equipment maintenance	3.5.2 System Maintenability	The RSU shall broadcast the location of a curve and other details to support the CSPD-COMP application.	I				RSU	NYC CVPD SAD: speed management information (See Figure 9 in Section 3.2.1.2)	RSU Procurement Specification Version 1.7 § 4.10.1.3
203.6.4	3.5.2.1 Functional Safety Requirements	Need ID 203: Need to manage CV equipment maintenance	3.5.2 System Maintenability	The RSU shall broadcast the location of a static work zone to support the SPDCOMPWZ application.				D	RSU	NYC CVPD SAD: lane closure information, restricted lanes parameters (See Figure 9 in Section 3.2.1.2)	RSU Procurement Specification Version 1.7 § 4.10.1.4
203.6.5	3.5.2.1 Functional Safety Requirements	Need ID 203: Need to manage CV equipment maintenance	3.5.2 System Maintenability	The RSU shall broadcast the location of a moving work zone to support the SPDCOMPWZ application.				D	RSU	NYC CVPD SAD: restricted lanes parameters (See Figure 9 in Section 3.2.1.2)	RSU Procurement Specification Version 1.7 § 4.10.1.5

203.6.6	3.5.2.1 Functional Safety Requirements	Need ID 203: Need to manage CV equipment maintenance	3.5.2 System Maintenability	The RSU shall broadcast the location of a school zone to support the SPDCOMPWZ application.				D	RSU	NYC CVPD SAD: restricted lanes parameters (See Figure 9 in Section 3.2.1.2)	RSU Procurement Specification Version 1.7 § 4.10.1.6
203.6.7	3.5.2.1 Functional Safety Requirements	Need ID 203: Need to manage CV equipment maintenance	3.5.2 System Maintenability	The RSU shall broadcast the location of a roadway's vehicle size restriction to support the OVC application.				D	RSU	NYC CVPD SAD: restricted lanes parameters (See Figure 11 in Section 3.2.1.2)	RSU Procurement Specification Version 1.7 § 4.10.1.7
203.7.1	3.1.1.1 Mechanical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The ASD shall provide evidence to detect tampering (e.g. opening of the case) through tamper-evident seals on all media ports and screw holes.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.5.4.1
203.7.2	3.1.1.1 Mechanical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The RSU shall provide evidence of tampering (e.g. opening of the case) through tamper-evident seals on media ports (e.g. USB) and screw holes.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 3.4.6.8
203.7.3	3.1.1.1 Mechanical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The RSU size dimensions shall not exceed 13” h x 13” w x 4” d exclusive of mounting hardware.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	Will be added to RSU Procurement Spec
203.11.1	3.5.2 System Maintenability	Need ID 203: Need to manage CV equipment maintenance	3.5 System Operations	The ASD software components shall accommodate failures in hardware or in adjacent software modules in a way that does not pose hazards.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.2.1
203.12.1	4.10 Vehicle Data Bus	Need ID 203: Need to manage CV equipment maintenance		The ASD shall utilize the OBD-II port, J-bus, or CAN bus.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.3
203.12.2	4.10 Vehicle Data Bus	Need ID 203: Need to manage CV equipment maintenance		The ASD shall conform to the associated SAE interface requirements for OBD-II port, J-bus, or CAN bus. (Clarification: the intent of this requirement is to prevent the ASD from interfering with other in-vehicle systems.)			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.4
203.12.3	4.10 Vehicle Data Bus	Need ID 203: Need to manage CV equipment maintenance		The application in the ASD shall collect and process vehicle-related information through a direct connection or a splitter cable. (Note: individual application data needs will be addressed through each application's requirement.)	I				ASD	NYC CVPD SAD: host commercial vehicle status, host transit vehicle status, host vehicle status (See Figure 8 in Section 3.2.1.1, Figures 9, 10, 11, and 13 in Section 3.2.1.2, and Figures 38 and 39 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.5

203.14.1	3.6.1 Maintenance	Need ID 203: Need to manage CV equipment maintenance	3.6 Policy and Regulation	The ASD interface design and test before production shall address poor choice of color, icon shape, location, or sound.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	
203.15.2	3.6.1 Maintenance	Need ID 203: Need to manage CV equipment maintenance	3.6 Policy and Regulation	The ASD installation procedure shall stipulate wire routing.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.18.1.2
203.16.1	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The current drawn by the ASD shall not exceed with the maximum allowable amperage specified by the ASD vendor.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.4.1
203.16.2	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The RSU shall not overload the power supplies provided by the RSU vendor based on maximum allowable power consumption. (During operation, turn off, turn on, etc. per NEMA TS2 environmental testing.)	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.10.1.8
203.17.1	3.1.4 Environmental Conditions	Need ID 203: Need to manage CV equipment maintenance	3.1 Physical	The RSU shall be designed to operate properly in the outdoor environment. (e.g. temperature, humidity, rain, fog, sun, snow, shock, vibration, etc.) {Ref augmented NEMA TS2-20XX}	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 3.4.5.1
203.17.2	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	All connections to the RSU shall be protected from lightening and power surges on the Ethernet.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 3.4.6.4
203.18.1	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The ASDs shall withstand electromagnetic interference (EMI) from external sources and electrical distribution.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.7.3
203.18.2	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The ASD shall withstand electrostatic discharge (ESD) from external sources and electrical distribution.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.7.4
203.18.3	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The RSU shall withstand electrostatic discharge (ESD) from external sources and electrical distribution. (Provide ESD definitions/specifications.)	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 3.4.5.15
203.19.1	3.1.1.2 Electrical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	The ASD design shall prevent battery drain.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.3.2

203.20.1	3.3.1 Security Management and Operations	Need ID 203: Need to manage CV equipment maintenance	3.3 System Security	The ASD shall prevent incoming messages with invalid conditions per criteria in the IEEE 1609.2 from being acted on.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.8.6.5
203.22.1	3.1.1.1 Mechanical Requirements	Need ID 203: Need to manage CV equipment maintenance	3.1.1 Construction	Connected Vehicle equipment mounted externally to the vehicle shall be contained within the envelope defined by the ASD vendor specification.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.5.3.2
203.25.1	4.10 Vehicle Data Bus	Need ID 203: Need to manage CV equipment maintenance		The ASD interface to the CAN bus shall not degrade or interfere with vehicle's normal operation.				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.6
203.25.2	4.10 Vehicle Data Bus	Need ID 203: Need to manage CV equipment maintenance		The ASD's interface to the CAN bus shall not interfere with the vehicle's passenger's safety systems (e.g., restraints and extrication).				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.7
203.26.1	3.2.1 Vehicle Performance Monitoring	Need ID 203: Need to manage CV equipment maintenance	3.2 System Performance Characteristics	The ASD shall be able to process (and authenticate and/or encrypt) the DSRC messages at a minimum rate of 10 Hz. This includes all messages on all channels: BSM, TIM, MAP, SPaT, etc. in addition to IP communications traffic for management applications.	I				ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	
203.28.1	3.5.2 System Maintenability	Need ID 203: Need to manage CV equipment maintenance	3.5 System Operations	The TMC staff shall be able to monitor the NYC CVPD system-wide ASD malfunctions.	I				TMC	NYC CVPD SAD: system monitoring, equipment status (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.1.1
203.31.1	3.1.2.1 Back-up Power	Need ID 203: Need to manage CV equipment maintenance	3.1.2 Durability	Back office servers shall have their power source augmented by an Uninterruptable Power Supply (UPS).	I				TMC		

204.3.1	3.1.4 Environmental Conditions	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.1 Physical	The audible message volume in the ASD shall be distinguishable from other sounds.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.9.1
204.3.2	3.1.4 Environmental Conditions	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.1 Physical	The audible message volume in the ASD shall be developed and tested in a real traffic environment.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.9.2
204.4.1	3.5.2.1 Functional Safety Requirements	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.5.2 System Maintenability	The NYC CVPD HMI shall communicate alerts to the driver through auditory devices.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.6.10.6
204.4.4	3.5.2.1 Functional Safety Requirements	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.5.2 System Maintenability	The NYC CVPD HMI shall communicate evacuation information to the driver through auditory alerts.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.16.1.4
204.5.1	3.2.1 Vehicle Performance Monitoring	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.2 System Performance Characteristics	The Host Vehicle ASD shall begin aural alerts within 250 milliseconds of being triggered by the application.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	
204.6.1	3.5.1 System Human Factors	Need ID 204: Need to limit additional vehicle cab devices that have the potential to distract drivers	3.5 System Operations	The system administrator shall be able to change the volume of the audio output (e.g. speakers).			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.4.2.9.3

401.1.1	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD Vehicle Communications wireless link shall have communications security to ensure the authenticity of all its messages in accordance to the standards prescribed by the overall USDOT connected vehicle program.		A			ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.8.5.1
401.1.2	3.2.1 Vehicle Performance Monitoring	Need ID 401: Need to have trusted communications	3.2 System Performance Characteristics	The ASD shall have sufficient power to authenticate messages on the Safety Applications defined in Table C-1 in time for the individual Safety Applications to meet their individual performance requirements.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	
401.2.1	4.4 Security Credential Management System (SCMS)	Need ID 401: Need to have trusted communications		The device supplier shall provide devices provisioned with valid enrollment certificates.	I				ASD; PID; RSU	NYC CVPD SAD: device enrollment information, security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 1.4.2.5; Personal Information Device (PID) Procurement version 1.7A & 4.5.1.1; RSU Procurement Specification Version 1.7 & 6.3.1.1
401.2.2	4.4 Security Credential Management System (SCMS)	Need ID 401: Need to have trusted communications		The device supplier shall provide devices that meet the interface requirements of the USDOT's certification program.	I				ASD; PID; RSU	NYC CVPD SAD: user permission sets (See Figure 17 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 2.1.2.1; Personal Information Device (PID) Procurement version 1.7A & 2.8.4.1; RSU Procurement Specification Version 1.7 & 6.3.1.2
401.2.6	3.7 System Life Cycle Sustainment	Need ID 401: Need to have trusted communications		The ASD shall meet pre-determined certification criteria based on procurement documents.	I				ASD	NYC CVPD SAD: user permission sets (See Figure 17 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.18.2.1
401.2.7	3.6.1 Maintenance	Need ID 401: Need to have trusted communications	3.6 Policy and Regulation	The RSU shall meet the USDOT certification requirements as defined prior to September 15, 2016.	I				RSU	NYC CVPD SAD: user permission sets (See Figure 17 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.5.1.1

401.3.1	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD shall carry out plausibility checking on the remote vehicle BSM data. (Definition of plausibility checking needs to be determined.)				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.6
401.3.2	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD shall sign its event log file entries using its BSM signing keys.	I				ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.7
401.3.3	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD operating system (OS) shall prevent the log file signing application from sending messages on any channel other than those that are identified by the PSID or WSA for particular service.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.27.1
401.3.4	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD shall indicate successful receipt of the pseudonym certificates.	I				ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.9
401.3.5	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The SCMS supplier shall track the expected expiry times of ASD enrollment certificates.	I				ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.10
401.3.6	4.10 Vehicle Data Bus	Need ID 401: Need to have trusted communications		The ASD shall carry out plausibility checking on the internal CAN/J-Bus data.				D	ASD	NYC CVPD SAD: host commercial vehicle status, host transit vehicle status, host vehicle status (See Figure 8 in Section 3.2.1.1, Figures 9, 10, 11, and 13 in Section 3.2.1.2, and Figures 38 and 39 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 4.2.2.8
401.3.7	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	When the ASD has no valid BSM signing certificates, it shall store the log file entries as IEEE 1609.2 data of type unsecured.	I				ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.8
401.3.8	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD vendor shall replace the ASDs that need to be re-enrolled with newer ASDs.	I				ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.11

~~401.4.1~~	~~3.3.1 Security Management and Operations~~	~~Need ID 401: Need to have trusted communications~~	~~3.3 System Security~~	~~The RSU shall support application certificates with different geographic validity region than the associated enrollment certificate.~~	-	-	-	~~D~~	RSU	~~NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)~~	~~RSU Procurement Specification Version 1.7 § 4.4.1.3~~
~~401.4.2~~	~~3.3.1 Security Management and Operations~~	~~Need ID 401: Need to have trusted communications~~	~~3.3 System Security~~	~~The RSU shall support setting the certificate geographic region to be requested for application certificates.~~	-	-	-	~~D~~	RSU	~~NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)~~	~~RSU Procurement Specification Version 1.7 § 4.4.1.4~~
~~401.4.3~~	~~3.3.1 Security Management and Operations~~	~~Need ID 401: Need to have trusted communications~~	~~3.3 System Security~~	~~The system administrators shall configure the RSU to request application certificates with only designated geographic locations.~~	~~I~~	-	-	-	RSU	~~NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)~~	~~RSU Procurement Specification Version 1.7 § 4.4.1.5~~
401.4.4	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSU supplier shall provide the serial number and its enrollment certificate for each RSU.	I				RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.6
~~401.4.5~~	~~3.3.1 Security Management and Operations~~	~~Need ID 401: Need to have trusted communications~~	~~3.3 System Security~~	~~The system administrator shall request new certificates bound to the new location if it moves from one location to another. (Note: its interface will allow requesting a new RSU application certificate with a particular site.)~~	-	-	-	~~D~~	RSU	~~NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)~~	~~RSU Procurement Specification Version 1.7 § 4.4.1.7~~
401.4.6	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSU-SCMS interface shall allow the RSU to request application certificates with different contents from the current ones during the lifetime of the current ones.				D	RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.8
~~401.4.7~~	~~3.3.1 Security Management and Operations~~	~~Need ID 401: Need to have trusted communications~~	~~3.3 System Security~~	~~The RSU shall delete old certificates upon location change.~~	~~I~~	-	-	-	RSU	~~NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)~~	~~RSU Procurement Specification Version 1.7 § 4.4.1.9~~

401.5.1	3.5.2 System Maintenability	Need ID 401: Need to have trusted communications	3.5 System Operations	All devices shall carry no more than two weeks' worth of operating certificates.	I				ASD; PID; RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.3.1; Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.8.1; RSU Procurement Specification Version 1.7 § 4.4.11.4
401.5.2	3.5.2 System Maintenability	Need ID 401: Need to have trusted communications	3.5 System Operations	The day before a new week becomes valid, the devices shall download the next week's worth of certificates.				D	ASD; PID; RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.3.2; Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.8.1; RSU Procurement Specification Version 1.7 § 4.4.11.5
401.6.2	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	If a device misbehaves, the SCMS shall blacklist the device and its enrollment certificates and prevent it from obtaining more authorization certificates.				D	ASD; RSU	NYC CVPD SAD: security credentials, device revocation request (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.3.12; RSU Procurement Specification Version 1.7 & 4.4.1.11
401.6.3	4.4 Security Credential Management System (SCMS)	Need ID 401: Need to have trusted communications		The SCMS shall maintain the blacklist internally.	I				RSU	NYC CVPD SAD: device revocation request (See Figure 18 in Section 3.2.2)	RSU Procurement Specification Version 1.7 & 6.3.1.5
401.6.4	4.4 Security Credential Management System (SCMS)	Need ID 401: Need to have trusted communications		The back office system shall acquire one SCMS certificate from each installed DSRC device and associate this certificate with the installed DSRC device. (Note: this requirement is temporary and will become obsolete after the SCMS deploys misbehavior detection and reporting features.)	I				ASD; PID; RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	Will be added to ASD, PID, and RSU Procurement Specs
401.6.5	4.4 Security Credential Management System (SCMS)	Need ID 401: Need to have trusted communications		The back office system administrator shall provide a DSRC device's acquired SCMS certificate when requesting that the SCMS registration authority add the associated DSRC device to the Certificate Revocation List (CRL). (Note: this requirement is temporary and will become obsolete after the SCMS	I				ASD; PID; RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	Will be added to ASD, PID, and RSU Procurement Specs

				deploys misbehavior detection and reporting features.)							
401.7.1	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD shall obtain certificates via IPv6 connectivity through the RSU.			T		ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.13
401.7.2	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSU shall broadcast the WSA for certificate download on control channel 178 and indicate IPv6 connectivity and the IP address on a service channel other than channel 172 or 178.				D	RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.13
401.7.3	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSU shall implement a firewall blocking all IP access from devices to any IP address other than those approved for specific applications.				D	RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.14
401.7.4	3.5.2 System Maintenability	Need ID 401: Need to have trusted communications	3.5 System Operations	Mobile devices in need of certificate update shall switch to the advertised channel.				D	ASD; PID; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	
401.7.5	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSUs shall support IPv6 tunneling over IPv4.				D	RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.15
401.7.6	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Communication between the ASD and the SCMS shall operate in an encrypted, end-to-end connection in accordance with the published SCMS interface. (Note: The SCMS interface should not need any further security.)				D	ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.15
401.7.7	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The information security manager shall investigate and monitor the data traffic usage to detect unapproved use of the IP connection.				D	TMC	NYC CVPD SAD: system monitoring (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.3.1.6
401.7.8	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Communication between the RSU and the SCMS shall operate in an encrypted, end-to-end connection in accordance with the published SCMS interface. (Note: The SCMS interface should not need any further security.)				D	RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.16

401.8.1	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The NYCDOT IT shall address any denial of service (DoS) attacks within each NYC network using its existing practices. (Note: the networks include NYCWiN, CityNet, DOTNet, any network that DoITT is responsible for.)	I				TMC	NYC CVPD SAD: system monitoring (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.3.1.6 https://www1.nyc.gov/site/doitt/business/it-security-requirements-vendors-contractors.page
401.8.2	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The information security manager shall monitor the DSRC communications performance to detect DoS attacks.	I				ASD; TMC	NYC CVPD SAD: system monitoring (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.16 Address in SDD
401.8.3	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSU shall report over a management interface if channel busy ratios go above a configurable threshold.				D	RSU	NYC CVPD SAD: operation and maintenance RSU data (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.17
401.8.4	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The ASD shall log an event report every second for which channel busy ratios go above a configurable threshold.				D	ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.3.17
401.9.1	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSU shall operate client-side transport layer security (TLS) and accept only TLS server certificates with specific URLs.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.18
401.9.2	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The RSU shall protect root certificates for client-side TLS against modification and provide other certificates in the chain, which shall not make a separate query to the internet to obtain the entire chain.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.19
401.11.1	3.5.2 System Maintenability	Need ID 401: Need to have trusted communications	3.5 System Operations	A device with DSRC communications interfaces shall continue normal operations regardless of the number, rate, or content of the DSRC messages received. (Note: the only exception to this is a firmware update in which case faulty software could violate this requirement.)				D	ASD; PID; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.4.1; Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.13.1 RSU Procurement Specification Version 1.7 § 4.4.11.6

401.11.2	3.5.2 System Maintenability	Need ID 401: Need to have trusted communications	3.5 System Operations	A device with DSRC communications interfaces shall continue normal operations regardless of the number, rate, or content of the DSRC messages transmitted.				D	ASD; PID; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.4.2; Personal Information Device (PID) Procurement Specification version 1.7A § 4.5.13.2 RSU Procurement Specification Version 1.7 § 4.4.11.7
401.12.1	3.2.1 Vehicle Performance Monitoring	Need ID 401: Need to have trusted communications	3.2 System Performance Characteristics	The RSU shall interface with signal controllers, NYCWiN, and DSRC messages from vehicles and pedestrians. (Note: this will be expanded into multiple requirements for each interface.)				D	RSU	NYC CVPD SAD: intersection control status, pedestrian presence status, intersection status, intersection geometry, vehicle location and motion (See Figure 13 in Section 3.2.1.2)	RSU Procurement Specification Version 1.7 § 5.2.1.2
401.14.1	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Devices shall communicate using SNMPv3 with SNMP messages protected by being sent over TLS.				D	ASD; PID; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.4.1; Personal Information Device (PID) Procurement version 1.7A & 4.5.3.2; RSU Procurement Specification Version 1.7 & 4.4.1.20
401.14.2	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Devices shall support establishment of a standard TLS-based VPN with client authentication for communication to the TMC, with a long-term client cert and a single CA cert trusted to authorize connections from the TMC.				D	ASD; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.5.1; RSU Procurement Specification Version 1.7 & 4.4.1.21
401.14.3	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Devices shall verify received messages per IEEE 1609.2 and per the relevant security profiles before using them for operations in any application.				D	ASD; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.27.3; RSU Procurement Specification Version 1.7 & 4.4.1.22

401.14.4	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Devices shall store RF Monitoring log file entries encrypted with an encryption key belonging to the TMC.				D	ASD; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.27.4; RSU Procurement Specification Version 1.7 & 4.4.1.23
401.14.5	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The host processor on the device shall perform and pass integrity checks as specified in requirements 401.14.6 - 401.14.9.				D	ASD; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.5; RSU Procurement Specification Version 1.7 & 4.4.1.24
401.14.6	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The integrity checks performed at boot shall use a hardware-protected value such that the integrity cannot be successfully compromised unless the hardware-protected value is modified.			T		ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.6; RSU Procurement Specification Version 1.7 & 4.4.1.24.1
401.14.7	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Until all integrity checks on the software and firmware configuration of the host have passed, the device shall not allow a privileged application (as defined in Security Management Operating Concept section 6.1.1) to sign a message.			T		ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.7; RSU Procurement Specification Version 1.7 & 4.4.1.24.2
401.14.8	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	If any integrity check on the software and firmware configuration of the host fails, the device shall not allow any application to have access to locally stored private keys.			T		ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.8; RSU Procurement Specification Version 1.7 & 4.4.1.24.3
401.14.9	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	If any integrity check on the software and firmware configuration of the host fails, the device shall not allow any privileged application (as defined in Security Management Operating Concept section 6.1.1) to operate.			T		ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.9; RSU Procurement Specification Version 1.7 & 4.4.1.24.4
401.14.10	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The OS on the device shall maintain an Access Control List (ACL) for which applications on the host may use each private key in the HSM.			T		ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.10; RSU Procurement Specification Version 1.7 & 4.4.1.25

401.14.11	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The OS shall not permit keys designated as private to be read from the HSM.			T		ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.18; RSU Procurement Specification Version 1.7 & 4.4.1.26
401.14.12	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The validation of signed software shall require use of a verification key that is protected by local hardware to a level equivalent to FIPS 140-2 at the level appropriate for the device.			T		ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.20; RSU Procurement Specification Version 1.7 & 4.4.1.27
401.14.13	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	All cryptographic software and firmware for the HSM shall be developed and installed in a form that protects the software and firmware source and executable code from unauthorized disclosure and modification.	I				ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.24; RSU Procurement Specification Version 1.7 & 4.4.1.28
401.14.14	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The HSM operating system shall prevent all operators and executing processes from modifying executing cryptographic processes (i.e., loaded and executing cryptographic program images). In this case, executing processes refer to all non-operating system processes (i.e., operator-initiated), cryptographic or not.				D	ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.32; RSU Procurement Specification Version 1.7 & 4.4.1.29
401.14.15	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The HSM operating system shall prevent operators and executing processes from reading cryptographic software stored within the cryptographic boundary.				D	ASD; PID; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.33; Personal Information Device (PID) Procurement version 1.7A & 4.5.6.34; RSU Procurement Specification Version 1.7 & 4.4.1.30
401.14.16	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The device shall provide tamper evidence to detect tampering of the device (e.g. opening of the case).	I				ASD; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.17.35; RSU Procurement Specification Version 1.7 § 3.4.6.8, 3.4.6.9

401.14.17	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	All unused media ports (e.g. USB) shall be sealed.	I				ASD; PID; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.36; Personal Information Device (PID) Procurement version 1.7A & 4.5.6.37; RSU Procurement Specification Version 1.7 & 3.4.6.10
401.14.18	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	There shall be no removable media.	I				ASD; PID; RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.17.37; Personal Information Device (PID) Procurement version 1.7A & 4.5.6.38; RSU Procurement Specification Version 1.7 & 3.4.6.11
401.14.19	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	The certificate management service shall start requesting a new certificate or batch of pseudonym certificates a day before the expiry of the current certificate or batch.			T		ASD; PID; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.8.5.15, 3.13.19.5; RSU Procurement Specification Version 1.7 & 4.4.1.31
401.14.20	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	When verifying, the device shall require that 1609.2 signed messages are signed by a certificate that is protected from modification by, or chains back to a certificate that is protected from modification by, the secure boot process.			T		ASD; PID; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.22.1; Personal Information Device (PID) Procurement version 1.7A & 4.5.10.1; RSU Procurement Specification Version 1.7 & 4.4.1.32
401.14.21	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	Devices shall implement certificate download per the SCMS Interface (detailed requirements to be derived during Phase 2 as the final interface document is not yet published)			T		ASD; PID; RSU	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	RSU Procurement Specification Version 1.7 & 6.3.1.6; SCMS ICD
401.14.22	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	A device shall not create or transmit messages for any usage scenario if the usage scenario requires it to use 1609.2 certificates and it does not currently have valid certificates for that usage scenario.				D	ASD; RSU	NYC CVPD SAD: equipment control commands, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.8.5.10; RSU Procurement Specification Version 1.7 & 4.4.1.33

401.14.23	3.3.1 Security Management and Operations	Need ID 401: Need to have trusted communications	3.3 System Security	A device shall verify a DSRC message when any of the following conditions is met: A) A device identifies the message as containing a new DE_TemporaryID value. B) The message results in the issuance of issue either advisory, warning, or alert. C) The remote vehicle constitutes a potential threat (define potential threat as a vehicle that may collide with the host vehicle based on the both vehicle's speeds and trajectories) D) The host vehicle constitutes a threat to a pedestrian using a DSRC equipped Personal Information Device. E) Other potential threat situations such as infrastructure size restrictions, speed compliance, red light violations, and other safety applications. F) Other situations as identified during the Phase 2 Design. Note: Verification consists of meeting the IEEE 1609.2 requirements specified herein this document and the associated message's Security Profile (to be provided in Phase 2).				D	RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 & 4.4.1.34
401.15.1	4.2.1 Wide Area Augmentation System (WAAS)	Need ID 401: Need to have trusted communications	4.2 Location Correction	Each DSRC device shall use WAAS corrections per J2945/1 Section 6.2.2.				D	ASD; PID; RSU	NYC CVPD: location and time (See Figure 15 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 4.1.2.1; Personal Information Device (PID) Procurement version 1.7A & 6.2.1.1; RSU Procurement Specification Version 1.7 & 4.2.1.3
401.15.2	4.2.1 Wide Area Augmentation System (WAAS)	Need ID 401: Need to have trusted communications	4.2 Location Correction	Each RSU shall broadcast WAAS corrections per its Store and Repeat configuration.				D	RSU	NYC CVPD: location correction (See Figure 15 in Section 3.2.2)	RSU Procurement Specification Version 1.7 & 6.2.1.1
401.15.3	4.2.2 Triangulation for ASD Location Accuracy	Need ID 401: Need to have trusted communications	4.2 Location Correction	RSUs shall exceed 802.11 ACK requirements in the following manner: Antenna referenced ACK turnaround time must be in (SIFS-12.5, SIFS+12.5) ns 95% for cable tested non-CSD signals. Note that any RSU employing the NXP based SAF5200 will support this by default. The position provided by the WSA shall be provided by the central system based on the 3D surveyed position.				D	RSU	NYC CVPD: location correction (See Figure 15 in Section 3.2.2)	Will be added to RSU Procurement Spec

401.16.1	4.3 Network Time Reference	Need ID 401: Need to have trusted communications		Devices unable to receive timing information per J2945/1 Section 6.2 shall set their time from an authenticated time reference using the Network Time Protocol Version 4 per Internet Engineering Task Force RFC 5905-5908.				D	ASD; PID; RSU	NYC CVPD: location and time (See Figure 15 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 4.1.3.1; Personal Information Device (PID) Procurement version 1.7A & 6.3.1.1
401.17.1	4.1 Global Navigation Satellite System (GNSS)	Need ID 401: Need to have trusted communications		Each DSRC device shall obtain its time and position from the GNSS per the requirements of J2945/1 Section 6.2.				D	ASD; PID; RSU	NYC CVPD: location and time (See Figure 15 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 4.1.1.1; Personal Information Device (PID) Procurement version 1.7A & 6.1.1.1; RSU Procurement Specification Version 1.7 & 6.1.1.1
402.1.1	3.5.3 System Reliability	Need ID 402: Need to manage equipment health	3.5 System Operations	The ASD shall revert to a fail-safe mode as specified in Table F-2 when unable to perform its normal operations.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.17.1.1
402.1.2	3.5.3 System Reliability	Need ID 402: Need to manage equipment health	3.5 System Operations	The RSU shall revert to a fail-safe mode as specified in Table F-2 when unable to perform its normal operations.			T		RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.12.1
402.1.3	3.5.3 System Reliability	Need ID 402: Need to manage equipment health	3.5 System Operations	The ASD shall report a self-diagnosed failure of itself or one of its software modules (1) to an RSU attempting to install new firmware or parameters and (2) to a device connected to the ASD's maintenance port.				D	ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.17.1.2
402.1.4	3.5.3 System Reliability	Need ID 402: Need to manage equipment health	3.5 System Operations	The RSU shall report a self-diagnosed failure through NYCWiN at the TMC.				D	RSU	NYC CVPD SAD: operation and maintenance RSU data (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 & 4.4.12.2
402.2.2	3.1.1.2 Electrical Requirements	Need ID 402: Need to manage equipment health	3.1.1 Construction	The RSU shall be able to resume normal function within 2 minutes of restoration of power.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 & 4.10.1.11
402.3.1	3.5.2 System Maintenability	Need ID 402: Need to manage equipment health	3.5 System Operations	The NYC CVPD performance monitoring subsystem shall measure the RF received range of each ASD.	I				TMC	NYC CVPD SAD: operation and maintenance ASD data (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.1.1

402.3.2	3.5.2 System Maintenability	Need ID 402: Need to manage equipment health	3.5 System Operations	The NYC CVPD performance monitoring subsystem shall measure the RF monitoring range of the RSU.	I				TMC	NYC CVPD SAD: operation and maintenance RSU data (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.3.1
403.1.1	4.4 Security Credential Management System (SCMS)	Need ID 403: Need to manage CV application life-cycle		The device supplier shall sign the firmware images and manage the certificate management process for the firmware images.	I				ASD; RSU	NYC CVPD SAD: device identification, user permission sets (See Figure 17 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.13.3, 3.13.19.4, Appendix K Section 2; RSU Procurement Specification Version 1.7 & 6.3.1.7
403.1.1.1	4.4 Security Credential Management System (SCMS)	Need ID 403: Need to manage CV application life-cycle		The SCMS certificate shall have a lifespan of 3 years instead of weeks.	I				ASD; RSU	NYC CVPD SAD: device identification, user permission sets (See Figure 17 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.13.3; RSU Procurement Specification Version 1.7 & 6.3.1.8
403.1.1.2	4.4 Security Credential Management System (SCMS)	Need ID 403: Need to manage CV application life-cycle		The SCMS signature scheme shall provide at least 128-bit security.	I				ASD; PID; RSU	NYC CVPD SAD: device identification, user permission sets (See Figure 17 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.13.13.3; Personal Information Device (PID) Procurement version 1.7A & 4.5.5.2; RSU Procurement Specification Version 1.7 & 6.3.1.9
403.2.1	3.3.1 Security Management and Operations	Need ID 403: Need to manage CV application life-cycle	3.3 System Security	The ASD shall support a secure session protocol through VPN over TLS to the TMC for protecting the firmware download.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.13.5.1
403.2.2	3.3.1 Security Management and Operations	Need ID 403: Need to manage CV application life-cycle	3.3 System Security	The RSU shall support a secure session protocol through VPN over TLS to the TMC for protecting the firmware download.	I				RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.35
403.3.1	3.3.1 Security Management and Operations	Need ID 403: Need to manage CV application life-cycle	3.3 System Security	The ASD shall partition enough storage space for its current and new firmware images. This is further amplified to ensure that the ASD has sufficient memory to allow the update of all firmware (OS and all applications) and all logs present – such that it can continue to operate properly prior to the changeover to the new version.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification

403.4.1	3.3.1 Security Management and Operations	Need ID 403: Need to manage CV application life-cycle	3.3 System Security	The ASD shall implement a download protocol that permits resumption of incomplete downloads instead of requiring an incomplete download to be restarted.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification
403.4.2	3.3.1 Security Management and Operations	Need ID 403: Need to manage CV application life-cycle	3.3 System Security	The RSU shall implement a download protocol that permits resumption of incomplete downloads instead of requiring an incomplete download to be restarted.			T		RSU	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.1.36
404.1.1	3.5.2 System Maintenability	Need ID 404: Need to manage CV application interrelationship	3.5 System Operations	The ASD shall include a threat arbitrator for advisories and alerts presented to the driver in cases where multiple safety advisories are indicated simultaneously.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.4.4
404.1.2	3.5.2.1 Functional Safety Requirements	Need ID 404: Need to manage CV application interrelationship	3.5.2 System Maintenability	The ASD shall incorporate a prioritization scheme as defined in the current version of J2735 for messages such that safety-enhancing messages will have priority over non-safety-enhancing messages.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.16.1.5
404.2.1	3.5.2.1 Functional Safety Requirements	Need ID 404: Need to manage CV application interrelationship	3.5.2 System Maintenability	The CV applications in the ASD shall run concurrently.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.16.1.6
404.2.2	3.5.2.1 Functional Safety Requirements	Need ID 404: Need to manage CV application interrelationship	3.5.2 System Maintenability	The CV applications shall prioritize alerts based on GPS location accuracy to prevent false and missed alarms from being triggered.			T		ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.16.1.7
404.3.1	3.5.2.1 Functional Safety Requirements	Need ID 404: Need to manage CV application interrelationship	3.5.2 System Maintenability	The ASD shall determine the threat arbitration rules for addressing multiple events occurring nearly simultaneously by the specific vehicle type (light-duty, bus, truck/commercial vehicle).				D	ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.4.5
405.1.1	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall allow recording of the RF signal level for any message received. (For example, clarification: when the ASD hears a BSM from another vehicle, it will measure and record the RF level of the received message.)				D	ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.6

405.1.2	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall record the first BSM it hears from each unique ASD ID along with its own location (X,Y,Z) and RF level information.			T		RSU	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.7
405.1.3	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall record the first MAP message it hears from each RSU ID along with the contents of its own location (X,Y,Z) at the time and the RF level.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.8
405.1.4	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall record the first SPaT message it hears from each RSU along with the contents of its own location (X,Y,Z) at the time and the RF level.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.9
405.1.5	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall record the last MAP message it hears from each RSU along with the contents of its own location (X,Y,Z) at the time and the RF level.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.10
405.1.6	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall record the last SPaT message it hears from each RSU along with the contents of its own location (X,Y,Z) at the time of receipt and the RF level.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.11
405.1.7	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD RF Log Entries shall be stored in the ASD local memory.	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.12
405.1.8	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD RF log entries shall be purged after 7 days.				D	ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.13
405.1.9	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD RF log space shall be sufficient to store 7 days of interactions with 8,000 ASDs and ~353 RSUs, equivalent to about 5,000 entries per day.		A			ASD	NYC CVPD SAD: operation and maintenance ASD data (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.14

405.1.10	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	If the ASD RF log files exceed the space allocated (Req 405.1.9), then the oldest data shall be written over without damaging newer log files. (Note: the ASD Ethernet port will be fully blocked after certification testing.)	I				ASD	NYC CVPD SAD: equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.15
405.1.11	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The following requirements shall apply to the ASD RF data monitoring, uploading, and purging.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.1
405.1.11.1	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall monitor the control channel (178) when the ASD encounters an RSU that supports the RF data upload.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.2
405.1.11.2	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall upload the contents of the RF logs to the back office systems.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.3
405.1.11.3	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall purge the logs after they have been acknowledged by the RSU.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.4
405.1.12	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The ASD shall authenticate all transactions to retrieve the RF logs.			T		ASD	NYC CVPD SAD: operation and maintenance ASD data, equipment configuration settings (See Figure 16 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.15.5.5
405.2.1	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The static RSU shall record the first BSM message it hears from each ASD along with the time and the RF level.			T		RSU	NYC CVPD SAD: operation and maintenance RSU data, equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.11.9
405.2.2	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The static RSU shall record the last BSM message it hears from each ASD along with the ime and the RF level.			T		RSU	NYC CVPD SAD: operation and maintenance RSU data, equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.11.10

405.2.3	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The RSU shall upload the data to the back office system whenever its buffers are full or more than 60 minutes old.			T		RSU	NYC CVPD SAD: operation and maintenance RSU data, equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.11.12
405.2.4	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	Once the RF log data is received and acknowledged by the back office system, it shall be purged from the RSU.			T		RSU	NYC CVPD SAD: operation and maintenance RSU data, equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.11.13
405.2.5	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The RSU shall authenticate all transactions to retrieve its RF logs.			T		RSU	NYC CVPD SAD: operation and maintenance RSU data, equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.11.14
405.2.6	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The RSU shall allow recording of the RF signal level for any message received. (For example, clarification: when the RSU hears a BSM from any vehicle, it shall be able to measure and record the RF level of the received message.)			T		RSU	NYC CVPD SAD: operation and maintenance RSU data, equipment configuration settings (See Figure 16 in Section 3.2.2)	RSU Procurement Specification Version 1.7 § 4.4.11.15
405.2.7	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The mobile RSU shall record the first BSM message it hears from each ASD along with the time and the RF level only when it is stopped.			T		RSU	NYC CVPD SAD: operation and maintenance ASD data, equipment configuration settings (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.2.1
405.2.8	3.5.2 System Maintenability	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)	3.5 System Operations	The mobile RSU shall record the last BSM message it hears from each ASD along with the time and the RF level only when it is stopped.			T		RSU	NYC CVPD SAD: operation and maintenance ASD data, equipment configuration settings (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.2.1
405.3.1	4.11 Advanced Traffic Signal Controllers	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)		Advanced Traffic Signal Controllers shall use TAI time to issue security credentials.			T		TMC	NYC CVPD SAD: time for ASTC (See Figure 15 in Section 3.2.2)	Peek Procurement Specification
405.3.2	4.11 Advanced Traffic Signal Controllers	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)		Advanced Traffic Signal Controllers shall issue messages to DSRC devices with security credentials that meet this document's IEEE 1609.2 requirements.			T		TMC	NYC CVPD SAD: time for ASTC (See Figure 15 in Section 3.2.2)	Peek Procurement Specification

405.3.3	4.11 Advanced Traffic Signal Controllers	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)		Advanced Traffic Signal Controllers shall maintain an authenticated NTP based time reference.			T		TMC	NYC CVPD SAD: time for ASTC (See Figure 15 in Section 3.2.2)	Peek Procurement Specification
405.3.4	4.11 Advanced Traffic Signal Controllers	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)		Advanced Traffic Signal Controllers shall export their UTC times (Line Frequency referenced from the traffic signal system) as UTC times referenced from their authenticated NTP based time reference.			T		TMC	NYC CVPD SAD: time for ASTC (See Figure 15 in Section 3.2.2)	Peek Procurement Specification
405.4.1	4.12 Traffic Signal System	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)		The CV system shall export RSU status to the traffic signal system for display on the traffic signal system map.			T		TMC	NYC CVPD SAD: intersection management application status (See Figure 39 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.3.1.1
405.4.2	4.12 Traffic Signal System	Need ID 405: Need to support automatic diagnostics for the system devices (RSU, ASD)		The CV system shall export RSU RF signal range information to the traffic signal system for display on the traffic signal system map.			T		TMC	NYC CVPD SAD: operation and maintenance RSU data (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.3.1.1
501.2.1	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The ASD shall include a general purpose event recording application.			T		ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.4, 3.11.1.5, 3.11.1.6, 3.11.1.7, 3.11.1.8, 3.11.1.9, 3.11.1.10, 3.11.1.11
501.2.1.1	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The ASD shall include a rotating 5 minute log of the raw data listed in Table G-4.			T		ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.5
501.2.1.2	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	Once the log has accumulated 5 minutes of data, it shall replace the oldest data with new data such that it always keeps the most recent 5 minutes of data to a 100 ms accuracy.			T		ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.6

501.2.1.3	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	Each log entry shall include a UTC time stamp accurate to 10 milliseconds.				D	ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.7
501.2.1.4	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	Each log entry shall include the BSM data for the host vehicle regardless of whether the data has changed.	I				ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.8
501.2.1.5	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	Each log entry shall include the peak accelerometer values since last entry. Clarification: accelerometer entries are added to the log whenever the value changes or at 1 second intervals whichever is shorter but not more rapidly that 10 times per second. Thus, the accelerometer entries show the times at which the value changed with a time stamp but no values are lost to the resolution of 1 second.				D	ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.9
501.2.1.6	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	Each log entry shall include the BSM data for all vehicles that are within a configurable distance (VDIS) from the host vehicle. (Clarification: typical values are expected to be 0-50 meters.)			T		ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.10
501.2.1.7	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	A log entry shall be made for each SPaT and MAP message received from two nearest RSUs.				D	ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.11
501.2.2	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	• 3.2 System Performance Characteristics	• The ASD shall continuously monitor the location of the host vehicle as described in SAE J2945/1.	•	•	•	• D	• ASD	• NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	• ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.12

501.3.1	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The ASD shall collect log entries into an event record to describe vehicle actions surrounding a CV application event.	I				ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.13
501.3.2	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The ASD shall log the information at 100 millisecond interval before and after an event.	I				ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 39 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.14
501.3.3	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The ASD shall log the information 5-300 seconds (configurable by type of event, time period, and resolution) before after each event.				D	ASD	NYC CVPD SAD: vehicle situation data, vehicle location and motion for surveillance (See Figure 39 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.15
501.3.4	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The ASD shall collect less detailed CV probe data for mobility data collection. (See ASD Demonstration Procurement Specification Version 2.2 Appendix L Mobility Data Section b for clarification.)	I				ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2), Figures 40 and 41 in Section 3.4.3	ASD Demonstration Procurement Specification Version 2.2 Appendix L Mobility Data Section b
501.3.5	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The durations shall have the capability of being modified by the CV application that triggers the warning.				D	ASD	NYC CVPD SAD: vehicle situation data parameters (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.20

501.3.6	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The safety applications listed in Table C-1 shall implement the most recent event recording parameters supplied externally to the application based on their own recording criteria in Table E-3.			T		ASD	NYC CVPD SAD: vehicle situation data parameters (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.21
501.4.1	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	A safety application shall record events based on the most recently received recording parameters set.				D	ASD	NYC CVPD SAD: vehicle situation data parameters (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 & 3.11.1.22
501.4.2	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	An application shall trigger an event recording when an alert is triggered.			T		ASD	NYC CVPD SAD: vehicle situation data parameters (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.23
501.4.3	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The event recording application shall collect pre- and post- trigger information using the host application's trigger recording times.	I				ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.24
501.4.4	3.2.3 Event Data Recording	Need ID 501: Need to collect detailed information when a warning is issued	3.2 System Performance Characteristics	The safety applications shall collect trigger information (event recording data) listed in Table G-1.				D	ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 - Appendix J, Table 29
501.4.5	~~3.2.3 Event Data Recording~~	~~Need ID 501: Need to collect detailed information when a warning is issued~~	~~3.2 System Performance Characteristics~~	~~The safety applications shall utilize event recording parameters listed in Table E-3.~~	-	-	-	~~D~~	ASD	~~NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)~~	~~ASD Demonstration Procurement Specification Version 2.2 - Appendix H, Table 24, 25~~
502.1.1	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	When the event recording receives a triggering input, it shall start the creation of an event record.				D	ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.1.23
502.1.2	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	Each event record shall indicate the application and the reason that the alarm was created; (Clarification: each triggering event (alarm) will notify the ASD logging system to initiate the creation of an event record and will provide some application specific (e.g. application ID, value which caused the trigger) information (up to XX bytes indicating the reason for the event); this data shall be included in the "header" for the event record.)			T		ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.2
502.1.2.1	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The event record data shall be included in the "header" for the event record.			T		ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.3

502.1.4	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The before and after times shall be configurable for each different application ID. (Note: different applications may request that the pre and post incident collection times be different from the default.)	I				ASD	NYC CVPD SAD: vehicle situation data parameters (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.4
502.1.5	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The ASD shall accept downloaded parameters to specify the number of seconds to be included in the event record prior to and after the occurrence of the event for each application ID. (Note that the pre-event and post-event collection times may be different values).				D	ASD	NYC CVPD SAD: vehicle situation data parameters (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.5
502.1.6	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The event recording application shall be able to simultaneously create and collect event records for up to 10 concurrent or staggered events. Clarification: as one event is concluded, it makes space for additional events.			T		ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.6
502.1.7	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The ASD shall be able to upload the event records to (through) an RSU when the service is available. (Clarification: this is expected to use IP communications – but is not specified at this time. The RSU's located in the barn and at choke points are intended to accomplish this upload process, although this could also be added to any or all of the RSU's.)				D	ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.7
502.1.9	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	Event records shall be automatically purged whenever the power is applied to the ASD and the time last log entry is more than a configurable number of hours (example: 96 hours). (Clarification: all of the vehicles for the NYC CVPD are fleet vehicles and hence normally return to their "barn" on a daily basis. However, in some cases, if a fleet vehicle is driven "home" and not returned to a location where an RSU can access its logs, the project would like to recover that data when the vehicle returns to the City if possible without compromising privacy.)			T		ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.8
502.1.10	3.2.4 Event Data Collection	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	Log entries shall be inserted in the event log whenever the vehicle engine is running.				D	ASD	NYC CVPD SAD: vehicle situation data (See Figure 38 in Section 3.4.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.11.2.9
502.1.12	3.4 Information Management	Need ID 502: Need to collect event recordings		Event records shall only be decrypted by the central performance analysis software.		A			ASD	NYC CVPD SAD: security credentials (See Figure 18 in Section 3.2.2)	ASD Demonstration Procurement Specification Version 2.2 § 3.14.1.3

502.2.1	3.2.5 Performance Data Collection and Processing	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The RSUs shall collect the selected mobility data in accordance with Appendix I, section I.3.2 in the NYC CVPD RSU Procurement Specification and transmit this data to the TMC for both real time traffic signal timing plan optimization and analysis for new timing plan development.	I				RSU	NYC CVPD SAD: vehicle situation data, traffic situation data (See Figure 38 in Section 3.4.2)	RSU Procurement Specification Version 1.7 § Appendix I, Section I.3.2
502.2.2	3.2.5 Performance Data Collection and Processing	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The RSU shall record the BSM data from the Host Vehicle (HV) in accordance with Appendix I, Section I.3.1, Number 12, in the NYC CVPD RSU Procurement Specification.	I				RSU	NYC CVPD SAD: vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2)	RSU Procurement Specification Version 1.7 & Appendix I, Section I.3.1
502.2.3	3.2.5 Performance Data Collection and Processing	Need ID 502: Need to collect event recordings	3.2 System Performance Characteristics	The BSM data shall be recorded based on distance traveled and time in accordance with Appendix I, Section I.3.1, Number 12, in the NYC CVPD RSU Procurement Specification.	I				RSU	NYC CVPD SAD: vehicle location and motion for surveillance (See Figure 38 in Section 3.4.2)	RSU Procurement Specification Version 1.7 & Appendix I, Section I.3.2
502.2.4	3.2.5 Performance Data Collection and Processing	Need ID 502: Need to collect event recordings Comment: Typically on the order of once per second or every 25 feet - configurable, whichever comes first.	3.2 System Performance Characteristics	The BSM data time and distance parameters shall be configurable in accordance with Appendix I, Section I.3.2 in the NYC CVPD RSU Procurement Specification.	I				RSU	NYC CVPD SAD: vehicle situation data parameters (See Figure 38 in Section 3.4.2)	RSU Procurement Specification Version 1.7 & Appendix I, Section I.3.2, Par 5
503.1.2	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate the change in speed limit adherence, speed variability, and the average segment speed for each vehicle fleet on a given roadway segment for a given time period (cycle length basis) from the Before period to the After period.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.7.1
503.2.8	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate whether the number of curve speed violations on each applicable studied roadway segment decreases from the Before period to the After period.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.2.1

503.3.5	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate whether the number of work zone speed violations on each applicable studied roadway segment decrease from the Before period to the After period and with/without CV.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.8
504.1.1	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall post-process the data surrounding the V2V application events.			T		TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.1.1
504.1.1.1	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the fatality, injury, and property damage only (PDO) crash rates from external crash database sources.			T		TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.1.1
504.1.2	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reportable vehicle-to-vehicle crashes from the Before period to the Pilot period.			T		TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.1.1
504.2.6	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of bus / right-turn vehicle crashes from the Before period to the Pilot period.	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.10
504.3.5	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate the change in the number and severity of red light violations at each studied intersection from the Before period and the Pilot period.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.6
505.1.6	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reported vehicle-to-pedestrian crashes from the Before period to the Pilot period.	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.5
505.2.2	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reported crashes involving visually-impaired pedestrians from the Before period to the Pilot period.	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.5.1; Personal Information Device (PID) Procurement Specification version 1.7A § 5.3.1.3

506.1.2	3.2.5 Performance Data Collection and Processing	Need ID 506: Need to assess vehicle-infrastructure crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall evaluate the change in the number of reported crashes decrease from the Before period to the Pilot period.	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.4.1
510.1.1	3.2.4 Event Data Collection	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall count the number of events after the events of applications listed in Table C-1 in the Before and After periods.			T		TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2), Figure 40 in Section 3.4.3	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.4.1
503.1.1.2	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average number of stops.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.7.1
503.1.1.3	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average speeds of the vehicles.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.7.1
503.1.1.4	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the reduction in speed limit violations Before and After periods.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.7.1
503.1.1.5	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the speed variations of the vehicles.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.7.1
503.1.1.6	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the driver actions in response to warnings and vehicle trajectories.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.7.1
503.2.7.1	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	503.2.7.1: The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the crash counts and rates of speed-related crashes from police crash databases.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.2.1
503.2.7.2	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	503.2.7.2: The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the lateral collision.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.2.1

503.2.7.3	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	503.2.7.3: The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the vehicle speeds at curve entry from the Host Vehicle BSM in the event records.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.2.1
503.2.7.4	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the number of warnings generated Before and After period.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.2.1
503.3.4.1	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the average speed of triggered events at work zone compared to posted speeds.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.8
503.3.4.2	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the vehicle speed limit violations in variable speed zone areas Before and/or After periods or with/without CV.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.8
503.3.4.3	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the data from the crash databases and measure the work zone related crash counts and rates in reduced speed zones.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.8
503.3.4.4	3.2.5 Performance Data Collection and Processing	Need ID 503: Need to assess speed compliance	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure time to collision for instantaneous safety in reduced speed zones.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.8
504.2.5.1	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the bus / right-turn related crash counts and rates.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.10
504.2.5.2	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure right-turn related conflicts between a bus and another vehicle.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.10
504.3.4.1	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the red light violation counts and rates.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.6

504.3.4.2	3.2.5 Performance Data Collection and Processing	Need ID 504: Need to assess vehicle-vehicle crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the crash counts and rates related to red light violation.				D	TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.6
505.1.5.1	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the pedestrian related crash counts and rates.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.5
505.1.5.2	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure pedestrian-related conflicts/hard braking events.	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.5
505.2.1.1	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the number of pedestrian crossing violation reductions.	I				TMC; PID		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.5.1; Personal Information Device (PID) Procurement Specification version 1.7A § Section 5.3
505.2.1.2	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the visually-impaired pedestrian-related crash counts and rates.	I				TMC; PID		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.5.1; Personal Information Device (PID) Procurement Specification version 1.7A § Section 5.3
505.2.1.3	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the conflicts with visually-impaired pedestrians.	I				TMC; PID		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.5.1; Personal Information Device (PID) Procurement Specification version 1.7A § Section 5.3

505.2.1.4	3.2.5 Performance Data Collection and Processing	Need ID 505: Need to assess vehicle-pedestrian crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the wait time for crossing at the intersections.	I				TMC; PID		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.5.1; Personal Information Device (PID) Procurement Specification version 1.7A § Section 5.3
506.1.1.1	3.2.5 Performance Data Collection and Processing	Need ID 506: Need to assess vehicle-infrastructure crashes	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed event data and measure the reduction in truck route violations Before and After period.			T		TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.4.1
510.2.1	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall normalize, obfuscate, aggregate, and analyze the performance measurement data specified in the Task 5 Performance Measurement Plan.				D	TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2), Figure 40 in Section 3.4.3	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.6.1.2
510.5.1	4.8 National Weather Service	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall collect hourly weather data observations from the following National Weather Service (NWS) stations in NYC: o Central Park (KNYC) o Kennedy International Airport (KJFK) o LaGuardia Airport (KLGA)	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2), Figure 40 in Section 3.4.3	SDD ¶ 3.1.3.1 National Weather Service
510.5.1.1	4.8 National Weather Service	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall obtain the weather data listed in Table G-2.	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2), Figure 40 in Section 3.4.3	SDD ¶ 3.1.3.1 National Weather Service
510.5.2	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall utilize the post-processed data and transmit it to the RDE.	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.6.1.1; NYC CVPD ICD: Performance Monitor <-> RDE interface
510.6.1	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall collect and post-process the volume counts from temporary automatic traffic recording (ATR) machines.	I				TMC	NYC CVPD SAD: volume counts (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.11
510.7.1	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall compare and post-process the travel time from MiM RFID tag readers.	I				TMC	NYC CVPD SAD: travel time records (See Figure 39 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.11

510.7.3	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall collect and post-process the travel time from MTA bus GPS datasets.	I				TMC	NYC CVPD SAD: MTA bus GPS travel time data (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.11
510.8.1	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall generate system performance reports on the number of active, inactive, and offline ASDs and RSUs in the field by time of day.	I				TMC	NYC CVPD SAD: system monitoring, equipment status (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.1.1 & § 3.1.2.3.1.1
510.8.2	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall generate system performance reports on the number of CV applications in operation and warnings produced by time of day.	I				TMC	NYC CVPD SAD: system monitoring, equipment status (See Figure 16 in Section 3.2.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.1.1
510.8.3	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall generate system performance reports on the network-wide system safety and mobility measurements. (Note: the reports shall include the crash frequencies and average speeds by peak period.)	I				TMC		Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.5.1.1
510.9.1	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The NYC CVPD performance monitoring subsystem shall provide obfuscated datasets without PII to the USDOT Independent Evaluator for additional evaluation.	I				TMC	NYC CVPD SAD: See Figure 41 ASD Context Diagram in Section 3.4.3.3	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.6.1.1; NYC CVPD ICD § Performance Monitor <-> TTI (USDOT IE) interface
510.10.1	3.5.1 System Human Factors	Need ID 510: Need to assess all CV applications	3.5 System Operations	The ASD shall have the ability to operate in either silent mode or active mode.				D	ASD	NYC CVPD SAD: See Figure 41 ASD Context Diagram in Section 3.4.3.3	ASD Demonstration Procurement Specification Version 2.2 § 3.7.1.1
510.10.1.1	3.5.1 System Human Factors	Need ID 510: Need to assess all CV applications	3.5 System Operations	The ASD shall record events* without audibly notifying the driver when operating in silent mode.				D	ASD	NYC CVPD SAD: See Figure 41 ASD Context Diagram in Section 3.4.3.3	ASD Demonstration Procurement Specification Version 2.2 § 3.7.4.1
510.10.1.2	3.5.1 System Human Factors	Need ID 510: Need to assess all CV applications	3.5 System Operations	The ASD shall record events* while audibly notifying the driver when operating in active mode.				D	ASD	NYC CVPD SAD: See Figure 41 ASD Context Diagram in Section 3.4.3.3	ASD Demonstration Procurement Specification Version 2.2 § 3.7.4.2
510.10.1.3	3.5.1 System Human Factors	Need ID 510: Need to assess all CV applications	3.5 System Operations	The ASD shall set the application mode to silent mode or active mode per the most recent parameters downloaded.				D	ASD	NYC CVPD SAD: See Figure 41 ASD Context Diagram in Section 3.4.3.3	ASD Demonstration Procurement Specification Version 2.2 § 3.7.4.3
510.10.2	3.2.2 IE Performance Monitoring	Need ID 510: Need to assess all CV applications	3.2 System Performance Characteristics	The ASD shall have the capability of operating in active mode and recording normal driver behaviors and reactions while notifying the user of the perceived warnings.	I				ASD	NYC CVPD SAD: See Figure 41 ASD Context Diagram in Section 3.4.3.3	ASD Demonstration Procurement Specification Version 2.2 § 3.7.4.2

510.11.1	4.7 Research Data Exchange (RDE)	Need ID 510: Need to assess all CV applications		The interface for transferring performance measurement information to the USDOT Research Data Exchange (RDE) shall be negotiated by the NYC CVPD project team and the USDOT RDE operators during the detailed design of the system in Phase 2.	I				TMC	NYC CVPD SAD: obfuscated data sets (See Figure 37 in Section 3.4.2)	Connected Vehicle Pilot Deployment Program Phase 2, System Design - New York City § 3.1.2.6.1.1

7 As Built Addendum

This section highlights changes made to the overall SDD due to the final deployment and the schedule of activity. Elements within this section supersede portions of the document not altered to reflect the details of the changes.

a. Originally, the PID was to receive the SPaT and MAP information over a DSRC or local short-range communications media. While a number of vendors had indicated that they could supply smartphones with DSRC capability, such devices were no longer available when the project team attempted to pursue them. Therefore, an alternate approach had to be used where the traffic controller (ASTC) sends the SPaT information to the TMC on a change driven basis and the MAP database is maintained at the TMC. The MAP data and the SPaT data are then transmitted to an Amazon Web Service (AWS) cloud server, where it is processed and distributed using cellular service instead of DSRC to the smartphones for use with the PID application. This same data flow (2A) shown in Figure 2 is now provided from the AWS cloud using a cellular service rather than directly to the PID using DSRC. Also in this new PID design, the PID will not be enrolled with the SCMS as initially discussed.

b. The PID application to assist the visually impaired pedestrian at CV equipped intersections has changed significantly. The SPaT information is received from the ASTC, and the MAP information stored at the TMC and sent to the AWS cloud where the SmartCross pedestrian application processes the data and transmits it to the PID via cellular service. This data is then collected and exported to the NYU data collection system for analysis and evaluation. Instead of distributing PIDs to the user community for testing/trials and evaluation, only 10 prototypes will be used with a select number of participants who will test/trial the PID application in a protected and assisted environment. Evaluation of the preliminary results indicated that the application is not robust enough to be distributed for use without supervision even in a protected environment. The detailed design has been provided in a separate document.

c. Note that the communications between the TMC and the RSU uses 2 different protocols: SNMPv3 for management of the MIB objects supported by the RSU, and XFER a proprietary protocol developed by the RSU vendor for uploading and downloading files used for data collection, and RSU configuration. It should be noted that NTCIP 1218 had not been developed at the time of this project, and it was necessary to utilize the vendor's protocol to support these exchanges. The vendor has made this protocol readily and publicly available without restriction for use with their RSUs.

d. While there is some discussion of the use of UPS participation and the participation of the Taxi fleets/owners, both of these did not become active participants in the project, The fleet is primarily composed of various City fleets including DCAS, Parks, DOT, Department of Corrections (DOC), Department of Environmental Protection (DEP), Department of Health Services (DHS), and other service fleets operated by NYC. The City fleets are generally equipped with Geotab devices which monitors their general usage; this data has been available to the CVPD project to determine the general routes and locations frequented by the City fleets participating in the CVPD project. This data will be used to evaluate the accuracy of the data collected and to assist the project in monitoring the health of the CV equipped vehicles.

e. The HSM is a rack-mountable appliance installed at the TMC to expand TMC operations with direct-to-vehicle messaging over latest V2X network technology. Traveler Information, MAP, and other infrastructure messages are inspected and digitally signed to prevent hacking so TMC messages can be trusted. The HSM authenticates incoming messages and signs certificates for outgoing messages to and from the TMC. The HSM inspects and formats TMC messages for acceptance by V2X networked devices. Installed RSUs and ASDs do not require any additional components. In addition to the NYCDOT TMC back-office management functions, the HSM has been critical for maintaining the security of the data being transmitted. Also known as the TMC Authority, provides complete support for IEEE 1609.2 algorithms and protocols including SAE J2735, and J2945/x. It also provides FIPS 140-2 Level 3 protection for V2X signing keys. The TMC Authority checks and digitally signs traffic management center messages for instant verification and acceptance, compliant with IEEE 1609.2 standards and cryptography. Data is secured inside and out with FIPS 140-2 Level 3 protection of keys and TLS v1.2 tunnels to TMC servers. High availability network failover is standard, including redundant power supplies and storage; the TMC Authority maintains trusted reliable operation, even in untrusted environments.
f. Achieving location augmentation has been critical especially in the urban canyon parts of the NYC CV Pilot area. To improve location accuracy for the DSRC devices in the NYC CV project, using the DSRC Radio Technical Commission for Maritime (RTCM) was considered first. As defined in SAE J2735, the RTCM messages would be transmitted along with the other DSRC messages over channel 172. However, the V2XLocate technology was chosen instead after multiple tests and demonstrations in the Manhattan grid section of the NYC CV pilot area.

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

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