City of Columbus

Solicitation Number: RFQ011270

Request for Proposals for
Connected Vehicle Environment In-Vehicle System Integration

Smart Columbus

Capital Improvements Project No: 530163-100030

Version Dated: January 29, 2019

Response Due Date and Time:

Tuesday, February 26, 2019

1:00 P.M., Eastern Time

Submit Electronic Proposal Package to:

https://columbus.bonfirehub.com/projects/

PROPOSAL SIGNATURE FORM

This page, signed by an officer of the offering firm or a designated agent empowered to bind that entity in a contract with Smart Columbus, should accompany each proposal submitted for consideration.

I, the undersigned, having carefully examined the Request for Proposals (RFP), propose to furnish services in accordance therewith as set forth in the attached proposal.

I hereby certify that, to the best of my knowledge, this submission is complete and all statements made therein are true and accurate.

I also affirm I am duly authorized to sign and submit this response on behalf of the Offeror named below.

I further acknowledge that by signing this form I am representing that, in the event this proposal is accepted, the Offeror is willing and able to execute a contract in the form shown in the RFP, with the understanding that the scope and compensation provisions will be negotiated and included in the final contract.

By my signature below, I attest that I have read, understand and agree to the terms, conditions and requirements set forth in the RFP, including, but not limited to: Smart Columbus' standard contract terms and conditions and any special terms and conditions incorporated in the solicitation documents.

Failure to sign and return this form may result in the rejection of the accompanying proposal.

OFFEROR INFORMATION:

OFFEROR (Company Name):

_____

ADDRESS:

_____

CITY, STATE, ZIP:

_____

PHONE: _____ EMAIL: _____

AUTHORIZATION TO PROPOSE:

_____ _____

Signature (Manually signed in ink) Date

_____ _____

Printed Name Title

CERTIFICATIONS AND REPRESENTATIONS

(GRANT FUNDS)

BYRD ANTI-LOBBYING AMENDMENT COMPLIANCE AND CERTIFICATION

For all orders above the limit prescribed in 2 CFR 215, Appendix A, Section 7 (currently $100,000), the Offeror must complete and sign the following:

The following certification and disclosure regarding payments to influence certain federal transactions are made per the provisions contained in OMB Circular A-110 and 31 U.S.C. 1352, the “Byrd Anti-Lobbying Amendment.”

The Offeror, by signing its offer, hereby certifies to the best of his or her knowledge and belief that:

No Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment or modification of any Federal contract, grant, loan, or cooperative agreement;

If any funds other than Federal appropriated funds (including profit or fee received under a covered Federal transaction) have been paid, or will be paid, to any person for influencing or attempting to influence an officer of employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress on his or her behalf in connection with this solicitation, the Offeror shall complete and submit, with its offer, OMB standard form LLL, Disclosure of Lobbying Activities, to the Contracting Officer; and

He or she will include the language of this certification in all subcontract awards at any tier and require that all recipients of subcontract awards in excess of $100,000 shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance is placed when this transaction was made or entered into. Submission of this certification and disclosure is a prerequisite for making or entering into this contract imposed by section 1352, title 31, United States Code. Any person making an expenditure prohibited under this provision or who fails to file or amend the disclosure form to be filed or amended by this provision, shall be subject to a civil penalty of not less than $10,000, and not more than $100,000, for each such failure.

SIGNATURE: _____

COMPANY NAME: _____

DATE: _____

TERMS AND CONDITIONS FOR OFFEROR

INFORMATION FOR OFFEROR

SUBMISSION OF PROPOSAL

Proposals must be submitted according to this proposal form.

ACCEPTANCE AND REJECTION

This proposal submitted by the Offeror to the City of Columbus will be accepted or rejected within a period of 180 days from proposal due date. The City reserves the right to waive technicalities, and to request new proposals (rebid) on the required material. Each invitation for Bids, Request for Statements of Qualifications, and Request for Proposals issued by the City shall state that the Bid or Request may be cancelled and that any bid or proposal may be rejected in whole or in part when it is for good cause and in the best interests of the City.

WITHDRAWAL OF PROPOSALS

Offerors may withdraw their proposals at any time prior to the time specified in the advertisement as the closing time for the receipt of proposals. However, no Offeror shall withdraw or cancel his/her proposal for a period of 180 calendar days after said advertised closing time for the receipt of proposals.

APPLICABLE LAWS

The Revised Code of the State of Ohio, the Charter of the City of Columbus, and all City ordinances insofar as they apply to the laws of competitive bidding, contracts, and purchases, are made a part hereof.

CONTRACT

The Offeror to whom an award is made will be required to execute a written contract with the City of Columbus, Ohio within forty-five days after receiving such contract for execution.

LIABILITY, INSURANCE, LICENSES AND PERMITS

Where Offerors are required to enter or go onto City of Columbus property to deliver materials or perform work or services as a result of bid award, the Offeror will assume full duty, obligation and expense of obtaining all necessary licenses, permits, and insurance when required. The Offeror shall be liable for any damages or loss to the City and its partners occasioned by negligence of the Offeror (or his or her agent) or any person the Offeror has designated in the completion of this contract as a result of his bid. Particular attention is directed to the statutory requirements of the State of Ohio relative to the licensing of corporation organized under the Laws of any other State.

TAXES

Federal and/or State Taxes are not to be included in prices quoted. The successful Offeror will be furnished an exemption certificate if needed.

CHANGES AND ADDENDA TO PROPOSAL DOCUMENTS

Questions as to the interpretation of the Request for Proposal shall be submitted in writing to the Office of Support Services at SmartColumbusRFP@columbus.gov. In order to receive consideration, questions must be received by the question cut-off date as indicated in the advertisement. Any interpretations of questions so raised, which in the opinion of the City or its representative require interpretations, will be issued by addenda posted on the City's Consultant Services web site. The City or its representative will not be bound by any oral interpretations which are not reduced to writing and included in the addenda.

CAMPAIGN CONTRIBUTIONS

Offeror hereby certifies the following: that it is familiar with Ohio Revised Code ("O.R.C.") Section 3517.13; that it is in compliance with Divisions (I) and (J) of that Section; that it is eligible for this contract under the law and will remain in compliance with O.R.C. Section 3517.13 for the duration of this contract and for one year thereafter.

IN THE EVENT OF A CONTRACT

An agreement which may result from this proposal shall not be modified or altered by any subsequent course of performance between parties or by additional terms contained in any subsequent documents unless said additional or differing terms are incorporated by contract modification authorized to be entered into by ordinance.

REMEDIES

All claims, counterclaims, disputes and other matters in question between the City, its agents and employees, and the Offeror arising out of or relating to this agreement or its breach will be decided in a court of competent jurisdiction within the County of Franklin,

State of Ohio. Terms and conditions, submitted with this proposal, which are contrary to City Code or Charter shall be disregarded for the purpose of any subsequent contract. The successful Offeror shall be notified as to which terms and conditions, if any, have been deleted.

CONTRACT COMPLIANCE

The City of Columbus encourages the participation of City certified minority and female business enterprises*.

All Offerors shall identify all subconsultant(s) who will perform any type of contracting on this proposal(s). All Offerors shall include in their proposal response the anticipated scope of work and percentage of work that will be performed by all Sub-Consultant(s), along with their contract compliance number(s).

All Offerors, including subconsultants, who are party to a contract as defined in Columbus City Code 3901.01, must hold valid contract compliance certification numbers.

This information is gathered and monitored by the Office of Diversity and Inclusion. Please contact ODI for assistance with identifying potential minority consultants. Go to Vendor Services to verify that vendors have an active contract compliance number.

http://vendorservices.columbus.gov/

Office of Diversity and Inclusion
1393 E. Broad Street, 2nd Floor
Columbus, Ohio 43205
(614) 645-4764

M/FBE Certification/Contract Compliance
Tia Roseboro 614-645-2203

ADDITIONAL CONTRACT TERMS AND REQUIRED DOCUMENTS IN THE EVENT OF A CONTRACT

This section sets forth contract terms and the required contract documents that the successful Offeror must execute following the award of the contract by the contracting authority.

SAVE HARMLESS

The Offeror shall protect, indemnify and save the City and its partners harmless from and against any damage, cost, or liability, including reasonable attorneys' fees resulting from claim, by third parties for any or all injuries to persons or damage to property arising from the intentional, willful, or negligent acts or omissions of the Offeror, its officers, employees, agents, or Subconsultants in providing goods or services under the terms and conditions of this contract.

SAVE HARMLESS DISCLOSURE OF PROPRIETARY INFORMATION

The Offeror agrees to indemnify and hold harmless the City of Columbus, Ohio and its partners and their respective officials, employees and other agents and representatives, against loss, claim, liability in tort or by statute imposed, charge, cost or expense, including without limitation, attorneys' fees to the extent permitted; by law, which may be incurred in connection with, or in any manner of any damage or loss arising from disclosure of proprietary information.

CONFIDENTIAL INFORMATION

The director of the agency requesting proposals may choose to keep RFP information in confidence during the evaluation process and until the time a contract is executed. This information may include all proposal documentation, notes, including detailed prices, references, resumes, technical and cost information, etc. Thereafter, proposals and all submissions will become public information, as the City is subject to R.C. 149.43, the Public Records Act.

OFFEROR'S PROPRIETARY INFORMATION

The Consultant acknowledges that the City is subject to chapter R.C.149.43, the State of Ohio Public Records Law. The City agrees to keep any information confidential except as otherwise required to be disclosed by law including but not limited to the contract.

INDEPENDENT CONSULTANT STATUS

The Offeror shall perform its duties as an independent consultant and not as an employee. Neither the Offeror nor any agent or employee of the Offeror shall be or shall be deemed to be an agent or employee of the City of Columbus or its partners. The Offeror shall pay when due all required employment taxes and income tax on any monies paid pursuant to the contract. The Offeror shall acknowledge that the Offeror and its employees are not entitled to unemployment insurance benefits unless the Offeror or a third party provides such coverage and that the City does not apply for or otherwise provide such coverage. The Offeror shall have no authorization, express or implied, to bind the City or its partners to any agreements, liability, or understanding except as expressly set forth in the contract. The Offeror shall provide and keep in force worker's compensation (and show proof of such insurance) and unemployment compensation insurance in the amounts required by law, and shall be solely responsible for the acts of the Offeror, its employees and agents.

PROTECTION OF CITY'S AND ITS PARTNERS' CONFIDENTIAL INFORMATION

The Offeror shall acknowledge that some of the material and information which may come into its possession or knowledge in connection with the contract or its performance, may consist of confidential information, the disclosure of which to, or use by, third parties could be damaging. Therefore, access to information concerning individual recipients of the City's and its partners' services to individual clients, among other items, shall not be granted except as authorized by law or agency rule. The Offeror shall agree to hold all such information in strictest confidence, not to make use thereof for other than the performance of the contract, to release it only to authorized employees or subconsultants requiring such information, and not to release or disclose it to any other party. The Offeror shall agree to release such information or material only to subconsultants who have signed a written agreement expressly prohibiting disclosure. The Offeror shall further agree to either destroy or return all such information at the end of the term of the contract.

This section does not impose any obligation on the Offeror if the information is: (1) publicly known at the time of disclosure; (2) already known to the receiving party at the time it is furnished to the Offeror; (3) furnished by the City or its partners to others without restrictions on its use or disclosure; or (4) independently developed by the receiving party without use of the proprietary information.

CONTRACT PROVISIONS FOR NON-FEDERAL ENTITY CONTRACTS UNDER FEDERAL AWARDS

In addition to other provisions required by the Federal agency or non-Federal entity, all contracts made by the non-Federal entity under the Federal award must contain provisions covering the following, as stated in 2 CFR 200 Appendix II:

(G) Clean Air Act (42 U.S.C. 7401-7671q.) and the Federal Water Pollution Control Act (33 U.S.C. 1251-1387), as amended–Contracts and subgrants of amounts in excess of $150,000 must contain a provision that requires the non-Federal award to agree to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401-7671q) and the Federal Water Pollution Control Act as amended Act (33 U.S.C. 1251-1387). Violations must be reported to the Federal awarding agency and the Regional Office of the Environmental Protection Agency (EPA).

(H) Mandatory standards and policies relating to energy efficiency which are contained in the state energy conservation plan issued in compliance with the Energy Policy and Conservation Act (42 U.S.C. 6201).

(J) Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)–Contractors that apply or bid for an award of $100,000 or more must file the required certification. Each tier certifies to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier must also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the non-Federal award.

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1 Project Information

1.1 Project Name

Smart Columbus – Connected Vehicle Environment In-Vehicle System Integration

Capital Improvement Project No: 530163-100030

1.2 Background

In June 2016, the City of Columbus, Ohio won the United States Department of Transportation (USDOT) Smart City Challenge. Columbus intends to define what it means to be a "Smart City" and serve as a model for other cities wishing to fully integrate innovative technologies, such as automated and connected vehicles into the transportation network. Columbus is acting as a laboratory for Intelligent Transportation Systems (ITS), and it is disseminating lessons learned and best practices to cities across the United States in an effort known as Smart Columbus. The goal of the Smart Columbus project is to connect people by creating opportunity for city residents to better access jobs and services while improving the overall safety and efficiency of the transportation network.

The Connected Vehicle Environment (CVE) project is one of multiple transportation-related projects in the Smart Columbus program. The CVE is expected to enhance safety and mobility for vehicle operators and improve pedestrian safety in school zones by deploying CV infrastructure on the roadside and CV equipment in vehicles. The CVE will also provide sources of high-quality data for traffic management and safety purposes.

The CVE project will integrate connected vehicles into the City's transportation environment by focusing on conducting two primary activities: installing technology, both in-vehicle and infrastructure to enable the environment; and developing and deploying the CV applications that enable the enhanced safety and mobility features Smart Columbus desires.

The technology and communications element of project entails building out the physical and logical CV ecosystem, which will consist of CV hardware and software (e.g. roadside units (RSUs), on-board equipment, front and backhaul communications, equipment interfaces, etc.). The CVE will generate the needed transportation-related data that are used by applications.

Building on the foundational CV elements, the project also entails deploying CV-specific applications that will leverage the data generated by the infrastructure to deliver real-time safety and mobility services to enabled vehicles. Further, CV data generated within the ecosystem will be sent to the Smart Columbus Operating System, Smart Columbus' data warehouse and exchange, and made available for use in performance measurement, evaluation and other Smart Columbus project applications.

Finally, beyond the technology components of CVE, workforce development is a priority of the Smart Columbus program management office and must be incorporated into this project. The workforce development component of this project should incorporate job training/skill development, employment opportunities and the engagement of local businesses. More specifically, the City of Columbus desires to leverage this project to help our businesses and employees learn new skills that will be vital to the jobs of the future. Specific engagement could include: training of local workers to install in-vehicle equipment, device configuration activities, or O&M responsibilities.

The CVE deployment will occur along four major corridors/areas as shown in **Figure 3**. The deployment of in-vehicle devices will target populations and vehicles that are located near or frequently use the infrastructure deployment corridors. The suite of applications that are envisioned are identified in ***Figure 2. CV Applications Summary***. Collectively, these applications, deployed on vehicles traveling in and near these equipped corridors is the heart of the CVE. When complete, the entire scope envisioned from the CVE include:

Infrastructure		Applications and Data	
100+ RSUs The project will install RSUs and necessary communications equipment at ~90 signalized intersections in the project areas.	**1,500 - 1,800 OBUs** The project will install onboard units (OBUs) on participating private, fleet, emergency, transit, and freight vehicles.	**CV Applications** The project will deploy vehicle-to-vehicle (V2V) safety, vehicle-to-infrastructure (V2I) safety, and V2I mobility applications.	**Data Capture** The project will capture, relate, store, and respond to data generated by the infrastructure, used by the applications for traffic management.

The *Concept of Operations for the Connected Vehicle Environment for the Smart Columbus Demonstration Program,* reference as part of Appendix A, and published in August 2018, provides greater detail on the background, needs, goals, and vision for the CVE. NOTE: Refinements to the specific deployment locations, vehicle quantities and types, and desired CV applications have occurred since the ConOps was published. Information provided in this RFP supersedes the ConOps.

The *System Requirements for Connected Vehicle Environment for the Smart Columbus Demonstration Program*, published November 2018, details the functional, physical, performance, and other requirements associated with the CVE. A reference to this document in included in Appendix B. The latest set of detailed requirements, organized by functional groups, is included for reference in Appendix C. Further, a Microsoft Excel file containing these same requirements in available on the City's Bonfire site (see section 0). Offeror will be expected to complete the Offeror response field for each requirement in the provided Excel file and include as part of their proposal.

With the initial systems engineering phase now complete, Smart Columbus has embarked upon the next phases of the project, to design and deploy the CVE. The first step in this process is the procurement of the vehicle and roadside equipment, and associated applications. The CVE project will continue to be managed by the Smart Columbus Program Office and the CVE Project Manager, however the successful realization of this phase will require the coordination and cooperation of additional parties, both public and private including the in-vehicle equipment vendor, and the infrastructure integrator. Together, these parties will be instrumental in equipping, operating and maintaining the vehicle and infrastructure elements associated with this project. Design and development activities are also expected to be a part of the upcoming phase.

Figure 1. CVE Project Relationships articulates all of the various parties that the offeror will work with to deliver the final CVE project. Details of the requirements and scope of the offeror follow.

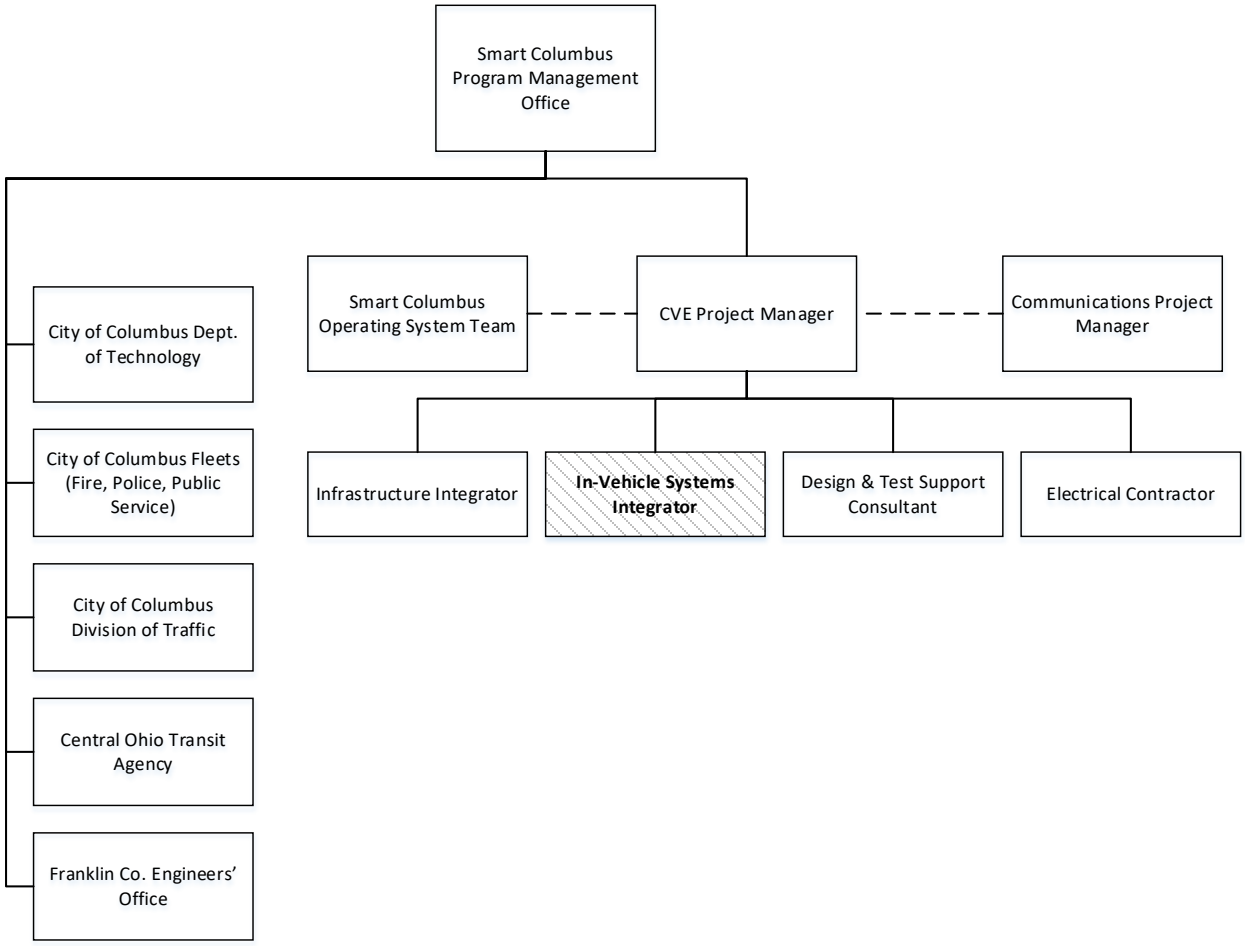

Figure 1. CVE Project Relationships

1.3 Connected Vehicle Environment Deployment Scope

Smart Columbus intends to utilize the professional services and capabilities of multiple entities to accomplish the task of deploying the necessary hardware, communications, and software components associated with the Connected Vehicle Environment (CVE). The CVE Project Manager, as supported by the Design and Test Support Consultant, hereafter known as the Management Team, will serve as the overarching project manager and technical lead, responsible for the coordination of all parties and ensuring that each meet their obligations according to their respective scope, schedule and budget. Additionally, the Management Team will serve to oversee system testing and acceptance and ensure that system failures or defects are properly attributed to the responsible party for remedy.

Further supporting the CVE PM will be a systems integrator responsible for infrastructure elements, and a separate systems integrator who will be responsible to integrate the in-vehicle components. Smart Columbus has also made the decision to secure the services of a local electrical contractor familiar with the Columbus network to perform all of physical network buildout as well as the installation of roadside units and supporting hardware. The selected system integrators will be expected to work closely with the each other, their respective equipment vendors (if different that the offeror), and the Management Team to ensure a successful deployment of the CVE. Further, the CVE PM will serve as a conduit between the Offeror and other interested and vested parties within the Smart Columbus program, to include the Smart Columbus program office, the Smart Columbus Operating System team, the Smart Columbus Communications team, other City departments and divisions (i.e. Traffic Management , Operations, Public

Safety , and Fleet), Smart Columbus partners (i.e. Central Ohio Transit Agency (COTA), Franklin County, DriveOhio/Ohio Department of Transportation), and other Smart Columbus projects. Each of these entities offer either inputs into the CVE, desire data from the CVE or some combination of both.

This RFP outlines the scope and requirements for the in-vehicle integrator role, which includes both on-board equipment and installation. Since the outcomes of both integration activities are tightly coupled, it is imperative that the offeror understand the scope and requirements of the infrastructure integrator as well. Further, while Smart Columbus intends to award two separate integrator contracts, one for the infrastructure and one for the in-vehicle integrators, an offeror is not precluded from submitting for both roles.

1.4 In-Vehicle Systems Integrator

As previously indicated, Smart Columbus intends to select and enter into contract with a system integrator / integrator team that shall be responsible for the identification and procurement, development, configuration, installation, test, maintenance, and in the case of private vehicles, possible removal, of the in-vehicle components that comprise the CVE. Removal of equipment from fleet vehicles, unless it is the case of malfunctioning equipment, is not part of the scope. In all cases, the goal is for the equipment to remain after the demonstration period is complete.

The scope of the work for the in-vehicle system integrator will also include development of any software components necessary to fulfill the OBU functions identified by the CVE System Requirements, including, but not limited to, software development activities necessary to provide the safety and mobility applications identified in Section 0 and as documented in the CVE Concept of Operations (Appendix A) and System Requirements (Appendix C), connecting to and implementing the statewide security credential management system that DriveOhio is deploying (see 1.1.1.3 below), and enabling over-the-air updates and data logging solutions, all of which are detailed in subsequent sections of this RFP.

1.4.1 OBU Source

Smart Columbus recognizes that not all onboard equipment may be suitable for all of the installation configurations that the project has identified (See Table 1), and that the quantity of devices required may be beyond the capability of a single vendor. As such, Smart Columbus encourages offerors to consider hardware sourced by more than one OBU provider with the provision that the approach to over-the-air updates, certificate management, or any other similar interaction with the RSU, necessitate a common, single approach to these interactions across all platforms/vendors and in coordination with the RSU provider. Offerors who propose OBUs from a single vendor will not be penalized as part of the evaluation criteria, however, evidence of successful interoperability testing must be provided. Smart Columbus seeks to demonstrate interoperability among all CV equipment deployed as part of this project, and is following DriveOhio's policy for this testing, which is as follows:

> **Interoperability Testing**
>
> All connected vehicle equipment, i.e. RSUs, OBUs, etc., shall pass any interoperability tests that DriveOhio may have developed to ensure that any hardware follows the SAE published standards. Initially, it is expected that initial testing will only include validation that SAE J2735, J2945/0, and J2945/1, including RF signal quality, are being followed. In the future, as further SAE J2945 standards are published, it is expected that any equipment manufacturers operating within the state validate against those published standards to ensure interoperability throughout the state. This testing will eventually be utilized for individual application use cases. The CVE Integrator will assist the DriveOhio partners by providing all documentation for deployed applications, including, but not limited to, message format, Frequency and channel, notification methods (haptic, visual symbols, audible sounds, etc.), and all data fields needed for the correct implementation/operation of the application.

1.4.2 Human Machine Interface

The detailed requirements (Appendix C) identifies many of the details of the OBU and HMI, but Smart Columbus recognizes that the technology continues to evolve and improve and that participant acceptance may be dependent on variables such as the form factor of the HMI. The choice of HMI is dependent on several factors including the cost, convenience of installation, long-term operations and ability to deliver unambiguous alerts and warnings to the participant compatible with the proposed CV applications. As such, a specific design has not been prescribed in the requirements, but instead, the Offeror is requested to recommend a solution or solution(s) based on their review of the detailed requirements. What would be considered acceptable, pending successfully meeting acceptance test criteria, are HMI of the following form:

- Heads Up Display
- Flat-Panel Display (not a tablet) less than 7" diagonal
- LED array(s)
- Static indicator panel (dashboard) with backlight 'icons'
- Audio Only

All options shall include an audio component with adjustable volume levels.

1.4.3 Security Credential Management System (SCMS)

All connected vehicle equipment, i.e. RSUs, OBUs, etc., shall be integrated into the DriveOhio Statewide SCMS hosted by Integrity Security Services (ISS). ODOT / DriveOhio has contracted with ISS to be the statewide SCMS provider for 1 year with provisions to extend for another 2 years. The offeror shall coordinate with ISS to have any equipment provisioned with the correct security certificates prior to shipment or as it aligns with the project goals. The SCMS will provide the following configuration for security operations:

- OBU pseudonym certificate use of 20 per week
- RSU application certificate use of 1 per week (per service offered by the RSU)
- Equipment to be provisioned at a coordinated site
- Security Certificates will be provided by Smart Columbus thru DriveOhio

1.4.4 Installer Requirements

In addition to the hardware, the successful offeror will be required to provide necessary staff, facilities, tools, equipment, and training necessary to procure, prepare, install and maintain the OBUs for the estimated 1000 private, and 800 public fleet participants, for the duration of the operational period which goes live in July 2020 and ends on March 31, 2021. Installers shall possess the appropriate National Institute for Automotive Service Excellence (ASE)[1] certification (depending on vehicle class), and in the case of fire and police vehicle installation, it is preferred that they also possess the Emergency Vehicle Technician (EVT) – Level 1 certification, in accordance with the EVT Certification Commission, Inc.[2] Most installation activities for private vehicles is expected to occur at facilities contracted by the offeror. Location of installation of fleet vehicles is dependent on the fleet, but in certain cases, may be coordinated to occur onsite of the vehicle's normal location (i.e. fire station). Further, the successful offeror will be expected to work with each of the various fleet owners through the Management Team to develop an installation approach and schedule that meets the unique policies and requirements of each of these fleet owners. Additionally, beyond the technology components of CVE, the Smart Columbus program management office is also committed to providing workforce development opportunities as part of the CVE project. As part of the response, the approach to workforce development should be detailed

[1] *https://www.ase.com/Home.aspx*

[2] *http://www.evtcc.org/*

and realistic. Workforce development may include those that get a job because of this program, learns a new skill set and/or uses businesses in our community to install the onboard units.

1.4.5 Workforce Development / DBE Goals

Smart Columbus desires the offeror work with two or three educational partners such as local trade/technical/community schools, service technicians, garages or similar to develop an expanded technical workforce in the region. While there is no formal minority or woman owned business goal, the City strongly encourages minority and disadvantaged business participation on all contracts. Offeror's experience related to these goals is encouraged and should be included in their response if applicable.

1.4.6 Inventory and Installation Management

The offeror will be responsible for managing the inventory of OBUs including their storage prior to installation as well as installation records and device configuration. The offeror will also be responsible for providing a mobile-accessible, online portal through which participants can schedule installation. All records must be protected in accordance with the Smart Columbus Data Privacy Plan[3] and adhere to the requirements for participant protections as identified by the Industrial Review Board (IRB) protocol[4] that is approved for this project. Close coordination with the Smart Columbus Communications and Outreach team will be necessary, as they will identify, recruit and manage private-sector participants. This coordination will take place through the Management Team. It is desired that any tool used to manage above said scheduling, inventory and installation records also be capable of managing participant interactions and communications (commonly referred to as a customer journey tracking tool) so that the Communications and Outreach team can use or potentially administer, the tool. This would allow the Communications Team to use the tool to track recruiting efforts. However, if a single tool solution is not feasible, the offeror provided tool must be capable of interacting with the recruitment management tool, at a minimum by providing export/import capabilities to support data transfer. The successful operator is not required, however, to perform any of the initial outreach activities.

As part of their response to this RFP, the offeror shall provide product sheets for the major components of the system proposed to be installed. This includes the OBU, HMI(s), antenna(s) and other components of the installed system visible to the participant. Examples of visible and/or audible (via written description) alerts and warnings issued by the OBU to the driver for each application should also be included. These elements will not be counted against the offerors' page count limit.

1.5 Participating Fleets

The fleet owners which are currently part of the CVE project are listed below. The number of vehicles provided by each partner are listed in Table 1 located in Section 1.5. Detailed lists of known vehicles to be equipped are included in Appendix D. Offerors should be aware, as outreach activities continue, the quantity and make/model of vehicle, and even the partners who are participating, may change. Smart Columbus will be actively involved in the recruiting and management of all participants, both private and fleet vehicles. Following are a list of the current partners and the expectations / constraints associated with installation in their fleet vehicles.

> **Central Ohio Transit Agency (COTA):** COTA will provide unsupervised access to the qualified installer at COTA's two garage facilities located at McKinley Avenue (fixed-route fleet) and Fields Ave (para-transit/other) during overnight hours between 8 PM and 4 AM, seven (7) days a week. Installer will be responsible for providing all materials and tools to complete the installation. A

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[3] Current version of Smart Columbus Data Privacy Plan will be provided upon award.

[4] IRB Outcomes to be provided

maximum of eight (8) vehicles will be made available for a given shift. Available vehicles will be parked in a designated area each night.

Through hole antenna mounting may be permitted on the coach if the antenna does not interfere with other existing antenna and preferably, replaces an existing, unused antenna left of the vehicle for purposes of preventing water incursion. Light-duty vehicles will not allow for thru-hole antenna placement.

For those vehicles that will log CV events and offload data to the COTA backoffice (fixed route and paratransit vehicles only), COTA staff will work with the installer to integrate the OBU with the bus on-vehicle network that enables transferring the logged CV data via Wi-Fi upon the vehicles' return to the garage. Offeror will be responsible to develop the backoffice software platform that will parse the logs and make them available for review via a simple dashboard. COTA will provide the server hardware. Tables C-1 thru C-3 in Appendix D list the full list of COTA vehicles to be equipped.

Columbus Department of Public Safety (DPS), Division of Fire / Division of Police: The successful offeror will be responsible to provide installation services for all identified fire and police vehicles listed in Tables C-4 and C-5 of Appendix D, respectively. Installation is expected to occur during normal business hours of 9 AM to 5 PM, Mon. through Friday, and installation may be performed at the installers' site or onsite of the vehicles' location as coordinated with the Management Team. As the installer will be not be permitted to transport the vehicle to their facility to conduct the work, close coordination with the Management Team must occur throughout this process. Installer will be responsible for providing all materials and tools to complete the installation. The appropriate quantity for installs will also need to be coordinated with the Management Team. Install times should be provided and adhered to as many public safety vehicles may be "in-service" units. No through hole mounting of the antenna will be allowed. Mounting of the vehicle in the trunk may also not be possible. Form factor and location of the HMI (EVP ACK only), placement of antenna and OBU, method to access siren, and approach to obtaining vehicle power must be approved for each vehicle type prior to installation.

Columbus Department of Public Service and Other Departments' Fleets: The City will provide supervised access for purpose of installation of the OBU hardware in City-owned fleet vehicles. Installation is expected to occur during normal business hours of 9 AM to 5 PM, Mon. through Friday, and installation may be performed at the installers' site or onsite of the vehicles' location. As the installer will be not be permitted to transport the vehicle to their facility to conduct the work, close coordination with the Management Team must occur throughout this process. Installer will be responsible for providing all materials and tools to complete the installation. A maximum of eight (8) vehicles will be made available for a given day, however this number is subject to change based on availability. No through hole mounting of the antenna will be allowed. Vehicles without an accessible secure trunk shall have the OBU mounted under the dash on the sidewall. Form factor and location of the HMI, placement of antenna and OBU, and approach to obtaining vehicle power must be approved for each vehicle type prior to installation. Table C-6 in Appendix D lists the quantity and year/make/model of other City-owned vehicles that are expected to be equipped.

Franklin County Engineer's Office: Similar to the City of Columbus Public Service fleet discussed above, the County will provide supervised access for purpose of installation of the OBU hardware in two (2) county-owned fleet vehicles. Installation will be expected to occur at the County's maintenance facility located at Dublin Rd. Installer will be responsible for providing all materials and tools to complete the installation. No through hole mounting of the antenna will be allowed. Vehicles without an accessible secure trunk shall have the OBU mounted under the dash on the sidewall. Form factor and location of the HMI, placement of antenna and OBU, and approach to obtaining vehicle power must be approved for each vehicle type prior to installation.

Table C-7 in Appendix D lists the quantity and year/make/model of other County-owned vehicles that are expected to be equipped.

Private Freight Operator: The City has partnered with a private freight carrier in the Rickenbacker Airport (RCK) region to implement freight-signal priority on a small quantity of private-owned heavy-duty vehicles. The freight operator will provide supervised access to the vehicles at the operator's facilities located in the RCK region. The selected offeror is expected to perform all installation activities. Specific year/make/model of tractor are TBD, but are expected to be Class 8 or higher tractor/trailer combination units. No through hole mounting of the antenna will be allowed. Location of antenna and OBU, and approach to obtaining vehicle power must be approved for each tractor type prior to installation.

Automated Vehicle Fleet Operator: Smart Columbus expects to deploy up to six (6) automated shuttles in the area encompassing the CVE deployment and desires these AVs to be equipped with OBUs that output the basic safety message (BSM) and log all events that are generated by the OBU which would normally be provided to the driver. No integration is expected with the vehicle systems itself other than connection to power and antenna placement, nor is an interface with the driver expected. The AV Operator will be expected to allow supervised access to the OBU installer during non-operational periods of the AV (likely overnight), and will be required as part of their scope to support this installation activity. No through hole mounting of the antenna will be allowed.

The off-loading of the data logged on the AV OBU may be automated via a cellular connection or via the vehicle's Wi-Fi network (if available), or manually transferred via a memory card swap or similar process, including physical connection to operator's network. Transferring the data will be the responsibility of the offeror to perform or to coordinate with AV operator.

The backend interface to allow for uploading of this data to the Operating System will be the responsibility of the operating system team, the design of which will be dependent on the approach implemented and will be completed during recurring sprint planning sessions. CV event data from the shuttle shall be uploaded to the Operating System, at a minimum, on a weekly basis.

Note: Depending on the AV Vendor selected, CV technology may already be installed, in which case, no in-vehicle integration is necessary.

1.6 Vehicle Classes and Quantities

Following is a table of expected vehicle types, source (partner) and quantities. A summary of the characteristics for each configuration are also listed. These various combinations are important as they dictate the applications deployed, human-machine interface type (if any), data logging and data transfer requirements, and any special provisions for installation coordination. The quantities shown represent the Smart Columbus goal. The minimum number of installation is 1500, the difference limited mostly to the private vehicle quantities.

Table 1. Vehicle Class and Quantity per Partner

Vehicle Type	Partner / Source	Quantity	Characteristics
Light-Duty Vehicle	Private Vehicle	1,019	All V2X Safety Apps, HMI, No data logging, Integrator-led installation
	Public Service City Fleet Vehicle	198	All V2X Safety Apps, HMI, No data logging, coordination of installation with City fleets
	COTA Supervisor Vehicle	25	All V2X Safety Apps, HMI, No data logging, coordination with COTA maintenance
Emergency Vehicle	Public Safety Fire Truck/EMS	30	EVP Only, Minimal HMI (EVP granted), no data logging, integration with sire, coordination of installation with City fleet
	Public Safety Police Cruiser	80	EVP Only, Minimal HMI (EVP granted), no data logging, integration with siren, coordination of installation with City fleet
Heavy-Duty Vehicle	Private Freight Vehicle	10	BSM and FSP Only, no HMI, no data logging, coordination with fleet owner
	County Engineer	2	BSM Only, no HMI, no data logging, coordination with fleet owner
Transit Vehicle	AV Shuttle (CEAV)	6	All V2X Safety Apps, No HMI, data logging and offloading, coordination with AV operator
	COTA Transit Bus* (fixed-route)	350	All V2X Safety Apps, TSP, No HMI, data logging and offloading, coordination with COTA maintenance
	COTA Paratransit Bus	80	All V2X Safety Apps, No HMI, data logging and offloading, coordination with COTA maintenance
	Total	**~1,800**	

*Only the buses designated for the C-MAX BRT service shall have active TSP. All others should be TSP capable but are not expected to be activated at the start of the deployment period.

The CVE System Requirements detail the unique characteristics of each OBU type (based on vehicle type and source). All OBUs, regardless of vehicle type, shall transmit the BSM Pt. 1 at 10 times per second.

1.7 CV Applications

The following CV applications are expected to be deployed on the various OBU configurations. The offeror should indicate their approach to implement each of these applications; whether an existing offering or new development, where the applications has been previously demonstrated or tested, whether it has been validated using any modeling or simulation tools, and was it based on open-source or other similar USDOT-sponsored research activities. Application performance shall be in accordance with the CVE System Requirements and the referenced test plan documents, indicated for each application below, and as adapted to meet the physical and operational characteristics of light-duty and other vehicle classes specific to Columbus. The offeror shall be expected to finalize the acceptance criteria for each application with the Management Team.

Further, for each application, the offeror should indicate their demonstrated performance characteristics, to include, but not limited-to: rate of false-positives, rate of missed-positives, warning priority-sequence, and time from detection-to-notification. Any test data provided by the offeror is not counted against the page count.

Class	Application Name	Vehicle OBU Class			
		Light-Duty Vehicle	Emer. Vehicle	Heavy Duty Vehicle	Transit Vehicle*
V2V Safety	Emergency Electronic Brake Light Warning	✓	-	-	✓
	Forward Collision Warning	✓	-	-	✓
	Intersection Movement Assist	✓	-	-	✓
	Lane Change Warning / Blind Spot Warning	✓	-	-	✓
V2I Mobility	Transit Signal Priority*	-	-	-	✓
	Freight Signal Priority*	-	-	✓	-
	Emergency Vehicle Preemption*	-	✓		-
	Vehicle Data for Traffic Operations	✓	✓	✓	✓
	Transit Vehicle Interaction Event Recording	-	-	-	✓
V2I Safety	Red Light Violation Warning	✓	-	-	✓
	Reduced Speed School Zone	✓	-	-	✓

Figure 2. CV Applications Summary

*Part of the Multi-Modal Intelligent Traffic Signal System (MMITSS) signal priority bundle. MMITSS (or similar) require applications deployed on both the RSU and OBU.

The **Emergency Electronic Brake Light (EEBL)** application enables a vehicle to broadcast a self-generated emergency brake event to surrounding vehicles. Any receiving vehicle determines the relevance of the event and, if appropriate, provides a warning to the vehicle operator to avoid a crash. This application is particularly useful when any receiving vehicle operators' line of sight is obstructed by other vehicles or bad weather conditions such as fog or heavy rain. This application provides an output to

drivers to improve awareness of emergency braking events in an attempt to address rear-end crashes between multiple vehicles at intersection and non-intersection locations. It is expected that this application will be completely performed by the OBU and is dependent on receipt of BSMs from other connected vehicles while having no requirement for infrastructure-based information. The publication, *Commercial Connected Vehicle Test Procedure Development and Test Results – Emergency Electronic Brake Light, NHTSA, Publication DOT HS 812 327, September 2016,* provides use cases to demonstration the efficacy of this application for heavy-duty trucks. The offeror shall provide evidence of similar performance testing for light-duty vehicle.

The **Forward Collision Warning (FCW)** application warns the vehicle operator of an impending rear-end collision with another vehicle ahead in traffic in the same lane and direction of travel. The application uses data received from other vehicles to determine if a forward collision is imminent. FCW advises vehicle operators to take specific action in order to avoid or mitigate rear-end vehicle collisions in the forward path of travel in an attempt to address rear-end crashes among multiple vehicles at intersections and non-intersection locations. It is expected that this application will be completely performed by the OBU and is dependent on receipt of BSMs from other connected vehicles while having no requirement for infrastructure-based information. The publication, *Commercial Connected Vehicle Test Procedure Development and Test Results – Forward Collision Warning (FCW), NHTSA, Publication DOT HS 812 298, July 2016,* provides use cases to demonstration the efficacy of this application for heavy-duty trucks. The offeror shall provide evidence of similar performance testing for light-duty vehicle.

The **Intersection Movement Assist (IMA)** application warns the vehicle operator when it is not safe to enter an intersection due to a high probability of collision with other vehicles at stop sign-controlled and uncontrolled intersections. This application can provide collision warning information to the driver, which may perform actions to reduce the likelihood of crashes at the intersections. This application provides an output to drivers to improve awareness of approaching vehicles on conflicting approaches in an attempt to address crashes between multiple vehicles at intersections. This application may also assist in addressing Angle Crashes between vehicles at non-intersection locations where vehicles are turning across traffic at driveway locations. It is expected that this application will be completely performed by the OBU and is dependent on receipt of BSMs from other connected vehicles while having no requirement for infrastructure-based information. The publication, *Commercial Connected Vehicle Test Procedure Development and Test Results – Intersection Movement Assist, NHTSA, Publication DOT HS 812 276, May 2016,* provides use cases to demonstration the efficacy of this application for heavy-duty trucks. The offeror shall provide evidence of similar performance testing for light-duty vehicle.

The **Blind Spot Warning and Lane Change Warning (BSW+LCW)** application warns the vehicle operator during a lane change attempt if the blind-spot zone into which the vehicle intends to switch is, or will soon be, occupied by another vehicle traveling in the same direction. Moreover, the application provides advisory information that informs the vehicle operator that another vehicle in an adjacent lane is positioned in a blind-spot zone of the vehicle even if a lane change is not being attempted. This output raises driver awareness in an attempt to address issues associated with sideswipe crashes among multiple vehicles at non-intersection locations. It is expected that this application will be completely performed by the OBU and is dependent on receipt of BSMs from other connected vehicles while having no requirement for infrastructure-based information. The publication, *Commercial Connected Vehicle Test Procedure Development and Test Results – Blind Spot Warning / Lane Change Warning, NHTSA, Publication DOT HS 812 317, November 2016,* provides use cases to demonstration the efficacy of this application for heavy-duty trucks. The offeror shall provide evidence of similar performance testing for light-duty vehicle.

The **Traffic Signal Priority/Preemption application** provides improved mobility for emergency vehicle operators, heavy-duty vehicle operators, and transit vehicle operators. Priority/preemption is able to operate in collaboration with or independently of surrounding intersections. Also, vehicles approaching from either the ‘main street’ and/or the ‘side street’ have the ability to communicate with roadside

equipment at intersections to acquire priority/preemption status, though the application can be configured to limit which approaches can receive priority/preemption based on traffic management policy. The decision on which approaches will be enabled will be determined collectively by Smart Columbus and the City's Division of Traffic Management at a later time, but the CV application must be able to support this flexibility.

Smart Columbus is aware of the Connected Vehicle Pooled Fund Study research and resulting open-source software entitled the Multi-Model Intelligent Traffic Signal System (MMITSS) that could serve as a possible solution for this application. It is also recognized that deployment of the signal priority/preempt application will require both OBU and RSU software elements as well as integration with the traffic signal controller. After NTP, the City's Division of Traffic Management will work with both the offeror and the infrastructure integrator to develop the specific conditions for signal timing changes.

- **Emergency Vehicle Preemption** is provided for emergency vehicle operators. EVP provides a high level of priority for emergency first responders, and it interrupts the current intersection state to provide service to a specified phase. Clearing queues and holding conflicting phases can facilitate emergency vehicle movement. For congested conditions, it may take additional time to clear a standing queue, so the ability to provide information in a timely fashion is important. In addition, transitioning back to normal traffic signal operations after providing preemption is an important consideration.
- **Signal priority** is provided for heavy-duty vehicle (HDV) operators and transit vehicle operators, and it is considered a lower level of priority compared with the needs of emergency vehicle operators. Signal priority is characterized by providing either an early green or an extended green for a specified phase. TSP deployment will run in parallel with the existing GTT TSP solution deployed by COTA along Cleveland Ave. and will not initially affect signal operations, but instead, be used to benchmark the technology. After the results are further analyzed, if favorable, consideration for actual use are possible. Freight signal priority will be enabled along Alum Creek Dr. and will be connected with the signal system in the area.

Upon determining that it is approaching an intersection, the vehicle sends a Signal Priority Request message to the roadside, where it is received, and the message handler/processor (on the roadside) determines of the request should be accepted. Alternatively, the priority request could be forwarded to the TMC, which would provide a response indicating whether or not the request should be accepted. If the request is accepted, the message handler provides the priority input to the traffic signal controller. A Signal Status Message is sent from the roadside back to the vehicle to indicate whether the priority request was granted. This allows the application to provide feedback to, on this environment, the emergency vehicle operator only, indicating whether the signal priority has been granted. In all cases, EVP has priority over any signal priority requests. The infrastructure integrator is expected to implement the necessary RSU and controller interfaces and algorithms to facilitate these requests from the OBU. The OBU is required to send the necessary SRM, and respond to the SSM, when appropriate. The publication, *Multi-Model Intelligent Traffic Signal System (MMITSS) System Development, Deployment and Field Test Plan, Version 5.1, October 2013,* provides use cases to demonstration the efficacy of this application for emergency, transit, freight and light-duty vehicles.

The **Vehicle Data for Traffic Operations (VDTO)** application captures telemetry (location, speed, trajectory) data obtained from vehicles and traffic signal data (such as signal state and signal priority requests) and makes this data available to support traffic operations, including incident detection and the implementation of localized operational strategies. The Connected Vehicle Traffic Management Center is responsible for processing and filtering data so that it can be made available to the Operating System. This processing and filtering transforms raw messages that are received by the CV TMC into useful operational information so that it can be used for traffic management purposes and removes PII so that operational data may be archived on the Operating System The frequency with which data is transmitted from the CV TMC to the Operating System depends on the data requirements of the Operating System.

The processing and filtering function of the CV TMC is expected to produce fundamental measures of operations such as, but not limited to roadway speed, queue/incident detection, travel time/intersection delay, and/or CV volume.

Traffic Management staff can use this operational data as the basis for implementing TMC-based traffic control strategies, which are outside the scope of this application. All infrastructure generated messages and all BSMs captured by the RSU shall be included as part of the universe of data available to this application. No unique requirements on the part of the OBU are expected to support this application.

The **Transit Vehicle Interaction Event Recording** application enables COTA Management Staff to capture output (not issued to the Transit Vehicle Operator) from applications so that it can assess the potential interactions and benefits that transit vehicle operators may receive should COTA decide to implement a UI on its transit vehicles. The application on the Transit Vehicle passively captures its own telematics data, BSMs from other vehicles and SPaT, MAP, and RSM messages from the roadside equipment in communications range.

The Transit Vehicle OBU will log these messages for a period of time before and after a warning or alert is issued from CV applications. The period of time over which this data is recorded is expected to be configurable for each alert or warning. These periods will consist of a few seconds (e.g., 10-20) prior to and a few seconds (e.g., 30-40) following the activation of the alert or warning.

This information is provided to the Transit Management Center, provided by COTA, via a backhaul connection between the transit vehicle and the Transit Management Center. The Transit Management Center transforms raw messages that were received by the transit vehicle into vehicle interaction data: a concise representation of an event that would have resulted in a notification or warning issued to a transit vehicle operator. The Transit Management Center makes this data available to the transit management staff so that they may assess the impact of providing notifications and warnings to transit vehicle operators. A filtered version (to remove PII) of this vehicle interaction data would be made available to the Operating System. This application addresses the need for COTA to assess how other drivers are behaving around transit vehicles and to assess the potential impact of notifications/warnings on transit vehicle operators.

The OBU in the transit vehicle will be connected to the bus's existing wireless network and offload data to a server controlled and maintained by COTA operations (may be cloud-based).

The **Red-Light Violation Warning (RLVW)** application enables a connected vehicle approaching a signalized intersection to receive information about the signal timing and geometry of the intersection. The application in the vehicle uses its speed and acceleration profile, along with the signal timing and geometry information, to determine if it appears that the vehicle will enter the intersection in violation of a traffic signal. If the violation seems likely to occur, a warning can be provided to the vehicle operator. This application provides an output to drivers to improve awareness when approaching a signal that will turn red before arriving at the intersection in an attempt to address crashes between multiple vehicles at intersections. This application is dependent on the infrastructure to provide SPAT, MAP, and RTCM to the OBU. All elements of the RLVW decision are performed by the OBU. The publication, *Vehicle-to-Infrastructure (V2I) Safety Applications - Performance Requirements, Vol. 3, Red Light Violation Warning (RLVW), Final Report — August 2015, FHWA-JPO-16-250,* provides performance requirements to demonstration the efficacy of this application for light-duty vehicles.

The **Reduced Speed School Zone (RSSZ) application** provides connected vehicles with information on a school zone's posted speed limit (generally 20 mph). The RSSZ application inside the CV uses the school zone location and speed limit, vehicle location, and the speed of the vehicle to determine whether to alert or warn the vehicle operator. The application will provide an alert to vehicle operators in advance when braking is required to reduce to the posted speed limit. This output increases driver awareness to active school zones and the school zone speed limit in an attempt to reduce speed when in school zones.

This application is dependent on the infrastructure to provide RSM to the OBU. All elements of the RSSZ decision are performed by the OBU. The publication, *Vehicle-to-Infrastructure (V2I) Safety Applications - Performance Requirements, Vol. 4, Reduced Speed Zone Warning with Lane Closure (RSWZ), Final Report — August 2015, FHWA-JPO-16-251,* provides performance requirements to demonstration the efficacy of this application for light-duty vehicles.

1.8 DSRC Messages and Origins

This section contains the primary over-the-air messages that will be necessary to implement the CVE. The majority of these messages originate from the infrastructure and are broadcast on recurring intervals by the RSU. RSU messages include SPAT, MAP, RTCM and RSM. All OBUs will broadcast BSM messages at 10Hz. SRM (OBU initiated) and SSM (RSU provided) are only exchanged when a pre-empt or priority request is made by an authorized vehicle. With the exception of RSM, which is currently in draft form within the SAE J2945/5 standard, all messages shall be compliant with SAE J2735:201603. A summary of the messages, source and purpose of each message are in the figure below. Details of the exact message content for each are included in Appendix E.

Table 2. CV Messages

Message	Source	Notes
BSM	OBU devices deployed by Smart Columbus	Enables V2V applications and VDTO.
SPAT	Traffic Signal Controller via RSU	Each signal controller that is equipped with CV technology shall produce the SPAT message.
MAP	Roadside Computing Platform / RSU	Each RSU shall broadcast the MAP message for the related intersection.
RTCM	ODOT managed CORS	Position Correction information relayed by the RSU to vehicle.
RSM*	Roadside Computing Platform / RSU	Part of SAE J2945 and used to support the reduced speed school zone application.
SRM	OBU in pre-empt/priority equipped vehicles.	Allows for emergency, transit and freight to request signal priority at select CV-equipped intersections.
SSM	Traffic Signal Controller via RSU	Allows signal pre-empt requestor to verify acceptance of request.

* Please note that SSP and PSIDs do not currently exist for RSMs; the offeror will need to work with the management team and appropriate standards body to obtain these.

1.9 Project Area

As a result of the stakeholder engagement that has continued since the original Smart City Challenge Technical Application, the Smart Columbus PMO has continued to refine the targeted locations for deploying CV technology on the roadside. ***Figure 3. CVE Deployment Areas - Overview*** shows the four major corridors that will be equipped. The upper region represents the primary deployment area that includes Linden. The lower area is along a high-use freight corridor. As it presently stands, 86

intersections are planned to be equipped with CV technology, as shown in ***Figure 4. CVE Infrastructure Primary Deployment Area - Linden*** and ***Figure 5. CVE Infrastructure Deployment - Freight Corridor***. Wireless communications from adjacent DSRC-equipped intersections are expected to cover the three school zones shown on the High Street and Cleveland Avenue corridors in Figure 4. Recruitment of private participants is expected to focus on individuals and fleets that live or travel through this same region as shown in Figure 4.

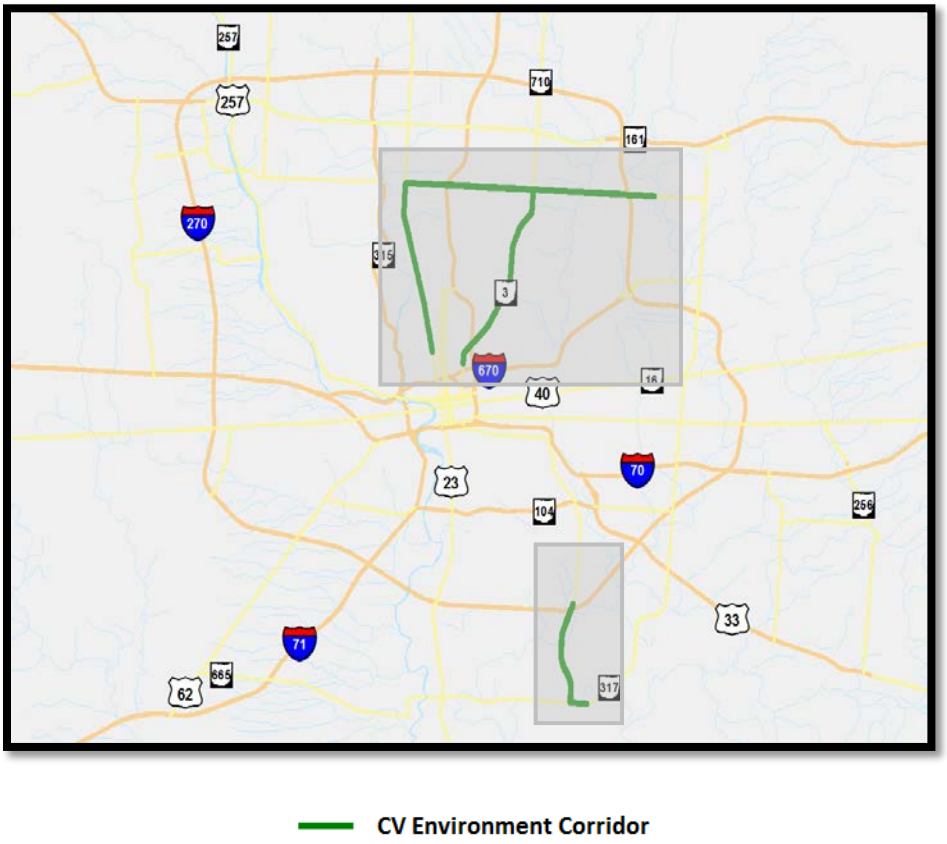
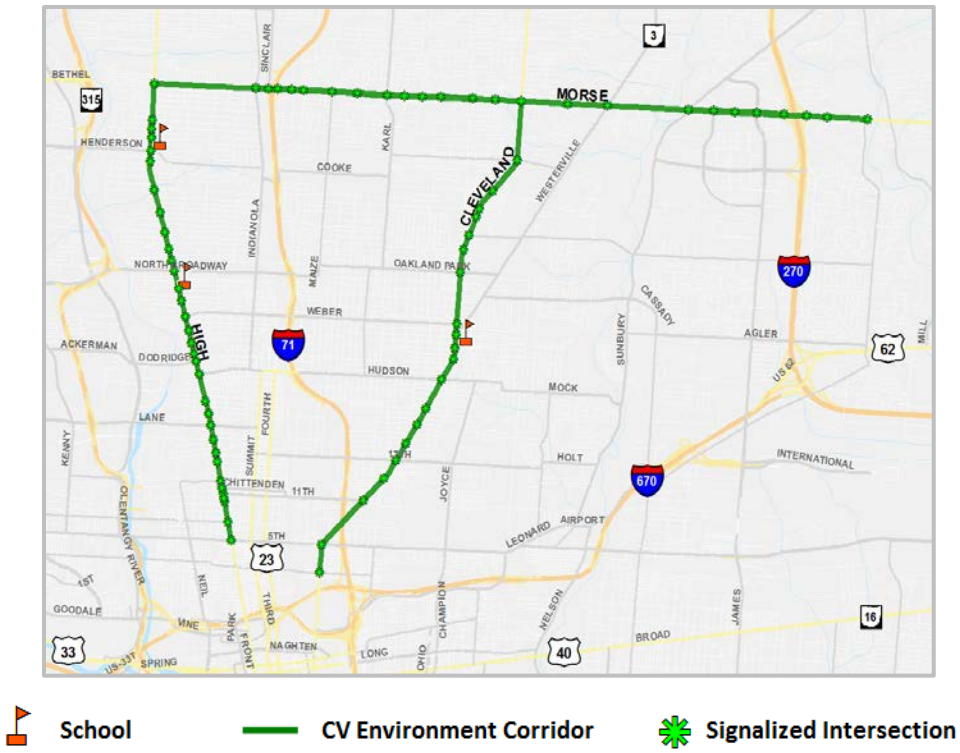


Figure 3. CVE Deployment Areas - Overview



School — CV Environment Corridor — Signalized Intersection

Figure 4. CVE Infrastructure Primary Deployment Area - Linden

CV Environment Corridor — Signalized Intersection

Figure 5. CVE Infrastructure Deployment - Freight Corridor

RSU deployment will be handled by a separate system integrator and an electrical contractor.

1.10 Acronyms and Abbreviations

Following is a list of common acronyms and abbreviations used within this RFP.

AASHTO	American Association of State Highway & Transportation Officials
ACK	Acknowledge
ANSI	American National Standards Institute
API	Application Programming Interface
ARP	Antenna Reference Point
ASE	Automotive Service Excellence
ATMS	Advanced Transportation Management System
ATP	Acceptance Test Plan
AV	Automated Vehicle
BRT	Bus Rapid Transit
BSM	Basic Safety Message
BSW	Blind Spot Warning
CAN	Controller Area Network
CEAV	Connected Electric Automated Vehicle
CORS	Continuously Operating Reference Station
COTA	Central Ohio Transit Agency
COTS	Commercial off the Shelf
CPU	Central Processing Unit
CTSS	Columbus Traffic Signal System
CV	Connected Vehicle
CVE	Connected Vehicle Environment
DBE	Disadvantaged Business Entity
DoT	City of Columbus Department of Technology
DOW	Day of Week
DPS	City of Columbus Department of Public Service
DSRC	Dedicated Short Range Communications
EEBL	Electronic Emergency Brake Light
EIP	Equipment Integration Plan
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
EVP	Emergency Vehicle Preempt
EVT	Emergency Vehicle Technician
FCC	Federal Communication Commission
FCW	Forward Collision Warning
FHWA	Federal Highway Administration
FID	Federal Identification Number / Contract Compliance Number

FSP	Freight Signal Priority
Gb	Gigabit
GHz	Gigahertz
GID	Geometric Intersection Description
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GPS RTCM	Global Positioning System Radio Technical Commission for Maritime Services
HDV	Heavy-Duty Vehicle
HMI	Human Machine Interface
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronics Engineers
IMA	Intersection Movement Assist
IP	Internet Protocol
IRB	Institutional Review Board
ISO	International Organization of Standardization
IT	Information Technology
ITS	Intelligent Transportation System
JPO	Joint Program Office
Kb	Kilobyte
Kb/s	Kilobits per second
LCW	Lane Change Warning
MAP	Geometric Intersection Description in SAE J2735 format
Mb	Megabyte
Mb/s	Megabits per second
MHz	Megahertz
MIB	Management Information Database
MMITSS	Multi-Modal Intelligent Traffic Signal System
MUTCD	Manual of Uniform Traffic Control Devices
NEMA	National Electrical Manufacturers Association
NHTSA	National Highway Traffic Safety Administration
NTP	Notice to Proceed
OBU	Onboard Unit
ODOT	Ohio Department of Transportation
OID	Object Identifier
ORC	Ohio Revised Code
OSADP	Open Source Application Data Portal
PDF	Portable Document Format

PM	Project Manager
PoE	Power over Ethernet
PSID	Provider Service Identifier
PSM	Personal Safety Message
RAM	Roadside Alert Message
RCK	Rickenbacker Airport
RFP	Request for Proposals
RLVW	Red Light Violation Warning
RSSI	Relative Received Signal Strength
RSSZ	Reduced Speed School Zone
RSU	Roadside Unit
S/N	Serial Number
SAE	Society of Automotive Engineers
SCMS	Security Credential Management System
SDK	Software Development Kit
SPaT	Signal Phase and Timing
SRM	Signal Request Message
SSM	Signal Status Message
TBD	To Be Determined
TIM	Traveler Information Message
TMC	Transportation Management Center
TMC	Traffic Management Center
TOD	Time of Day
TSP	Transit Signal Priority
USDOT	United States Department of Transportation
UTC	Coordinated Universal Time
V2I	Vehicle-to-Infrastructure (communications)
V2V	Vehicle-to-Vehicle (communications)
VAC	Volt Alternating Current
VDC	Volt Direct Current
VDTO	Vehicle Data for Transportation Operations
ZIP	Zone Improvement Plan

1.11 Project Schedule

Following is the high-level project schedule commencing with the notice to proceed (NTP expected to occur on or before July 29, 2019. The detailed Smart Columbus schedule will be provided to the successful offeror upon award.

Task	Timeline
RSU Procurement (Notice to Proceed Issued by)*	July 29, 2019
OBU Procurement (Notice to Proceed Issued by)*	July 29, 2019
Application Development for OBUs (Light Vehicles)	July 30, 2019 – March 6, 2020
Application Development for OBUs (Other Vehicles)	July 30, 2019 – March 6, 2020
Participant Recruitment	September 3, 2019 – September 23, 2020
OBU Installation	December 3, 2019 – September 23, 2020
RSU Installation	August 2019 – February 2020
Demonstration Period	July 7, 2020 – March 31, 2021

*Approximate Date for NTP. Integrator to begin work immediately upon NTP.

2 Scope of Services

This section identifies a high-level work plan that Smart Columbus believes will allow for successful completion of the integration activities associated with the CVE project and meet the goals of the broader Smart Columbus program. Deviations from this plan will be considered but must be documented by the offeror in their proposal.

2.1 Detailed Tasks

Task 1 – Project Management and Reporting

Upon notice to proceed, the selected offeror will be provided with the current Smart Columbus schedule identifying the key milestones and deliverables of the CVE project. Offeror shall, in turn, prepare and submit a detailed work plan and schedule that meets the Smart Columbus schedule. A draft of this work plan shall be submitted within two (2) weeks of NTP. Offeror shall update and submit revised work plan and schedule within 1 week of receipt of comments. Smart Columbus shall have 5 business days to review, as will be typical for all deliverable / approval items provided for all tasks delineated in this scope.

Offeror shall participate in a Weekly Status Meeting with the CVE Management Team. Offeror shall also be expected to attend bi-weekly ‘Scrum of Scrum’ meetings with the Smart Columbus Program Management Office (PMO). These are held the first and second Wednesday of each month from 8:15 am to 9:35 am.

Offeror shall provide Monthly Status Reports that identify accomplishments, upcoming activities, risks/concerns, status of percent complete for each of the major installation phases/groups and updated schedule.

Deliverables

- Work Plan (draft/final)
- Monthly Status Report

Task 2 – In-Vehicle Device and Related Services Procurement

Upon approval of work plan, offeror shall initiate procurement of the hardware and software components necessary to meet the in-vehicle requirements for CVE in accordance with the approved schedule and work plan. Further, if it is necessary to secure facilities, tools and other services related to the installation and testing, this work may proceed upon approval of the work plan.

Smart Columbus will coordinate with the offeror and try to provide for a test and integration lab that will allow the offeror, the infrastructure integrator and City traffic engineering staff to work together for overall system integration and testing activities to occur. Bench space, power, internet, GNSS-services and access to both the CV network and the traffic signal network will be made available for two (2) staff. Only limited space for inventory is expected, however, the City is willing to work with the offeror to determine if said space can be identified. This outcome however will not be known until more information about the offeror's needs are disclosed thru this RFP process. As such, Offeror should plan for identifying a location for secure storage.

It is the responsibility of the offeror to produce any procurement documents and/or specifications necessary to complete these activities. Any specifications produced, quantities and cost estimates of items to be purchased, and other related procurement documents shall be provided to Smart Columbus for approval before initiating the actual purchase. Smart Columbus will provide either feedback or approval within 5 working days of receipt of procurement package.

Offeror will be responsible for receipt, inspection, and storage of all purchased items and shall maintain an accurate accounting of this equipment. Any major equipment items not already identified by a vendor serial number shall be tagged for inventory and installation tracking purposes by the offeror. Any damage or discrepancy items shall be reported to the Smart Columbus CVE PM along with remedy plan. These will be tracked as part of the weekly status.

A representative example of the OBU, including antenna, HMI and any other major component shall be made available to Smart Columbus by September 3rd in order to support outreach activities.

The initial procurement should expect to secure up to 1500 OBUs, with 700 intended for the private light-duty fleet. The balance of 300 light-duty OBUs for private vehicles, if authorized, would be expected to occur within 6 months of NTP. Table 1 above list these vehicles and quantities.

All equipment for which the offeror has been reimbursed becomes the property of Smart Columbus with the offeror serving in the role of custodian.

Deliverables

- Procurement Documentation
- Inventory/Discrepancy Reports
- Representative Hardware (for outreach)
- OBU, plus antenna, wiring, and HMI (if selected)

Task 3 – Software (S/W) Development (as necessary)

Smart Columbus recognizes that not all of the proposed CV applications are fully developed and will likely require additional development in order to be deployment ready. The offeror shall be responsible for development of any software to be deployed on the OBU. Further, interfaces to the various systems within Smart Columbus also need developed. The offeror is not expected to develop these interfaces,

however, coordination with the Operating System team and other partners will be necessary to ensure final project data is properly sent to and stored by the Operating System. The high-level design of these interfaces is shown in Appendix E.

As part of their proposal, the offeror shall include a list of applications and interfaces that the offeror believes will need developed and the estimated level of effort for each of these components. The specific methodology used to develop any software component or interface is at the discretion of the offeror, but the methodology should be discussed in the response to this RFP. Further, information regarding the processes and tools that will be employed for application validation, defect tracking, configuration management, and backups of any software to be developed as part of this contract should also be discussed. Any software developed under contract to Smart Columbus shall be considered open-source and shall be ultimately published to the USDOT Open Source Application Data Portal (OSADP) upon successful testing and release. Any claims to proprietary software must be identified as part of the proposal.

Representatives of the Operating System team will be made available to the offeror to coordinate interfaces between the CVE and the Operating System, as will the resources from the City DoT and ODOT necessary to implement the interfaces to public resources such as the SCMS, CORS, etc. It is not expected for the OBU to interface directly with the Operating System. All data exchange will be enabled thru the RSU. As all V2I CV applications require software modules on both the OBU and RSU, the offeror will also be expected to work with the infrastructure integrator in an open, collaborative environment.

Deliverables

- Source-code and related documentation published to OSADP

Task 4 – Unit Preparation

The offeror will be expected to perform any/all activities necessary to prepare devices for installation. This includes changing default passwords, reviewing default device security settings, performing firmware updates, loading of application software, completing network configuration, installing and configuring certificate management, configuring firewall settings, configuring logging capability, etc.

The offeror shall, in advance of commencing unit preparation, prepare detailed procedures and a high-level checklist, for each unit type/configuration that will be deployed. These procedures and the resulting checklist shall require the approval of Smart Columbus before unit preparation activities commence in full. A copy of the approved checklist shall be completed for each unit provisioned and maintained along with installation records related to each unit. A copy of the completed checklists shall be made available to the Management Team upon request. All records for all units shall be transferred to Smart Columbus upon completion of the demonstration period.

Deliverables

- Unit Preparation Procedures and Checklist
- Completed Unit Preparation Checklists

Task 5 – Installation and Application Testing

Before performing any installation activities, the offeror should prepare and submit installation plans for each of the four (4) major OBU configurations; light-duty, heavy-duty, transit and emergency vehicle, and any variations of each. These plans will be reviewed and approved by Smart Columbus and representatives of the respective vehicle types. Further, the offeror should prepare Installation Training Plans to accompany these Installation Plans in order to ensure installers are adequately prepared to install the device.

Using the approved plans, the offeror shall then install and demonstrate at least one example of each of the four configurations. Necessary modifications to the installation plans should be captured during this activity. These plans are intended to be used to support installation training for subsequent installation activities as identified in Task 6. These OBUs will be installed in City-owned vehicles.

Upon completion of this installation, the offeror will be expected to demonstrate the operation of the device and the performance of the CV applications, shown in Figure 2, in accordance with the acceptance test plan (ATP). In order to ensure the safety of occupants during testing, simulated scenarios used to trigger the V2V safety applications may be necessary. For V2I application testing, at least one operational instance of each configuration of RSU deployment will be available to support this activity.

The ATP will be prepared by Smart Columbus, based on the CVE System Requirements, and in coordination with the Offeror. Test cases will be developed that include pass/fail criteria. All functional requirements in the test cases shall be expected to pass during the witness testing to grant final acceptance. Any special considerations needed to fully demonstrate the applications, such as temporary road closures, will be considered by Smart Columbus and coordinated appropriately.

Deliverables

- Device Installation Plans and Checklist (4 versions)
- Installation Training Plans
- Completed Installations (min. 4)
- Test Results and supporting Data

Task 6 – Equipment Installation

Upon approval of the device for deployment (Task 5), and in coordination with the Communications Team and fleet managers, the offeror shall proceed with the installation of in-vehicle systems. The Communications Team will be responsible for outreach and directing participants to the mobile-assessible, online installation appointment scheduling system for initial scheduling. Once in the system, the Offeror will be responsible for managing the participant appointments as follows:

Exhibit A: Typical Appointment Process

- Greet and explains process to participant. Script will be developed in coordination with the Communications Team
- Confirm participant opt-in by having them sign the necessary forms. These will be developed in coordination with the broader Smart Columbus team and IRB facilitator.
- Initiate participant training activities (See Task 7 below)
- Complete installation
- Test installation
- Return Vehicle to participant
- Ask if follow up questions, including vehicle walkthrough. Frequently asked questions will be made available to offeror
- Provide participant with incentive. To be provided by Communications Team
- Dismiss participant
- Complete paperwork by updating online records, filing signatures, etc.

Exhibit B: Aborted Installation Process

- Greet and explains process to participant. Script will be developed in coordination with the Communications Team
- Confirm participant opt-in by having them sign the necessary forms. These will be developed in coordination with the broader Smart Columbus team and IRB facilitator.

- Initiate participant training activities (See Task 7 below)
- Commence installation
- Determine that installation cannot be completed
- Return Vehicle to participant
- Explain reason for aborting installation
- Provide participant with incentive
- Dismiss participant
- Complete paperwork by updating online records, filing signatures, etc.

Exhibit C: Participant No-Show

- Log no-show in scheduling tool
- Contact participant via preferred method using prepared message. Communications team will provide language for method as we as have recorded preferred contact method.
- Complete paperwork by updating online records

Exhibit D: Participant Arrives without Scheduled Appt.

- Great participant
- Determine reason for visit
- If for new install
    - schedule appointment and exit this procedure
- If repair / removal
    - Determine if can be accommodated while customer waits
    - Else, schedule appointment and exist procedure
- Complete repair/removal
- Return vehicle to participant
- Ask if follow up questions, including vehicle walkthrough. Frequently asked questions will be made available to offeror
- Obtain signature on repair/removal
- Dismiss participant
- Complete paperwork by updating online records, filing signatures, etc.

Offeror is responsible for providing all elements related to the installation, including facilities, tools, trained installers, and the configured in-vehicle systems. OBU installation is expected to be performed in locations convenient to the participant base using qualified and trained staff. Fleet installation will be conducted in accordance with the agreement with each fleet owner as discussed in paragraph 1.1.1.5 and may entail use of the offeror-provided facilities.

Participant recruitment is expected to focus on the following ZIP codes: 43201, **43210**, 43202, **43214**, 43229, 43224, 43231, 43230, **43219,** and **43211** with preferred installation locations indicted in bold. As noted, it is expected that multiple locations may be necessary to support the schedule for installation. Hours are expected to include evenings and Saturdays, but not all locations will be required to be open at all times. Ideally, the work area will be sufficient to hold multiple vehicles and include a customer lounge and restroom facilities. Offeror should discuss any approach to workforce development and training associated with the installation workforce.

Offeror should report on workforce development activities associated with this task. As noted previously, Smart Columbus defines workforce development as instances where an individual gets a job because of this program, learns a new skill set and/or the offeror uses businesses in our community to install the onboard units. Therefore, this reporting should identify those individuals hired and trained for the program or number of installations completed by newly trained talent or local businesses.

The Management Team will provide a single instance of a fully functioning RSU for each installation site to allow for final vehicle acceptance testing.

Device installation should be accompanied by completion of an installation checklist and confirmation that the device is fully operational. These results will be managed along with the device configuration checklist.

Offeror is requested to offer any recommended changes to these procedures as part of their proposal.

Deliverables

- Operational Service Centers
- Workforce development outcomes (monthly)
- Completed Installations (1500 min. / 1800 target)
- Completed installation checklist and test results

Task 7 – Participant Interaction and Training

Expanding of the participant engagement and training activities identified in the Task 6 workflow (Exhibits A through D), Offeror will be expected to be solely responsible for interactions with the participant once they arrive at the installation facility. This includes participant training on the use of the equipment, answering questions, as well as collecting the necessary participant signatures and IRB consent forms. In this capacity, the Offeror will be the face of Smart Columbus and as such, this role is very critical to the success of the project.

Prior to the start of the installation phase, the Smart Columbus Communications Team will develop, in coordination with the Offeror, all of the training material necessary to inform a participant about the operation, expectations and limitations of the installed in-vehicle system. This includes, but is not limited to confirmation that device is operational, and the description of the purpose of any audible or visible indicators a driver might receive. Smart Columbus will be responsible for preparing the final training materials, whether print, video, or online.

In addition to the training, the Offeror will be required as part of the installation process to provide the participant with an incentive, likely in the form of gift card. These will be provided by Smart Columbus, but it will be the responsibility of the Offeror to track these assets similar to tracking OBUs.

The offeror will be responsible to perform these activities in conjunction with the installation activities prescribed in Task 6. Training is expected to take no more than 10 minutes per participant.

Deliverables

- Equipment Technical Data Sheets, Operations Manuals and support for creating training media
- Training and engagement as part of installation

Task 8 – Operations and Maintenance

As part of Task 6, the offeror is expected to operate service centers to allow for installation of OBUs. Participants should also be provided the capability to schedule an appointment to repair, replace or remove devices. Offeror shall be responsible for documenting and reporting on all activities related to the installation, repair and removal of any devices, both directly by the offeror, or when in coordination with the fleet owners, provide fleet information including the City's identification number (aka brass tag). Weekly reporting shall include installations performed, upgrades, repairs, removals, etc.

Offeror shall be prepared to repair/replace any failing equipment within two business days of a request by a vehicle owner. Communications Team will encourage participants to schedule follow-up visits using the online scheduling tool, however Offeror should try to accommodate walk-ins, at a minimum, by scheduling a free time.

Deliverables

- Weekly Report as indicated

Task 9 – Equipment Removal

Smart Columbus intends to leave all OBUs in place for the duration of the initial demonstration period and beyond. However, we recognize that not all participants will desire to retain the device for the entirety of the demonstration period. Upon the request of a participant, via the Communications Team, preferably requested using the same system used to schedule installation, the offeror shall make necessary arrangements to remove the OBU from the participant vehicle. Only private participants will be eligible for this service. City fleet will be expected to retain the equipment or remove using separate resources. All equipment removed will remain property of Smart Columbus, who will determine if the equipment should be re-used or disposed. It is expected that the offeror provide/retain capabilities to perform the uninstall throughout the deployment period.

Deliverables

- Equipment Removal service

3 On-Board Unit Specifications

3.1 General Description

OBUs shall be supplied for the minimum of 1500 vehicles for each class and configuration previously defined, with an additional 300 units targeted for light-duty vehicles priced separately and only to be purchased if Smart Columbus meets its goal of 1800 vehicles. The timing of purchases and quantities will be coordinated with the Offeror and the Management Team. OBUs will typically be comprised of the physical computing unit, a single, external, multi-band antenna, the human-machine interface (HMI) where applicable, and all cabling and mounting hardware. The offeror shall also provide the following quantities for each OBU configuration type to allow for spares. 10 for private vehicles, five (5) for City fleet vehicles, 5 for public safety vehicles, 5 for COTA transit vehicles, two (2) for freight operator, one (1) for the AV. If the selected OBU can be software configured to meet any of the configurations specified, a total quantity of 20 spares will satisfy this requirement. The offeror shall also maintain this level of quantity on hand for the duration of the deployment, replacing any non-operational devices within 30 calendar days.

3.2 OBU and CV Application Requirements

System functional, performance, interface, etc. requirements for the various configuration of OBUs and the corresponding CV applications are detailed in Appendix C. As part of the RFP response, the offeror is requested to review each requirement and to provide an assessment of their ability to meet each using the following response (this is not counted toward the maximum page requirements):

Fully Compliant – The proposed solution can meet the requirement exactly as indicated using an off-the-shelf product.

Comply with minor modification – The proposed solution can meet the requirement with minimal changes to the product and without impacting the ability to deliver on schedule. Offeror should indicate the proposed change or reason need for change.

Comply with major modification – The proposed solution can meet the requirement with changes to the product that would likely impact the ability to deliver per the current schedule. Offeror should indicate what an expected revised delivery might be and the reason for not meeting the requirement.

Non-Compliant – The proposed solution cannot meet the requirement without significant change that will have major impact to budget and schedule.

4 System Integration and Testing Requirements

4.1 General Description

System integration and testing includes necessary integration into vehicle systems as well as connectivity to the roadside units (RSU) to enable end-to-end communications and prove functionality and operation for local device assembly, local subsystem and final system. The integration services include all necessary configuration and programming work at communication aggregations points, subsystem locations and the traffic management center (TMC).

4.2 Integration Requirements

OBU shall integrate to the Security and Credentials Management System (SCMS) from DriveOhio to make sure that it is working with data from trusted sources. (See 1.1.1.2). OBU-produced BSMs shall be transmitted in real-time (<0.5 sec latency) to the Smart Columbus Operating System (OS).

Each data stream forwarded to the OS will include raw data elements for one DSRC message. The following transmission instructions should be applied to each message

- Message Type/Description
- Message PSID
- Message Priority
- Transmission Channel Mode
- Transmission Channel
- Transmission Interval (set to Null)
- Message Delivery (transmission) start time (set to Null)
- Message Delivery (transmission) stop time (set to Null)
- Signature
- Encryption

4.3 Interface Log Files

The OBU will provide operators the ability to capture packets transmitted and received on any enabled communication interface for troubleshooting purposes. Interface logs are not intended for long term data capturing. The OBU shall:

a. Have the ability to log all transmitted and received packets across all enabled communication interfaces, while in the "Operate" State. All Interface Log File configurations contained in SNMPv3 MIB OID 1.0.15628.4.1.9 shall have the following default values:

- Generate=off
- Max file size=20MB
- Max collection time=24 hr.

c. Generate Interface Log Files. Each file shall be generated in the industry standard packet capture (pcap) format and contain the following data:

- Date and Time (in UTC, when the packet was logged)
- RSSI (for Packets Received over DSRC)
- TxPower (for Packets Transmitted over DSRC)
- Packet (complete transmitted or received packet)

d. Close an active Interface Log File upon reaching the configured "Max file size" in SNMPv3 MIB OID 1.0.15628.4.1.9.

e. Close all active Interface Log Files when transitioning to "standby" state.

f. Close an active Interface Log File upon reaching the configured "Max collection time" in SNMPv3 MIB OID 1.0.15628.4.1.9.

g. Generate a new Interface Log File upon closing a previously active Interface Log File when the configured "Max file size" in SNMPv3 MIB OID 1.0.15628.4.1.9 is reached.

h. Be named according to the following convention:

- OBU ID (see MIB OID 1.0.15628.4.1.17)
- Interface ID
- Transmit, receive, or both
- Date and time (UTC date and time when the file was created

i. Allow authorized users to view Interface Log Files stored in the Interface Log File directory on the device through an Ethernet interface

4.4 Data and Interface Requirements

Details of message and interface requirements will be provided to the successful operation in the form of the final Interface Connection Diagram (ICD). A draft version is included in Appendix E for purposes of this RFP.

5 Proposal Submittal Instructions

Proposals shall be submitted as a PDF document online via Bonfire until 1:00 PM Eastern Time on February 26, 2019. Proposals received after this date and time shall be rejected by Smart Columbus.

Submit Electronic Proposal Package to:

https://columbus.bonfirehub.com/projects/

5.1 Procurement Schedule

The expected timeline for this procurement is as follows:

RFP Sequence of Events	
Date of Advertisement - RFP/Bid Issued	January 29, 2019
Pre-Proposal Meeting	February 8, 2019
Proposal Inquiry Period Ends	February 14, 2019
Proposals Due/Opened	February 26, 2019
Interviews (if necessary)	March 19-20, 2019
Notice to Proceed	No later than July 2019

RFP Pre-Proposal Meeting: February 8, 2019 from 1:00 PM – 2:30 PM

Location:

Smart Columbus Experience Center,

170 S. Civic Center Dr., Columbus, OH 43215

WebEx Information:

https://cocmeetings.webex.com/cocmeetings/j.php?MTID=m2e59fd7a8a86a445e99b26d7888ebe45

Audio Connection: 1-650-479-3207

Access Code: 733 003 241

5.2 Electronic Submittals

Proposals shall be submitted as a PDF document. The maximum file size is 100 MB. Please do not embed any documents within the uploaded file as such documents will not be accessible or evaluated. Proposals shall be uploaded, submitted, and finalized prior to the Closing Time of 1:00 PM Eastern Time on February 26, 2019. Smart Columbus strongly encourages Offerors to allow sufficient time and at least one (1) day before the Closing Time to begin the upload process and to finalize their submissions.

5.2.1 Important Notes Regarding Submissions: Proposals will only be visible and accessible to the Department or evaluators after the Closing Time.

5.2.2 Uploading large documents may take significant time, depending on the size of the file(s) and Offerors' internet connection speed.

5.2.3 Offerors will receive an email confirmation with a unique confirmation number once they finalize their submissions. The date/time stamp on the email confirmation constitutes the official date/time of receipt. Offerors are solely responsible for ensuring their proposals have been successfully uploaded and received by Bonfire before the Closing Time specified in the RFP. Responses cannot be uploaded to Bonfire after the Closing Time specified in the RFP, and any in process uploads cannot be finalized once the Closing Time has been reached.

5.2.4 Smart Columbus cannot see any uploads into Bonfire prior to the Closing Time specified in the RFP. Smart Columbus is unable to tell if an upload was successful until after the Closing Time specified in the RFP. However, successful submissions will receive an email as described in Section 5.2.3.

5.2.5 Minimum system requirements: Internet Explorer 11, Microsoft Edge, Google Chrome, or Mozilla Firefox. JavaScript and browser cookies shall be enabled.

5.3 Bonfire Technical Help

Smart Columbus is using a Bonfire portal for accepting and evaluating proposals digitally. Offerors shall contact Bonfire for technical help related to submissions at:

- https://columbus.bonfirehub.com/portal/support
- or 1-800-354-8010 (extension 2)

5.4 Questions

Direct questions via the Bonfire portal or SmartColumbusRFP@columbus.gov. No contact is to be made with Smart Columbus other than with the Contract Manager through e-mail with respect to proposals or the status thereof. The deadline for questions is February 14, 2019. Answers to questions received will be posted on the Bonfire portal as an addendum no later than February 19, 2019. For technical questions regarding submissions on Bonfire, see Section 5.3.

5.5 Evaluation

Proposals will be evaluated based on the enclosed selection criteria and in accordance with Columbus City Code, Section 329.28. The evaluation criteria for any contract awarded under this section shall include, but need not be limited to, the following: (1) The competence of the offeror to perform the required service as indicated by the technical training, education and experience of the offeror's personnel who would be assigned to perform the work; (2) The quality and feasibility of the offeror's technical proposal; (3) The ability of the offeror to perform the required service competently and expeditiously as indicated by the offeror's workload and the availability of necessary personnel, equipment and facilities; (4) Past performance of the offeror as reflected by evaluations of the city agency, other city agencies and other previous clients of the offeror with respect to such factors as quality of work, success in controlling costs, and success in meeting deadlines; and (5) An environmentally preferable factor except when there is not an environmentally preferable manner in which to carry out the purpose of the contract. Pricing will be included in the evaluation criteria.

PUBLIC RECORDS REQUESTS

The City of Columbus, as a political subdivision of the State of Ohio, is subject to Ohio Revised Code Chapter 149, known as the Ohio Public Records Law. Consequently, the Offeror understands that ALL documents submitted in response to this RFP are considered public records and WILL be released when a public records request is made by news media, competitors, or other interested parties, in accordance with the law. If you contend that certain CLEARLY MARKED portions of your response constitute an

exception to Ohio's public records law, you MUST submit your legal basis in support of that assertion with your response.

If a public records request is made for any portion of the documents that you have submitted and you have NOT clearly marked such documents as information constituting an exception to Ohio's public records law, your information will be released immediately.

If a public records request is made for such information and you HAVE clearly marked portions of your response as information constituting an exception to Ohio's public records law, AND you have submitted the legal basis supporting such claim, the City will release a redacted version of your information to the requestor and notify you that a request was made and that a redacted version of your response was released. Should the requestor indicate that the redacted version is not sufficient for their purposes, you then will be IMMEDIATELY responsible for obtaining an order from a Court of competent jurisdiction in Franklin County, Ohio enjoining release of your clearly marked information constituting an exception to Ohio's public records law.

If a public records request is made for such information and you HAVE clearly marked portions of your response as information constituting an exception to Ohio's public records law, but you have NOT submitted the legal basis supporting such claim, the City WILL RELEASE your information to the requestor and notify you that a request was made and that your response was released.

DO NOT mark your entire response/submittal as information constituting an exception to Ohio's public records law. If your entire response/submittal is so marked, the City of Columbus will not consider your offer.

5.6 Proposal Format

Only the following format will be accepted.

5.6.1 Proposals may not exceed twenty-five (25) letter-size (8.5" x 11") pages and shall include the information specified in Section 5.7.

5.6.2 Complete the required Proposal Signature Form and the Byrd Anti-Lobbying Amendment Compliance and Certification Form. That document shall be signed by a person authorized to obligate the Offeror's firm and included as the front page of the Offeror's proposal. This does not count towards the 25-page limit described in Section 5.6.1.

5.6.3 Page numbers shall be centered at the bottom of each page.

5.6.4 Font shall be 12 point, Times New Roman or Arial.

5.6.5 Cover letters are not required. If submitted, a cover letter will count against the 25-page limit of the proposal.

5.7 Proposal Content

5.7.1 The Offeror shall limit the proposal to no more than 25 total pages of information (e.g. text, graphics, etc.). A 'page' is one side of a sheet of paper with text, graphics, etc. If only one side of a sheet of paper has text, graphics, etc., then that is one page. If both sides of a sheet of paper have text, that is two pages. The proposal shall include the Proposal Signature Form, which is not counted in the 25-page limit. The required response to the requirement matrix is not counted in the 25-page limit. Vendor specs for products, as requested, are not counted in the 25-page limit. No appendices or additional information is acceptable. **Proposals exceeding the 25-page limit will be rejected.**

5.7.2 Provide information requested below in the order outlined or the proposal may be rejected.

5.7.3 Proposals shall address each of the following subjects in the order specified below, using the headings provided. These elements correspond to the evaluation criteria noted in Section 6. Note that page breaks **are not** required between sections. **Failure to provide the information requested may result in the proposal being rejected.**

Section A. Project Team

Identify the Project Team, including any subcontractors or vendors and the percentage of work to be performed by each firm. Present the education, training, experience, overall qualifications, and availability for the project manager and key staff.

In addition, provide an overview of the resources Smart Columbus should consider as part of the implementation plan.

Section B. Past Performance

Present the team's past performance on specific projects relevant to this project. For each project identified include: project name, project characteristics (including any unique conditions), team members and contact information, contract amount, and project duration (including dates). Projects with greater relevancy to this project will be given greater consideration. In addition, proposals shall demonstrate the financial stability and experience of the organization.

Section C. Solution, Understanding of the Project & Approach

Address understanding of the topics and provide technical capabilities related to the areas discussed in Sections 1 through 4 and Appendix C.

Present a project proposal that demonstrates the Offeror's understanding of the scope, challenges, and limits within the context of the project. Include an explanation of public involvement, workforce development, innovative approaches, and cost containment measures for project execution. Also include recommended testing procedures the Offeror would use to demonstrate their abilities to the public before deployment. Offeror shall submit the completed requirements table in Appendix C identifying which requirements they currently meet, will meet at deployment or will not meet.

Section D. Pricing

Based on the outlined approach, please provide a complete cost for deployment. Provide a per-unit cost for equipment as well as a lump sum cost for installation, integration, and testing as identified in Section 6. Include licensing costs, new release options, typical operations and maintenance, and costs of shipping and return in the pricing proposal. See the cost table in Appendix F for additional guidance.

6 Evaluation Criteria

Each proposal will be evaluated using the same criteria and associated point value as identified below. The maximum value that can be assigned to a proposal response is 100 points. The proposal responses will be reviewed by a committee comprised of the City of Columbus and DriveOhio. Resultant scores will be based on the content included in the submitted proposals, and if deemed necessary, interviews with selected Offerors.

6.1 Project Team

Section Maximum Value: 20 Points

To support the Offeror's proposed solution, the Offeror should provide an overview of the staff it will provide, and the resources Smart Columbus should consider as part of the implementation plan. The City of Columbus will be the contracting agency with the Offeror. Smart Columbus will guide the design, data collection, research, and evaluation efforts, while also serving as the project manager in support of the overall deployment. The organizational support plan should include the following components:

- A draft table of the Offeror's organization of staff and qualifications needed to deliver the proposed solution.
- A job description for each position within the draft table of Offeror's organization that identifies the roles and responsibilities in supporting the Offeror's proposed solution.
- The education, training, experience, overall qualifications, and availability for the project manager. Candidates should have strong communication skills and should have experience managing similar projects.
- A discussion of the approach the project manager and team will take to effectively manage this project.

6.2 Past Performance

Section Maximum Value: 25 Points

Responding Offerors will identify a maximum of three specific projects in its portfolio that best encapsulate the breadth of its capabilities directly related to this project's requirements, its ability to deliver the solution on time and its ability to send data to the Operating System. These featured projects will include a point of contact that can be called by the selection team as a reference. As the Offeror responds to the RFP, it should be made clear as to how many implementations have been delivered to date, both in the United States and internationally. Further, Offeror should include a representative qualification for each sub-contractor included on the offerors team.

Offeror should describe its experiences deploying the proposed technology in varying classes of vehicles and CV applications.

6.3 Solution, Understanding of Project & Approach

Section Maximum Value: 40 Points

The connected vehicle environment pilot program is vital to evaluating how connected vehicle technology can be used to enhance transportation safety and operations in a city. This score will be based on completeness of the response, understanding of and support for the goals of the program, and alignment with Smart Columbus' expectations. When submitting the details of the solution, please respond to the items and address the individual functional requirements defined in Sections 2 through 4 and Appendix C.

The Offeror should identify adherence to the schedule and how it intends to meet the required deliverables and dates to fully deploy the project.

Offeror should describe its ability to meet Smart Columbus' goals, including the plan to address installation in numerous vehicle types, the challenges of obtaining and maintaining reliable positioning, the varying maturity levels of CV applications and the plan to develop and test those needing further development, and data capture to the Operating System. Further, offeror should identify approach to meeting workforce development opportunities.

Offeror should describe the ability to meet the needs of the end users, as well as those of Smart Columbus.

The Offeror should demonstrate a thorough understanding of the project and how the Offeror's entire team will successfully execute the project. The Offeror should make a clear presentation of how the project team is organized, how they will coordinate with multiple related parties including the infrastructure integrator, the fleet owners, the Communications Team, the Management Team, the Operating System Team, and the PMO, and their understanding of the project requirements, including the challenges and areas of risk and a detailed plan for execution.

Specifically, the Offeror's proposal shall contain a narrative description tailored to the project, describing the staff assignments and the approach the Offeror intends to take to complete the project. The proposal should identify unique characteristics of the project and the challenges those elements present as well as options to overcome those challenges.

The Offeror's proposal should give the selection team a clear understanding of the Offeror's:

6.3.1 Process – The Offeror's process/approach to planning, executing, and evaluating deployments such as this.

6.3.2 Capabilities – Demonstration that the Offeror's capabilities fulfill the requirements of the RFP, and additional needs that may arise.

6.3.3 Initial Thinking – Offeror's initial ideas for achieving the project's objectives. This may include preliminary thoughts for operating in suboptimal conditions, initial recommendations for testing procedures, and insights on how to advertise to and educate potential participants.

6.3.4 Collaboration – How the Offeror will collaborate with the Smart Columbus team and within the Offeror's team to successfully deliver on the project's objectives. This includes a commitment to flexibility in operating parameters, particularly installation scheduling, in response to possible changes in real-world conditions.

6.3.5 Creativity – This may include proven innovations in the approach to meet and/or exceed this RFP's requirements, not explicitly outlined within this RFP.

6.3.6 Understanding of connections to other Smart Columbus projects – Understanding of and commitment to the aims of the entire Smart Columbus program.

6.3.7 Organizational and Infrastructure Support for Offeror's Solution – In order to support the Offeror's proposed solution, the Offeror should provide an overview of the resources Smart Columbus should consider as part of the implementation plan. The City of Columbus will be the contracting agency with the Offeror. Smart Columbus will lead the design, data collection, research, and evaluation efforts, while also serving as the project manager in support of the overall deployment. The organizational support plan should include the following components:

- A draft table of organization of staff needed to support the Offeror's proposed solution.

A job description for each position within the draft table of organization that identifies the roles and responsibilities in supporting the Offeror's proposed solution.

6.4 Price

Section Maximum Value: 15 Points

The City will negotiate scope and price with the Offeror prior to contract execution. The City will have the ability to modify the Offeror's contract if changes in scope are agreed upon by all parties. The total cost of the approach for the duration of the demonstration (approximately 19 months total, including preparation, testing, and nine (9) full months of operational period) will be assessed, including the following cost breakouts:

- CV Application development
- OBU setup, including integration and testing, up until normal operations begin
- Any one time and ongoing licensing costs
- Coordination and participant installation management
- Equipment and installation by vehicle type
- Shipping and returns
- Workforce training premium (if any)
- Operations and maintenance

See Appendix F for an example table of what should be submitted by each Offeror. Additional rows may be added as appropriate. The tables in Appendix G and Appendix H are included for reference and will be completed by the Offeror after selection.

7 Selection Process

The Selection Committee shall evaluate the Offerors strictly upon the submitted proposals and interviews with selected Offerors if interviews are conducted.

The committee shall evaluate all Offerors and proposals received and rank the Offerors based upon the evaluation criteria specified in the RFP. The committee may select two (2) or more of the highest qualified offerors with which to hold additional discussions. Offerors not selected for further discussions may be excluded from further consideration for the contract upon notification by the City.

The discussions identified in this subsection may include, but are not limited to, presentations by the offerors to the committee to elaborate upon their qualifications, proposals, and/or other pertinent information. The committee may permit revisions of proposals so long as all offerors who are selected for additional discussions are given equal opportunity to revise their proposals.

Based upon the content of the proposals received including any revisions thereto, and upon any additional discussions with the offerors the committee shall rank the remaining offerors based upon the evaluation criteria specified in the RFP.

The committee shall submit its ranking of the offerors along with a written explanation to the Chief Innovation Officer. The ranking and written explanation shall become part of the contract file.

The Chief Innovation Officer shall have discretion consistent with appropriate citywide administrative rules in selecting the Offeror with which to enter into contract negotiations. The city shall enter into contract negotiations with the selected offeror to determine the terms and conditions of the contract, including compensation to be paid by the city. If negotiations fail, negotiations with this offeror shall be terminated, and the city agency may enter into contract negotiations with another Offeror as selected by the director. This process may continue until a contract is successfully negotiated.

After successfully negotiating a contract, the city agency shall submit legislation to city council requesting approval of the contract. In its request for approval, the city agency shall explain the basis for the selection of the chosen contractor. No contract awarded under this section shall be effective until approved by ordinance of city council.

Appendix A: CVE Concept of Operations

<See separate CVE_ConOps file provided in Bonfire>

Note: The CVE Concept of Operations represented the state of the system when the document was published. Information related to vehicle quantities, HMI-types, and CV application needs, as stated in this RFP supersede those in the ConOps.

Appendix B: CVE System Requirements

<See separate CVE_SysRS file provided in Bonfire>

Note: The CVE Systems Requirements represented the state of the system when the document was published. The current, updated set of system requirements, specific to the OBU may be found in Appendix C of this document.

Appendix C: Requirements Verification Matrix

As part of the RFP response, the offeror is requested to review each of requirements associated with the in-vehicle components of the CVE as documented in this appendix (and for the offerors convenience – included as a separate Microsoft Excel file available in Bonfire); and to provide an assessment of the offeror's ability to meet each of these requirements using the following criteria:

Fully Compliant – The proposed solution can meet the requirement exactly as indicated using an off-the-shelf product.

Comply with minor modification – The proposed solution can meet the requirement with minimal changes to the product and without impacting the ability to deliver on schedule. Offeror should indicate the proposed change or reason need for change.

Comply with major modification – The proposed solution can meet the requirement with changes to the product that would likely impact the ability to deliver per the current schedule. Offeror should indicate what an expected revised delivery might be and the reason for not meeting the requirement.

Non-Compliant – The proposed solution cannot meet the requirement without significant change that will have major impact to budget and schedule.

This appendix is organized by functional groups (Common, DSRC Messages, Transit Management Center, V2I Mobility, V2I Safety, V2V Safety, Vehicle Onboard Equipment) and includes requirements of the type functional, performance, interface, etc. To assist in identifying the requirement type, we have included the numbering convention that is in use for the CVE System Requirements. The numbering scheme follows immediately and the remainder of the appendix list the requirements.

Requirement Numbering Scheme

Each constraint and requirement contains a unique ID for traceability and configuration management. Requirements for all projects in the Smart Columbus program will follow the same convention. This identifier contains three elements partitioned into five octets, each representing an identifiable attribute of the requirement. **Table 3: Requirements Numbering Convention** lists the naming convention of the requirements.

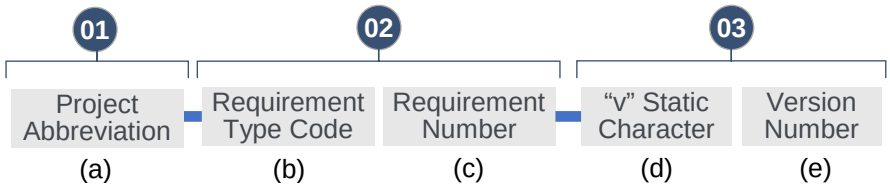


Table 3: Requirements Numbering Convention

	Description	**Data Type, Casing**	**# of Characters and/or Digits**
Project Abbreviation	The designated Smart Columbus project acronym (e.g. CVE, EPM, etc.)	String, upper case	Variable
Requirement Type Code	• FN: Functional • PR: Performance • IF: Interface • DR: Data • SR: Security • RG: Policy and Regulation • PY: Physical • AR: Availability and Recovery • MT: Maintainability • ST: Storage and Transport • DP: Disposal • IM: Information Management • LC: Life Cycle Sustainability	String, upper case	2
Requirement Number	An integer incrementing by one, indicating the number of requirements established	Integer	3
"v" Static Character	Static letter "v" represents the requirement version	Character	1
Version Number	An integer incrementing by one, indicating the number of revisions made to the requirement	Integer	2

Source: City of Columbus

Table 4: Common Requirements

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DP1465-V01	Common	The CVE should remain operational after the completion of the deployment period	Demonstration	
CVE-MT1593-V01	Common	DPS shall retain Support Staff to troubleshoot and diagnose RSU and OBU issues.	Demonstration	
CVE-MT1594-V01	Common	A set of support, diagnostic and troubleshooting procedures shall be developed to guide the support staff.	Demonstration	
CVE-MT1595-V01	Common	DPS shall maintain a list of OBU equipment and contact information for vehicle owners that have OBUs installed	Demonstration	
CVE-MT1596-V01	Common	Support Staff Device installers shall be approved by DPS to install roadside equipment (including RSUs) in signal cabinets and along the roadside.	Demonstration	
CVE-MT1597-V01	Common	Support Staff Device installers shall be approved by DPS to install OBUs in participant vehicles.	Demonstration	
CVE-MT1598-V01	Common	Support Staff shall be trained by the RSU vendor to install RSU Devices	Demonstration	
CVE-MT1599-V01	Common	Support Staff shall be trained by the OBU vendor to install OBU Devices	Demonstration	
CVE-MT1600-V01	Common	Support Staff Device installers shall be approved by DPS to install OBU devices in private light-duty vehicles, city fleet vehicles, transit vehicles, Emergency Vehicles, freight vehicles, and CEAVs.	Demonstration	
CVE-MT1602-V01	Common	Department of Public Service shall maintain the RSUs installed along the roadside.	Demonstration	
CVE-MT1603-V01	Common	Department of Public Service shall provide contact information for participants inquire about OBUs.	Demonstration	
CVE-MT1604-V01	Common	A participant shall be able to return the OBU to DPS for any reason (OBU malfunction, remove/uninstall OBU, etc.)	Demonstration	

Table 5: DSRC Messages Requirements

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR3005-V01	Basic Safety Message	The BSM Part I shall include all data elements contained in the (coreData) BSMcoreData data frame (SAE J2735, Section 6.8)	Demonstration	
CVE-DR3006-V01	Basic Safety Message	The BSM Part II shall include all data elements contained in the (trailers) TrailerData data frame (SAE J2735, Section 6.135)	Demonstration	
CVE-PR1105-V01	Basic Safety Message	The BSM shall be broadcast at a frequency of 10 Hz when congestion control algorithms (SAE J2945/1) do not prescribe a reduced rate	Test	
CVE-PR3003-V01	Basic Safety Message	The BSM shall always include Part I data (SAE J2735, Section 6.8)	Demonstration	
CVE-PR3007-V01	Basic Safety Message	The BSM generated by a vehicle with a coupled trailer (typically an HDV) should always contain Part II (SpecialVehicleExtensions) trailers TrailerData (SAE J2735, Section 6.8)	Demonstration	
CVE-PR3008-V01	Basic Safety Message	The BSM generated by a vehicle with a coupled trailer (typically an HDV) shall contain Part II content (specified the data requirements) at a minimum of 1 Hz	Demonstration	
CVE-PR3009-V01	Basic Safety Message	The BSM shall be broadcast at the frequency specified by congestion control algorithms (SAE J2945/1) when congestion control algorithms (SAE J2945/1) prescribe a reduced frequency	Demonstration	
CVE-DR1144-V01	MapData Message	The MAP Message shall contain the (msgIssueRevision) MsgCount data element (SAE J2735, Section 7.104)	Demonstration	
CVE-DR1145-V01	MapData Message	The MAP Message shall contain the (intersections) IntersectionGeometryList data frame (a sequence of IntersectionGeometry; SAE J2735, Section 6.35)	Demonstration	
CVE-DR1146-V01	MapData Message	The MAP Message shall contain the IntersectionGeometry data frame under the (intersections) IntersectionGeometryList data frame	Demonstration	
CVE-DR1147-V01	MapData Message	The MAP Message shall contain the (id) IntersectionReferenceID data frame (SAE J2735, Section 6.36) under the IntersectionGeometry data frame	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR1148-V01	MapData Message	The MAP Message shall contain the (id) IntersectionID data element (SAE J2735, Section 7.56) under the (id) IntersectionReferenceID data frame	Demonstration	
CVE-DR1149-V01	MapData Message	The MAP Message shall contain the (revision) MsgCount data element (SAE J2735, Section 7.104) under the IntersectionGeometry data frame	Demonstration	
CVE-DR1150-V01	MapData Message	The MAP message shall contain the (refPoint) Position3D data frame (SAE J2735, Section 6.87) under the IntersectionGeometry data frame	Demonstration	
CVE-DR1151-V01	MapData Message	The MAP Message shall contain the (lat) Latitude data element (SAE J2735, Section 7.91) under the (refPoint) Position3D data frame	Demonstration	
CVE-DR1152-V01	MapData Message	The MAP Message shall contain the (long) Longitude data element (SAE J2735, Section 7.95) under the (refPoint) Position3D data frame	Demonstration	
CVE-DR1153-V01	MapData Message	The MAP Message shall contain the (laneWidth) LaneWidth data element (SAE J2735, Section 7.90) under the IntersectionGeometry data frame	Demonstration	
CVE-DR1154-V01	MapData Message	The MAP Message shall contain the LaneList data frame (a sequence of GenericLane; SAE J2735, Section 6.47) under the IntersectionGeometry data frame	Demonstration	
CVE-DR1155-V01	MapData Message	The MAP Message shall contain the GenericLane data frame (SAE J2735, Section 6.29) under the LaneList data frame	Demonstration	
CVE-DR1156-V01	MapData Message	The MAP Message shall contain the (laneID) LaneID data element (SAE J2735, Section 7.88) under the GenericLane data frame	Demonstration	
CVE-DR1157-V01	MapData Message	The MAP Message shall contain the (maneuvers) AllowedManeuvers data element (SAE J2735, Section 7.4) under the GenericLane data frame	Demonstration	
CVE-DR1158-V01	MapData Message	The MAP Message shall contain the NodeListXY data frame (SAE J2735, Section 6.72) under the GenericLane data frame	Demonstration	
CVE-DR1159-V01	MapData Message	The MAP Message shall contain the (nodes) NodeSetXY data frame (a sequence of NodeXY; SAE J2735, Section 6.77) under the NodeListXY data frame	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR1160-V01	MapData Message	The MAP Message shall contain the NodeXY data frame (SAE J2735, Section 6.78) under the (nodes) NodeSetXY data frame	Demonstration	
CVE-DR1161-V01	MapData Message	The MAP Message shall contain the (delta) NodeOffsetPointXY data element (SAE J2735, Section 6.75) under the NodeXY data frame (Any representation Node-XY-20b through Node-XY-32b; SAE J2735, Section 6.61, 6.62, 6.63, 6.64, 6.65, 6.66)	Demonstration	
CVE-DR1162-V01	MapData Message	The MAP Message shall contain the (connectsTo) ConnectsToList data frame (a sequence of Connection; SAE J2735, Section 6.16) under the GenericLane data frame	Demonstration	
CVE-DR1163-V01	MapData Message	The MAP Message shall contain the Connection data frame (SAE J2735, Section 6.14) under the (connectsTo) ConnectsToList data frame	Demonstration	
CVE-DR1164-V01	MapData Message	The MAP Message shall contain the (connectingLane) ConnectingLane data frame (SAE J2735, Section 6.13) under the Connection data frame	Demonstration	
CVE-DR1165-V01	MapData Message	The MAP Message shall contain the (lane) LaneID data element (SAE J2735, Section 7.88) under the (connectingLane) ConnectingLane data frame	Demonstration	
CVE-DR1166-V01	MapData Message	The MAP Message shall contain the (maneuver) AllowedManeuvers data element (SAE J2735, Section 7.4) under the (connectingLane) ConnectingLane data frame	Demonstration	
CVE-DR1167-V01	MapData Message	The MAP Message shall contain the (signalGroup) SignalGroupID data element (SAE J2735, Section 7.171) under the Connection data frame	Demonstration	
CVE-DR1168-V01	MapData Message	The MAP Message should describe all egress lanes. This makes it possible to connect each ingress lane to the corresponding egress lane and also to describe the allowed maneuvers on all ingress lanes.	Demonstration	
CVE-DR1169-V01	MapData Message	The MAP Message egress lanes (if included) may optionally contain a maneuvers field or a connectsTo field	Demonstration	
CVE-DR1170-V01	MapData Message	The MAP Message egress lanes (if included) may optionally contain the nodes in the NodeSet sequenced such that the first node is the stop bar	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR1171-V01	MapData Message	The MAP Message Node points shall correspond to the center of the lane	Demonstration	
CVE-DR1172-V01	MapData Message	The MAP Message Node points should extend to a recommended minimum of 300 m from the stop bar	Demonstration	
CVE-DR1173-V01	MapData Message	The MAP Message shall include a minimum of two node points to define the lane	Demonstration	
CVE-DR1174-V01	MapData Message	The MAP Message shall define node points such that the perpendicular distance between two node points and the center of the lane shall be less than 0.5 m	Demonstration	
CVE-DR1175-V01	MapData Message	The MAP Message nodes in NodeSet shall be sequenced, in the case of an ingress lane, such that the first node is the stop bar	Demonstration	
CVE-DR1176-V01	MapData Message	The MAP Message shall describe all ingress lanes	Demonstration	
CVE-DR1177-V01	MapData Message	The MAP Message shall contain a maneuvers field and a connectsTo field for each ingress lane. The connectsTo field describes one or more Connections to egress lanes.	Demonstration	
CVE-DR1178-V01	MapData Message	The MAP Message Connection field shall contain the lane, maneuver, and signalGroup associated with the Connection. The signalGroup identifies which signal group in the SPaT controls the flow of traffic from the ingress lane to the egress lane.	Demonstration	
CVE-DR1179-V01	MapData Message	The MAP message containing a single physical lane which has multiple different signals assigned (e.g., for straight and for right-turn movement), shall be represented by a single ingress lane and multiple connections that specify the relevant movements and the associated signal groups	Demonstration	
CVE-DR1181-V01	MapData Message	The MAP message IntersectionGeometry revision shall be changed only if the map information was updated.	Demonstration	
CVE-DR1182-V01	MapData Message	The MAP message shall contain a laneList. Each lane in the laneList shall be identified as an ingress lane or an egress lane through the laneAttributes->directionalUse field.	Demonstration	
CVE-PR1183-V01	MapData Message	The MAP message shall be expressed with an accuracy of 0.5 m or less.	Inspection	
CVE-PR2993-V01	MapData Message	The MAP message shall be transmitted with a frequency of at least 1 Hz	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR1374-V01	Radio Technical Commission for Maritime Services Corrections Message	The RTCM message (SAE J2735, Section 7.163) shall include message type 1001 GPS L1 observations at 5 Hz	Demonstration	
CVE-DR1375-V01	Radio Technical Commission for Maritime Services Corrections Message	The RTCM message (SAE J2735, Section 7.163) shall include message type 1005 Antenna Reference Point (ARP) coordinates at 2 Hz	Demonstration	
CVE-DR1292-V01	Roadside Safety Message	The Traffic CV Management System shall generate a RSM consistent with SAE J2945/4	Demonstration	
CVE-DR1294-V01	Roadside Safety Message	The RSM shall contain the speed limit for the reduced speed (school) zone (SAE J2945/4, Section 2.5.2.2.2.3)	Demonstration	
CVE-DR1296-V01	Roadside Safety Message	The RSM shall contain the reduced speed zone geometry (SAE J2945/4, Section 2.5.2.2.2.4).	Demonstration	
CVE-DR3089-V01	Roadside Safety Message	The RSM shall contain the event identification number (SAE J2945/4, Section 2.5.2.1.1)	Demonstration	
CVE-DR3090-V01	Roadside Safety Message	The RSM shall contain the event type (SAE J2945/4, Section 2.5.2.1.2)	Demonstration	
CVE-DR3091-V01	Roadside Safety Message	The RSM shall contain the event start time (SAE J2945/4, Section 2.5.2.1.3.1)	Demonstration	
CVE-DR3092-V01	Roadside Safety Message	The RSM shall contain the event duration (SAE J2945/4, Section 2.5.2.1.3.1)	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR3093-V01	Roadside Safety Message	The RSM shall contain all data elements in the Geographic Information data frame (SAE J2945/4, Section 2.5.2.1.5)	Demonstration	
CVE-DR1378-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (timeStamp) MinuteOfTheYear data element (SAE J2735, Section 7.100)	Demonstration	
CVE-DR1379-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (intersections) IntersectionStateList data frame (a sequence of IntersectionState; SAE J2735, Section 6.38)	Demonstration	
CVE-DR1380-V01	Signal Phase and Timing Message	The SPaT Message shall contain the IntersectionState data frame (SAE J2735, Section 6.37) under the IntersectionStateList data frame	Demonstration	
CVE-DR1381-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (id) IntersectionReferenceID data frame (SAE J2735, Section 6.36) under the IntersectionState data frame	Demonstration	
CVE-DR1382-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (revision) MsgCount data element (SAE J2735, Section 7.104) under the IntersectionState data frame	Demonstration	
CVE-DR1383-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (status) IntersectionStatusObject data element (SAE J2735, Section 7.57) under the IntersectionState data frame	Demonstration	
CVE-DR1384-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (timeStamp) Dsecond data element (SAE J2735, Section 7.39) under the IntersectionState data frame	Demonstration	
CVE-DR1385-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (states) MovementList data frame (a sequence of MovementState; SAE J2735, Section 6.52) under the IntersectionState data frame	Demonstration	
CVE-DR1386-V01	Signal Phase and Timing Message	The SPaT Message shall contain the MovementState data frame (SAE J2735, Section 6.53) under the MovementList data frame	Demonstration	
CVE-DR1387-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (signalGroup) SignalGroupID data element (SAE J2735, Section 7.171) under the MovementState data frame	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR1388-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (state-time-speed) MovementEventList data frame (a sequence of MovementEvent; SAE J2735, Section 6.50) under the MovementState data frame	Demonstration	
CVE-DR1389-V01	Signal Phase and Timing Message	The SPaT Message shall contain the MovementEvent data frame (SAE J2735, Section 6.51) under the MovementEventList data frame	Demonstration	
CVE-DR1390-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (eventState) MovementPhaseState data element (SAE J2735, Section 7.103) under the MovementEvent data frame	Demonstration	
CVE-DR1391-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (timing) TimeChangeDetails data frame (SAE J2735, Section 6.134) under the MovementEvent data frame	Demonstration	
CVE-DR1392-V01	Signal Phase and Timing Message	The SPaT Message shall contain the (minEndTime) TimeMark data element (SAE J2735, Section 7.194) under the TimeChangeDetails data frame	Demonstration	
CVE-DR1393-V01	Signal Phase and Timing Message	The SPaT Message should contain the (maxEndTime) TimeMark data element (SAE J2735, Section 7.194) under the TimeChangeDetails data frame	Demonstration	
CVE-DR1394-V01	Signal Phase and Timing Message	The SPaT Message should contain the (likelyTime) TimeMark data element (SAE J2735, Section 7.194) under the TimeChangeDetails data frame	Demonstration	
CVE-DR1395-V01	Signal Phase and Timing Message	The SPaT Message shall contain a 'states' field, which is a list of one or more MovementStates. The number of MovementStates shall correspond to the number of movements defined in the MAP messages which should be based on controller traffic phases that are currently active at the intersection.	Demonstration	
CVE-DR1396-V01	Signal Phase and Timing Message	The SPaT Message signalGroup shall be assigned number and is not necessarily based on the controller phase number	Demonstration	
CVE-DR1397-V01	Signal Phase and Timing Message	The SPaT Message should provide maxEndTime or likelyTime	Demonstration	
CVE-DR1398-V01	Signal Phase and Timing Message	The SPaT Message should provide maxEndTime if the traffic signal controller is running fixed-time, and if transmitted shall be equal to minEndTime	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-PR1399-V01	Signal Phase and Timing Message	The SPaT messages shall be generated and transmitted by the RSU with a minimum frequency of 10 Hz	Test	
CVE-PR1400-V01	Signal Phase and Timing Message	The SPaT MsgCount data field shall be incremented with every update that is made to the corresponding IntersectionState data frame	Test	
CVE-PR1401-V01	Signal Phase and Timing Message	The SPaT MovementStates shall be updated with at least the computation frequency of the traffic signal controller. If the controller is operating at 1 Hz, it is permissible to repeat the same MovementState information in 10 SPaT messages. However, if the controller is operating at 10 Hz or greater, the MovementStates needs to be updated for every message.	Test	
CVE-DR1402-V01	Signal Request Message	The OBU shall generate a SRM consistent with SAE J2735	Demonstration	
CVE-DR1404-V01	Signal Request Message	The SRM shall contain the (second) DSecond data element (SignalRequestMessage.second) (SAE J2735, Section 7.39)	Demonstration	
CVE-DR1405-V01	Signal Request Message	The SRM shall contain the (requests) SignalRequestList data frame (sequence of SignalRequestPackage; SAE J2735, Section 6.118)	Demonstration	
CVE-DR1406-V01	Signal Request Message	The SRM shall contain the SignalRequestPackage data frame (SAE J2735, Section 6.119) under the SignalRequestList data frame	Demonstration	
CVE-DR1407-V01	Signal Request Message	The SRM shall contain the (request) SignalRequest data frame (SAE J2735, Section 6.120) under the SignalRequestPackage data frame	Demonstration	
CVE-DR1408-V01	Signal Request Message	The SRM shall contain the (id) IntersectionReferenceID data frame (SAE J2735, Section 6.36) under the SignalRequest data frame	Demonstration	
CVE-DR1409-V01	Signal Request Message	The SRM shall contain the (id) IntersectionID data element (SAE J2735, Section 7.56) under the intersectionReferenceID data frame	Demonstration	
CVE-DR1410-V01	Signal Request Message	The SRM shall contain the (requestID) RequestID data element (SAE J2735, Section 7.153) under the SignalRequest data frame	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR1411-V01	Signal Request Message	The SRM shall contain the (requestType) PriorityRequestType data element (SAE J2735, Section 7.142) under the SignalRequest data frame	Demonstration	
CVE-DR1412-V01	Signal Request Message	The SRM shall contain the (inBoundLane) IntersectionAccessPoint data frame (SAE J2735, Section 6.33) under the SignalRequest data frame	Demonstration	
CVE-DR1413-V01	Signal Request Message	The SRM shall contain the (lane) LaneID data element (SAE J2735, Section 7.88) under the IntersectionAccessPoint data frame	Demonstration	
CVE-DR1414-V01	Signal Request Message	The SRM shall contain the (approach) ApproachID data element (SAE J2735, Section 7.11) under the IntersectionAccessPoint data frame	Demonstration	
CVE-DR1415-V01	Signal Request Message	The SRM shall contain the (connection) LaneConnectionID data element (SAE J2735, Section 7.86) under the IntersectionAccessPoint data frame	Demonstration	
CVE-DR1416-V01	Signal Request Message	The SRM shall contain the (requestor) RequestorDescription data frame (SAE J2735, Section 6.98)	Demonstration	
CVE-DR1417-V01	Signal Request Message	The SRM shall contain the (id) VehicleID data frame (SAE J2735, Section 6.147) under the RequestorDescription data frame	Demonstration	
CVE-DR1418-V01	Signal Request Message	The SRM shall contain the (entityID) TemporaryID (SAE J2735, Section 7.187) under the VehicleID data frame	Demonstration	
CVE-PR2995-V01	Signal Request Message	The SRM shall be broadcast at the configured frequency (functional reqs describe when to start/stop broadcasting)	Demonstration	
CVE-DR1420-V01	Signal Status Message	The RSU shall generate a SSM consistent with SAE J2735	Demonstration	
CVE-DR1422-V01	Signal Status Message	The SSM shall contain the (second) DSecond data element (SignalStatusMessage.second) (SAE J2735, Section 7.39)	Demonstration	
CVE-DR1423-V01	Signal Status Message	The SSM shall contain the (status) SignalStatusList data frame (sequence of SignalStatus; SAE J2735, Section 6.121)	Demonstration	
CVE-DR1424-V01	Signal Status Message	The SSM shall contain the (sequenceNumber) MsgCount data element (SAE J2735, Section 7.104) under the SignalStatus data frame	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-DR1425-V01	Signal Status Message	The SSM shall contain the (id) IntersectionReferenceID data frame (SAE J2735, Section 6.36) under the SignalStatus data frame	Demonstration	
CVE-DR1426-V01	Signal Status Message	The SSM shall contain the (sigStatus) SignalStatusPackageList data frame (sequence of SignalStatusPackage; SAE J2735, Section 6.122) under the SignalStatus data frame	Demonstration	
CVE-DR1427-V01	Signal Status Message	The SSM shall contain the SignalStatusPackage data frame (SAE J2735, Section 6.123) under the SignalStatusPacakageList data frame	Demonstration	
CVE-DR1428-V01	Signal Status Message	The SSM shall contain the (requestor) SignalRequestorInfo data frame (SAE J2735, Section 6.117) under the SignalStatusPackage data frame	Demonstration	
CVE-DR1429-V01	Signal Status Message	The SSM shall contain the (id) VehicleID data frame (SAE J2735, Section 6.147) under the SignalRequestorInfo data frame	Demonstration	
CVE-DR1430-V01	Signal Status Message	The SSM shall contain the (request) RequestID (SAE J2735, Section 7.153) under the SignalRequestorInfo data frame	Demonstration	
CVE-DR1431-V01	Signal Status Message	The SSM shall contain the (sequenceNumber) MsgCount (SAE J2735, Section 7.104) under the SignalRequestorInfo data frame	Demonstration	
CVE-DR1432-V01	Signal Status Message	The SSM shall contain the (inboundOn) IntersectionAccessPoint data frame (SAE J2735, Section 6.33) under the SignalStatusPackage data frame	Demonstration	
CVE-DR1433-V01	Signal Status Message	The SSM shall contain the (lane) LaneID data element (SAE J2735, Section 7.88) under the IntesectionAccessPoint data frame	Demonstration	
CVE-DR1434-V01	Signal Status Message	The SSM shall contain the (approach) ApproachID data element (SAE J2735, Section 7.11) under the IntesectionAccessPoint data frame	Demonstration	
CVE-DR1435-V01	Signal Status Message	The SSM shall contain the (connection) LaneConnectionID data element (SAE J2735, Section 7.86) under the IntesectionAccessPoint data frame	Demonstration	
CVE-DR1436-V01	Signal Status Message	The SSM shall contain the (status) PrioritizationResponseStatus data element (SAE J2735, Section 7.140) under the SignalStatusPackage data frame	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-PR2999-V01	Signal Status Message	The SSM shall be broadcast at the configured frequency (functional reqs describe when to start/stop broadcasting)	Demonstration	

Table 6: Transit Management Center Requirements

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN3039-V01	Transit CV Management System	The Transit CV Management System shall provide a means of allowing Transit Management Staff to download archived Transit Vehicle Interaction Events.	Demonstration	
CVE-FN3040-V01	Transit CV Management System	The Transit CV Management System shall copy all archived Transit Vehicle Interaction Events into the archived CV data backup storage	Demonstration	
CVE-FN3042-V01	Transit CV Management System	The Transit CV Management System shall allow transit management staff to configure the generation of performance measures from archived CV data (e.g. a recurring database query).	Demonstration	
CVE-FN3043-V01	Transit CV Management System	The Transit CV Management System shall transmit performance metrics (as configured by transit management staff and defined in the Performance Measurement Plan) to the Smart Columbus OS	Demonstration	
CVE-IF1277-V01	Transit CV Management System	The Transit CV Management System shall generate performance metrics (as configured by transit management staff and as defined in the Performance Measurement Plan)	Demonstration	
CVE-IF1472-V01	Transit CV Management System	The Transit CV Management System shall send Transit Vehicle Interaction Events to the Smart Columbus OS	Demonstration	
CVE-IF1473-V01	Transit CV Management System	The Transit CV Management System shall make Transit Vehicle Interaction Events available to Transit Management Staff	Demonstration	
CVE-PR3035-V01	Transit CV Management System	The Transit CV Management System shall be able to store at a minimum of 5 TB of archived Transit Vehicle Interaction Events	Inspection	
CVE-PR3036-V01	Transit CV Management System	The Transit CV Management System shall be able to store at a minimum of 5 TB of backup archived Transit Vehicle Interaction Events	Inspection	
CVE-PR3037-V01	Transit CV Management System	The Transit CV Management System shall copy all archived Transit Vehicle Interaction Events into the backup archived Transit Vehicle Interaction Events once per day.	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-PY3038-V01	Transit CV Management System	The Transit CV Management System shall store archived Transit Vehicle Interaction Events and backup archived Transit Vehicle Interaction Events on separate physical storage devices.	Inspection	

Table 7: V2I Mobility Requirements

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1493-V01	Emergency Vehicle Preemption	An Emergency Vehicle OBU shall request to receive signal preemption at RSU-equipped intersections	Demonstration	
CVE-FN1497-V01	Emergency Vehicle Preemption	The EVP application should employ algorithms that are used in MMITSS to enable emergency vehicle preemption	Demonstration	
CVE-FN3107-V01	Emergency Vehicle Preemption	An Emergency Vehicle OBU shall request to receive signal preemption for all possible movements for the leg of the intersection of which it is approaching.	Demonstration	
CVE-PR1531-V01	Emergency Vehicle Preemption	The EVP application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-PR1532-V01	Emergency Vehicle Preemption	An Emergency Vehicle OBU (host) shall issue a signal preemption notification to the Emergency Vehicle Operator (via the HMI) when preemption has been granted	Demonstration	
CVE-FN1479-V01	Freight Signal Priority	An HDV OBU shall request to receive signal priority at RSU-equipped intersections	Demonstration	
CVE-FN1480-V01	Freight Signal Priority	An HDV OBU shall broadcast a SRM when approaching an RSU-equipped intersection	Demonstration	
CVE-FN1481-V01	Freight Signal Priority	An HDV OBU shall broadcast a SRM when it is within a configurable distance of the intersection it intends to request priority for	Demonstration	
CVE-FN1482-V01	Freight Signal Priority	An HDV OBU shall only request priority for movements is plans to make along a designated freight route (specific to the requesting HDV)	Demonstration	
CVE-FN1483-V01	Freight Signal Priority	An HDV OBU shall only request priority in a SRM	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1484-V01	Freight Signal Priority	An HDV OBU shall cease broadcasting SRMs for priority at a given intersection for a configurable amount of time after it has received an SSM from that intersection that contains the HDV OBU ID (security layer of SRM contains information that can be used as identifier)	Demonstration	
CVE-PR1527-V01	Freight Signal Priority	The FSP application should employ algorithms that are used in MMITSS to enable freight signal priority	Demonstration	
CVE-PR1528-V01	Freight Signal Priority	The FSP application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-DR1477-V01	General Priority/Preemption	The TSP Application shall require data from the SSM Message	Demonstration	
CVE-DR1478-V01	General Priority/Preemption	The TSP Application shall generate data for the SRM Message	Demonstration	
CVE-FN1498-V01	General Priority/Preemption	The SRM shall contain the intersection ID that is provided in the MAP message for the priority requested intersection	Demonstration	
CVE-FN1499-V01	General Priority/Preemption	The SRM shall contain information regarding the movement for which priority is being requested	Demonstration	
CVE-FN1520-V01	General Priority/Preemption	The Traffic CV Management System shall maintain a modifiable list of OBU IDs (security layer of SRM contains information that can be used as identifier) authorized to send SRMs along with time periods when each vehicle is able to receive priority or preemption at each intersection, and movements for which each vehicle is able to receive priority or preemption at each intersection.	Demonstration	
CVE-FN1521-V01	General Priority/Preemption	The Traffic CV Management System shall maintain a modifiable list of intersections for which each authorized OBU is allowed to request priority or preemption at.	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1524-V01	General Priority/Preemption	The RSU shall have a method of determining if an OBU ID (security layer of SRM contains information that can be used as identifier) is authorized to receive signal priority at the intersection it is located at	Demonstration	
CVE-FN1525-V01	General Priority/Preemption	The RSU shall have a method of determining if an OBU ID (security layer of SRM contains information that can be used as identifier) is authorized to receive signal preemption at the intersection it is located at	Demonstration	
CVE-FN1488-V01	Transit Signal Priority	A Transit Vehicle OBU shall request to receive signal priority at RSU-equipped intersections	Demonstration	
CVE-FN1489-V01	Transit Signal Priority	A Transit Vehicle OBU shall send a SRM to an RSU when it is within a configurable distance of the intersection it intends to request priority for	Demonstration	
CVE-FN1490-V01	Transit Signal Priority	A Transit Vehicle OBU shall only request priority in an SRM	Demonstration	
CVE-FN1491-V01	Transit Signal Priority	A Transit Vehicle OBU shall only request priority for movements along the route being traversed by that transit vehicle	Demonstration	
CVE-FN1492-V01	Transit Signal Priority	A Transit Vehicle OBU shall cease broadcasting SRMs for priority at a given intersection for a configurable amount of time after it has received an SSM from that intersection that contains the Transit Vehicle OBU ID (security layer of SRM contains information that can be used as identifier)	Demonstration	
CVE-IF1526-V01	Transit Signal Priority	The TSP Application shall receive data from the OBU's internal processing functions.	Demonstration	
CVE-PR1529-V01	Transit Signal Priority	The TSP application should employ algorithms that are used in MMITSS to enable transit signal priority	Demonstration	
CVE-PR1530-V01	Transit Signal Priority	The TSP application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-DR1533-V01	Transit Vehicle Interaction Event Recording	The TVIER Application shall capture data from V2V Safety and V2I Safety applications deployed on the Transit Vehicle	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1534-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall determine when to record a Transit Vehicle Interaction Event. Note: A Transit Vehicle Interaction Event contains the type of event along with a log of selected messages and/or parameters (vehicle speed, acceleration/deceleration, vehicle location). Logging shall be configurable and shall include the ability to log based on a trigger (e.g. DSRC message, emergency event).	Demonstration	
CVE-FN1535-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall not issue alerts to the transit vehicle operator	Demonstration	
CVE-FN1536-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall log a Transit Vehicle Interaction Event when there is emergency braking ahead by an OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1537-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall log a Transit Vehicle Interaction Event when a forward collision is imminent with another OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1538-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall log a Transit Vehicle Interaction Event when there is an intersection collision detected with another OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1540-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall log a Transit Vehicle Interaction Event when a lane change collision is imminent with another OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1541-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall log a Transit Vehicle Interaction Event when the transit vehicle (host) runs a red light at an RSU-equipped intersection	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1542-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall log a Transit Vehicle Interaction Event when the vehicle will enter an RSU-equipped school zone over the active school zone speed limit	Demonstration	
CVE-FN1543-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall log a Transit Vehicle Interaction Event when the vehicle is inside of an RSU-equipped school zone over the active school zone speed limit	Demonstration	
CVE-FN1544-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall store any BSMs received in local memory for a configurable amount of time.	Demonstration	
CVE-FN1545-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall store any SPaT messages received in local memory for a configurable amount of time.	Demonstration	
CVE-FN1546-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall store any MAP messages received in local memory for a configurable amount of time (configuration should allow MAP messages to be stored for 7 days)	Demonstration	
CVE-FN1547-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall store any BSMs broadcast in local memory for a configurable amount of time.	Demonstration	
CVE-FN1548-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall store any SRMs broadcast in local memory for a configurable amount of time.	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1549-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall store any SSMs received in local memory for a configurable amount of time.	Demonstration	
CVE-FN1550-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle Interaction Event shall consist of the type of event (emergency braking ahead, forward collision imminent, intersection movement, blind spot, lane change, red light violation, school zone speed limit, priority request)	Demonstration	
CVE-FN1551-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall log a Transit Vehicle Interaction Event when the transit vehicle OBU broadcasts an SRM	Demonstration	
CVE-FN1554-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall remove Transit Vehicle Interaction Event data with the oldest start times from memory until it is able to log a newly received interaction event	Demonstration	
CVE-FN1555-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall upload all Transit Vehicle Interaction Event data to the Transit CV Management System when it connects to the vehicle's regular data upload service.	Demonstration	
CVE-FN1556-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU shall remove all Transit Vehicle Interaction Event data from memory once uploaded to the Transit CV Management System.	Demonstration	
CVE-FN1557-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle Interaction Event shall consist of the start time of the event (UTC)	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1558-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle Interaction Event shall consist of the end time of the event (UTC) (in the case where multiple events of the same warning are issued based on messages received from the same vehicle or intersection within a configurable amount of time)	Demonstration	
CVE-FN1559-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle Interaction Event shall consist of all locally stored messages (SPaT, MAP, received BSMs, broadcast BSMs) from a configurable amount of time before the start time of the event	Demonstration	
CVE-FN1560-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle Interaction Event shall consist of all locally stored messages (SPaT, MAP, received BSMs, broadcast BSMs) from a configurable amount of time after the end time of the event	Demonstration	
CVE-FN3081-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall determine if a vehicle is in its blind spot for each BSM it receives	Demonstration	
CVE-FN3082-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall determine if there is emergency braking ahead for each BSM it receives.	Demonstration	
CVE-FN3083-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall determine if a forward collision is imminent for each BSM it receives	Demonstration	
CVE-FN3084-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall determine if an intersection collision is imminent for each BSM it receives.	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN3085-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall determine if a lane change collision is imminent for each BSM it receives.	Demonstration	
CVE-FN3086-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall determine if the OBU-equipped (host) vehicle will run a red light for each SPaT message it receives, provided it has also received a MAP message for the intersection that corresponds to the SPaT message.	Demonstration	
CVE-FN3087-V01	Transit Vehicle Interaction Event Recording	A Transit Vehicle OBU (host) shall determine if the OBU-equipped (host) vehicle will be speeding in a school zone once per second, provided it is receiving a school zone RSM.	Demonstration	
CVE-IF1561-V01	Transit Vehicle Interaction Event Recording	The TVIER Application shall receive data from the OBU's internal processing functions.	Demonstration	

Table 8: V2I Safety Requirements

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN3078-V01	Red Light Violation Warning	The Red Light Violation Warning Application shall identify when a vehicle is expected to cross the stop bar during a red signal by using the following data items:	Demonstration	
CVE-PR1290-V01	Red Light Violation Warning	The RLVW application should employ algorithms that are used in applications verified by CAMP to issue an RLVW	Inspection	
CVE-PR1291-V01	Red Light Violation Warning	The RLVW application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-PR3118-V01	Red Light Violation Warning	The RLVW application shall issue alerts with a false discovery rate (number of false positive alerts divided by total number of alerts) no greater than 2%.	Test	
CVE-FN1300-V01	Reduced Speed School Zone	The LDV OBU (host) shall parse received RSMs to identify the school zone speed limit (J2945/4).	Demonstration	
CVE-FN1301-V01	Reduced Speed School Zone	The LDV OBU (host) shall parse received RSMs to identify when the school zone speed limit is active.	Demonstration	
CVE-FN1302-V01	Reduced Speed School Zone	The LDV OBU (host) shall parse received RSMs to identify the applicable regions of use geographical path (J2945/4).	Demonstration	
CVE-FN3079-V01	Reduced Speed School Zone	The Reduced Speed School Zone Application shall identify when a host vehicle is expected to enter the school zone but not below the school zone speed limit (given its current location, motion, and expected braking rate) during active school zone hours by using the following data items:	Demonstration	
CVE-PR1306-V01	Reduced Speed School Zone	The RSSZ application should employ algorithms that are used in applications verified by CAMP to issue an RSSZ warning	Inspection	
CVE-PR1307-V01	Reduced Speed School Zone	The RSSZ application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-PR3119-V01	Reduced Speed School Zone	The RSSZ application shall issue alerts with a false discovery rate (number of false positive alerts divided by total number of alerts) no greater than 2%.	Test	

Table 9: V2V Safety Requirements

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN3074-V01	Blind Spot Warning	The Blind Spot Warning Application shall identify when a remote vehicle is within the blind spot (a configurable area to the rear right and rear left of a vehicle that moves with the vehicle) of a host vehicle, and is moving in the same direction of travel as the host vehicle by using the following data items:	Demonstration	
CVE-PR1111-V01	Blind Spot Warning	The BSW application should employ algorithms that are used in CAMP to issue a BSW alert.	Demonstration	
CVE-PR1112-V01	Blind Spot Warning	The BSW application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-PR3113-V01	Blind Spot Warning	The BSW application shall issue alerts with a false discovery rate (number of false positive alerts divided by total number of alerts) no greater than 2%.	Test	
CVE-FN3075-V01	Emergency Electronic Brake Light	The Emergency Electronic Brake Light Application shall identify when an emergency braking maneuver has been detected by a remote vehicle, the host vehicle is within a calculated distance threshold (a function of the speed of the host vehicle) and is directly ahead in the same lane (not necessarily moving in the same direction of travel) by using the following data items:	Demonstration	
CVE-PR3114-V01	Emergency Electronic Brake LIght	The EEBL application shall issue alerts with a false discovery rate (number of false positive alerts divided by total number of alerts) no greater than 2%.	Test	
CVE-PR1119-V01	Emergency Electronic Brake Light Warning	The EEBL application should employ algorithms that are used in applications verified by CAMP to issue an EEBL alert.	Demonstration	
CVE-PR1120-V01	Emergency Electronic Brake Light Warning	The EEBL application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN3073-V01	Forward Collision Warning	The Forward Collision Warning Application shall identify when the host vehicle is within a calculated distance threshold (a function of the speed of the host vehicle and the remote vehicle) and is directly ahead in the same lane (not necessarily moving in the same direction of travel) by using the following data items:	Demonstration	
CVE-PR1127-V01	Forward Collision Warning	The FCW application should employ algorithms that are used in applications verified by CAMP to issue a FCW alert	Demonstration	
CVE-PR1128-V01	Forward Collision Warning	The FCW application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-PR3115-V01	Forward Collision Warning	The FCW application shall issue alerts with a false discovery rate (number of false positive alerts divided by total number of alerts) no greater than 2%.	Test	
CVE-FN3077-V01	Intersection Movement Assist	The Intersection Movement Assist Application shall identify when the host vehicle has a trajectory (based on position, speed, acceleration) that may interfere with remote) vehicle trajectory in a side impact fashion, and the host vehicle is within a calculated distance threshold (a function of the speed of the host vehicle) by using the following data items:	Demonstration	
CVE-PR1135-V01	Intersection Movement Assist	The IMA application should employ algorithms that are used in applications verified by CAMP to issue an IMA alert	Demonstration	
CVE-PR1136-V01	Intersection Movement Assist	The IMA application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-PR3116-V01	Intersection Movement Assist	The IMA application shall issue alerts with a false discovery rate (number of false positive alerts divided by total number of alerts) no greater than 2%.	Test	
CVE-FN3076-V01	Lane Change Warning	The Lane Change Warning Application shall identify when a host vehicle is changing lanes into a remote vehicle, and is moving in the same direction of travel as the host vehicle by using the following data items:	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-PR1142-V01	Lane Change Warning	The LCW application should employ algorithms that are used in applications verified by CAMP to issue a LCW alert	Demonstration	
CVE-PR1143-V01	Lane Change Warning	The LCW application shall meet TRL 6 criteria (has been tested in a realistic environment outside of a laboratory and satisfies operational requirements when confronted with realistic problems)	Analyze	
CVE-PR3117-V01	Lane Change Warning	The LCW application shall issue alerts with a false discovery rate (number of false positive alerts divided by total number of alerts) no greater than 2%.	Test	

Table 10: Vehicle Onboard Equipment Requirements

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1215-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall not broadcast SRMs when its lights are off and siren is off	Demonstration	
CVE-FN1216-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall only broadcast SRMs when its lights are on and siren is on.	Demonstration	
CVE-FN1494-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall send a SRM to an RSU when it is less than a configurable amount of time away from arriving at the intersection it intends to request priority for	Demonstration	
CVE-FN1495-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall only request preemption in an SRM	Demonstration	
CVE-FN1496-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall cease sending SRMs for preemption to an RSU at a given intersection for a configurable amount of time after it has received an SSM from the RSU at that intersection that contains the Emergency Vehicle OBU ID (security layer of SRM contains information that can be used as identifier)	Demonstration	
CVE-FN2957-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall send BSMs (Part I) consistent with SAE J2735 to a Transit Vehicle OBU	Demonstration	
CVE-FN2958-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall send BSMs (Part I) consistent with SAE J2735 to an RSU	Demonstration	
CVE-FN2961-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive position data from GNSS satellites	Demonstration	
CVE-FN2964-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive security certificates from an SCMS via the RSU	Demonstration	
CVE-FN2975-V01	Emergency Vehicle OBU	An RSU shall broadcast MAP messages loaded on the RSU to an Emergency Vehicle OBU	Demonstration	
CVE-FN2977-V01	Emergency Vehicle OBU	An RSU shall send a SSM to an Emergency Vehicle OBU containing the results of the requests made by one or more vehicles for a configurable period of time	Demonstration	
CVE-FN2998-V01	Emergency Vehicle OBU	The Emergency Vehicle OBU shall be able to send the SRM at a configurable rate	Demonstration	
CVE-IF1221-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall send BSMs (Part I) consistent with SAE J2735 to an LDV OBU	Demonstration	
CVE-IF1228-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive SPaT messages from an RSU	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-IF1232-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive MAP messages from an RSU	Demonstration	
CVE-IF1236-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive RTCM messages from an RSU	Demonstration	
CVE-IF1239-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive SSM messages from an RSU	Demonstration	
CVE-IF1244-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive the flashing light status from the appropriate vehicle system	Demonstration	
CVE-IF1245-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall receive the siren status from the appropriate vehicle system	Demonstration	
CVE-IF1247-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall issue a signal priority notification to the Emergency Vehicle Operator	Demonstration	
CVE-IF1248-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall provide a means of ceasing the broadcast of DSRC messages	Demonstration	
CVE-IF1251-V01	Emergency Vehicle OBU	An Emergency Vehicle OBU shall send SRMs to an RSU	Demonstration	
CVE-FN1184-V01	General OBU	An OBU shall be capable of being reset and reconfigured so that it can be installed into another vehicle of the same type (e.g. LDV, HDV, etc.)	Demonstration	
CVE-FN1185-V01	General OBU	An OBU host processor shall perform integrity checks on boot to ensure that it is in a known good software state.	Demonstration	
CVE-FN1186-V01	General OBU	An OBU shall not continue to start up and will log an error if the host processor determines it is not in a known good software state on boot up.	Demonstration	
CVE-FN1198-V01	General OBU	An OBU should notify the vehicle operators of the power status of device (e.g., off, powering up and online).	Demonstration	
CVE-FN1204-V02	General OBU	An OBU shall acquire time from the Location and Time Service (LTS) interface in accordance with J2945/1 section 6.2.4.	Demonstration	
CVE-FN1205-V01	General OBU	An OBU shall acquire location from the LTS interface in accordance with J2945/1 section 6.2.1.	Demonstration	
CVE-FN1207-V01	General OBU	The OBU may capture vehicle brake status over the OBU-OBD-II interface to the host vehicle	Demonstration	
CVE-FN1209-V01	General OBU	An OBU device shall comply with IEEE 1609.2: Standard for WAVE Security Services for Applications and Management Messages	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1212-V01	General OBU	An OBU shall implement a download protocol that permits resumption of incomplete downloads instead of requiring an incomplete download to be restarted.	Demonstration	
CVE-FN3198-V01	General OBU	An OBU device shall support the full range of Provider Service Identifiers (PSID) as specified in IEEE 1609.12-2016 Standard for WAVE - Identifier Allocations	Demonstration	
CVE-IF3210-V01	General OBU	An OBU shall implement an interface to allow for over the air updates of firmware via DSRC.	Demonstration	
CVE-MT1252-V01	General OBU	An OBU shall support physical access to support maintenance activities.	Demonstration	
CVE-MT1253-V01	General OBU	An OBU shall support role-based authentication to enable physical access.	Demonstration	
CVE-PR2907-V01	General OBU	An OBU shall have a minimum reserve (processor, dynamic storage, persistent storage) capacity of 50% upon deployment to have the capacity to install and run future firmware image updates	Demonstration	
CVE-PR3199-V01	General OBU	An OBU shall have completed and passed the Device Certification Testing Compliance through USDOT Connected Vehicle Classification Centers (as referenced and listed in http://www.its.dot.gov/deployment_resources.htm)	Inspection	
CVE-PR3200-V01	General OBU	An OBU shall be ETSI TS 103 097 compliant and provide an onboard hardware security module ("HSM") that has been NIST validated as meeting FIPS 140-2 Level 3 (referenced in ISS_V2X_Root_CA_Certificate_Policy documentation	Inspection	
CVE-PR3207-V01	General OBU	An OBU shall be compliant with the electromagnetic compatibility requirements of SAE J1113, including procedures -2, -4, -11, -13, -21, -22, -26, -27, 41, 42j.	Inspection	
CVE-PR3212-V01	General OBU	An OBU shall be fully compatible with all RSUs in the CVE, and also allow for future interoperability with other RSU and OBU systems deployed in the region. (Note: The Integrator shall demonstrate this through documentation outlining the interoperability of their proposed OBU with other DSRC systems in the market).	Demonstration	
CVE-PY3201-V01	General OBU	An OBU shall be configured to run off 12V or 24V automotive power source as required by the vehicle classification.	Inspection	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-PY3202-V01	General OBU	An OBU shall be capable of being installed in a typical vehicle in 90 minutes or less with a two-person team.	Demonstration	
CVE-PY3203-V01	General OBU	An OBU, when installed, shall require no permanent modifications to the vehicle (e.g. drilling holes).	Inspection	
CVE-PY3204-V01	General OBU	An OBU, when installed, may include wires that are routed to the exterior of the vehicle through door/window gaps as long as the cable is suitably protected for this type of use.	Inspection	
CVE-PY3205-V01	General OBU	An OBU shall include a multi-band DSRC/GPS antenna, integrated or externally mounted and environmentally hardened.	Inspection	
CVE-PY3206-V01	General OBU	An OBU (including the HMI, as applicable) shall implement a method for secure physical attachment to the host vehicle.	Inspection	
CVE-PY3208-V01	General OBU	An OBU shall be resistant to permanent damage from shock and vibrations normally associated with automotive electrical components and consistent with SAE J1211.	Demonstration	
CVE-PY3209-V01	General OBU	An OBU shall be protected from contaminant intrusion consistent with international standard EN 60529 IP 64 or greater.	Inspection	
CVE-PY3211-V01	General OBU	An OBU shall have a minimum of 500 MB ram, and 500 MHz Central Processing Unit (CPU) speed (Note: Transit Vehicle OBU requires minimum 4GB storage, in accordance with Requirement 2913)	Inspection	
CVE-RG1607-V01	General OBU	An OBU shall meet the license requirements as specified in subpart l of part 95 of FCC rules.	Inspection	
CVE-SR1254-V01	General OBU	An OBU shall cease transmission of BSMs if the OBU determines that it has been blacklisted. Note: Blacklists detail devices that should not be trusted in the system or network	Demonstration	
CVE-SR1255-V01	General OBU	An OBU shall prevent incoming messages with invalid conditions per criteria in the IEEE 1609.2 from being acted on.	Demonstration	
CVE-SR1256-V01	General OBU	An OBU Vehicle Communications link shall have communications security to ensure the authenticity of all its messages in accordance to the standards prescribed by wireless messaging security standards.	Demonstration	
CVE-SR1257-V01	General OBU	An OBU shall carry out plausibility checking on the remote vehicle BSM data.	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-SR1258-V01	General OBU	An OBU shall indicate successful receipt of the pseudonym certificates.	Demonstration	
CVE-SR1259-V01	General OBU	When the OBU has no valid BSM signing certificates, it shall store the log file entries as IEEE 1609.2 data of type unsecured.	Demonstration	
CVE-SR1261-V01	General OBU	An OBU shall obtain certificates via IPv6 connectivity through the RSU.	Demonstration	
CVE-SR1262-V01	General OBU	An OBU shall communicate using SNMPv3 with SNMP messages protected by being sent over TLS.	Demonstration	
CVE-SR1263-V01	General OBU	An OBU shall support establishment of a standard TLS-based VPN with client authentication for communication to the Traffic CV Management System, with a long-term client cert and a single CA cert trusted to authorize connections from the Traffic CV Management System.	Demonstration	
CVE-SR1264-V01	General OBU	An OBU shall verify received messages per IEEE 1609.2 and per the relevant security profiles before using them for operations in any application.	Demonstration	
CVE-SR1265-V01	General OBU	An OBU shall provide real-time tamper data which indicates that the device has been tampered with (e.g. opening of the case).	Demonstration	
CVE-SR1266-V01	General OBU	An OBU 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.	Demonstration	
CVE-SR1267-V01	General OBU	An OBU shall only transmit messages for any usage scenario if the usage scenario requires it to use 1609.2 certificates and it currently has valid certificates for that usage scenario	Demonstration	
CVE-SR1268-V01	General OBU	An OBU shall verify a DSRC message when a device identifies the message as containing a new DE_TemporaryID value.	Demonstration	
CVE-SR1269-V01	General OBU	An OBU shall verify a DSRC message when the message results in the issuance of an advisory, warning, or alert	Demonstration	
CVE-SR1270-V01	General OBU	An OBU shall verify a DSRC message when 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	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-SR1271-V01	General OBU	An OBU shall verify a DSRC message when other potential threat situations such as red-light violations, and other safety applications are active	Demonstration	
CVE-FN2959-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall receive position data from GNSS satellites	Demonstration	
CVE-FN2962-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall receive security certificates from an SCMS via the RSU	Demonstration	
CVE-FN2968-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall send BSMs (Part I and Part II) consistent with SAE J2735 to a Transit Vehicle OBU	Demonstration	
CVE-FN2969-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall send BSMs (Part I and Part II) consistent with SAE J2735 to an RSU	Demonstration	
CVE-FN2996-V01	Heavy-Duty Vehicle OBU	The HDV OBU shall be able to send the SRM at a configurable rate	Demonstration	
CVE-IF1219-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall send BSMs (Part I and Part II) consistent with SAE J2735 to an LDV OBU	Demonstration	
CVE-IF1226-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall receive SPaT messages from an RSU	Demonstration	
CVE-IF1230-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall receive MAP messages from an RSU	Demonstration	
CVE-IF1234-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall receive RTCM messages from an RSU	Demonstration	
CVE-IF1237-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall receive SSM messages from an RSU	Demonstration	
CVE-IF1249-V01	Heavy-Duty Vehicle OBU	An HDV OBU shall send SRMs to an RSU	Demonstration	
CVE-FN1107-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert to the LDV Operator via the HMI when there is an OBU-equipped (remote) vehicle in the host vehicle's blind spot	Demonstration	
CVE-FN1108-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall determine if a vehicle is in its blind spot for each BSM it receives	Demonstration	
CVE-FN1115-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert to the LDV Operator via the HMI when there is emergency braking ahead by an OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1116-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall determine if there is emergency braking ahead for each BSM it receives	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1122-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert to the LDV Operator via the LDV HMI when a forward collision is imminent with another OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1123-V01	Light-Duty Vehicle OBU	The LDV OBU shall present alerts to drivers (via the HMI) using an HMI device that drivers are familiar with and limits driver interaction.	Demonstration	
CVE-FN1124-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall determine if a forward collision is imminent for each BSM it receives	Demonstration	
CVE-FN1131-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert to the LDV Operator via the HMI when an intersection collision is imminent with another OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1132-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall determine if an intersection collision is imminent for each BSM it receives	Demonstration	
CVE-FN1138-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert to the LDV Operator via the HMI when it is changing lanes into another OBU-equipped (remote) vehicle	Demonstration	
CVE-FN1139-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall determine if a lane change collision is imminent for each BSM it receives	Demonstration	
CVE-FN1187-V01	Light-Duty Vehicle OBU	An LDV OBU shall communicate with a LDV Operator via an HMI	Demonstration	
CVE-FN1188-V01	Light-Duty Vehicle OBU	The LDV OBU shall have two levels of alert	Demonstration	
CVE-FN1189-V01	Light-Duty Vehicle OBU	The LDV OBU shall have a low-level alert	Demonstration	
CVE-FN1190-V01	Light-Duty Vehicle OBU	The low-level alert shall consist of a configurable audio/visual warning	Demonstration	
CVE-FN1191-V01	Light-Duty Vehicle OBU	The LDV OBU shall have a high-level alert	Demonstration	
CVE-FN1192-V01	Light-Duty Vehicle OBU	The high-level alert shall consist of a configurable audio/visual warning	Demonstration	
CVE-FN1193-V01	Light-Duty Vehicle OBU	The high-level alert shall be louder and more visible compared to the low-level alert	Demonstration	
CVE-FN1194-V01	Light-Duty Vehicle OBU	The LDV OBU shall not display more than one alert to the LDV Vehicle Operator at a time	Demonstration	
CVE-FN1195-V01	Light-Duty Vehicle OBU	The LDV OBU shall contain a configurable priority order for notifying with alerts	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN1196-V01	Light-Duty Vehicle OBU	The order of alerts shall be configurable so that the order of alerts can be modified once priority has been established.	Demonstration	
CVE-FN1197-V01	Light-Duty Vehicle OBU	The LDV OBU should provide system status information to LDV operators. Information included in the system status includes power status, system settings, status of applications availability, and pending update status	Demonstration	
CVE-FN1202-V01	Light-Duty Vehicle OBU	The LDV OBU shall provide messages that can be seen and/or heard by the LDV Operator via the HMI from the LDV Vehicle Operator's normal seating position	Demonstration	
CVE-FN1203-V01	Light-Duty Vehicle OBU	The LDV OBU shall provide only the highest priority alert to the LDV vehicle operator when more than one alert is currently active	Demonstration	
CVE-FN1210-V01	Light-Duty Vehicle OBU	An LDV OBU shall determine when to issue an Emergency Electronic Brake Light alert	Demonstration	
CVE-FN1213-V01	Light-Duty Vehicle OBU	The LDV OBU should provide a visual output (via the HMI) that is similar in look and feel (i.e. similar in size, consistent use of color in icons or graphics, similar styles of icons or graphics) from various applications, if presenting visual information to LDV Operators	Demonstration	
CVE-FN1286-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert to the LDV Operator via the HMI when a red-light violation will occur at an RSU-equipped intersection	Demonstration	
CVE-FN1287-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall determine if the OBU-equipped (host) vehicle will run a red light for each SPaT message it receives, provided it has also received a MAP message for the intersection that corresponds to the SPaT message.	Demonstration	
CVE-FN1298-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert to the LDV Operator via the HMI when the OBU-equipped (host) vehicle will enter an RSU-equipped school zone over the active school zone speed limit	Demonstration	
CVE-FN1299-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall issue an alert when the OBU-equipped (host) vehicle is inside of an RSU-equipped school zone over the active school zone speed limit	Demonstration	
CVE-FN2952-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive BSMs from a Transit Vehicle OBU	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN2953-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive BSMs from an Emergency Vehicle OBU	Demonstration	
CVE-FN2970-V01	Light-Duty Vehicle OBU	An LDV OBU shall broadcast BSMs (Part I) consistent with SAE J2735 to a Transit Vehicle OBU	Demonstration	
CVE-FN2971-V01	Light-Duty Vehicle OBU	An LDV OBU shall broadcast BSMs (Part I) consistent with SAE J2735 to an RSU	Demonstration	
CVE-FN3011-V01	Light-Duty Vehicle OBU	An LDV OBU shall determine when to issue a Forward Collision Warning alert	Demonstration	
CVE-FN3012-V01	Light-Duty Vehicle OBU	An LDV OBU shall determine when to issue an Intersection Movement Assist alert	Demonstration	
CVE-FN3013-V01	Light-Duty Vehicle OBU	An LDV OBU shall determine when to issue an Lane Change Warning/Blind Spot Warning alert	Demonstration	
CVE-FN3014-V01	Light-Duty Vehicle OBU	An LDV OBU shall determine when to issue a Red Light Violation Warning alert	Demonstration	
CVE-FN3015-V01	Light-Duty Vehicle OBU	An LDV OBU shall determine when to issue a Reduced Speed School Zone alert	Demonstration	
CVE-FN3021-V01	Light-Duty Vehicle OBU	The LDV OBU shall be customizable for the following options (via the HMI): Volume, Brightness (if screen is used), Text size (if screen is used), Display contrast(if screen is used), Mounting Eye Position (if screen is used)	Demonstration	
CVE-FN3022-V01	Light-Duty Vehicle OBU	The LDV OBU should provide system status to drivers (via the HMI)	Inspection	
CVE-FN3023-V01	Light-Duty Vehicle OBU	The LDV OBU should notify the LDV Operator of the power status of the OBU (via the HMI) (e.g. off, powering up, online, powering down)	Demonstration	
CVE-FN3024-V01	Light-Duty Vehicle OBU	The LDV OBU should allow the LDV Operator to adjust the system settings of the device (via the HMI) (e.g. version, brightness (if screen is used), volume, text size (if screen is used), contrast (if screen is used))	Demonstration	
CVE-FN3025-V01	Light-Duty Vehicle OBU	The LDV OBU shall not allow the driver to adjust settings while the vehicle is in motion.	Demonstration	
CVE-FN3026-V01	Light-Duty Vehicle OBU	The LDV OBU should notify the LDV Operator of application availability (via the HMI) (e.g. failed, operating, disabled).	Demonstration	
CVE-FN3027-V01	Light-Duty Vehicle OBU	The LDV OBU should notify the LDV Operator of pending updates for the LDV OBU (via the HMI) (e.g. applications, firmware, operating system).	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN3028-V01	Light-Duty Vehicle OBU	The LDV OBU shall provide a visible and/or audible sound (via the HMI) when the vehicle is started up to indicate to the LDV Operator that they are in a CV-equipped vehicle.	Demonstration	
CVE-FN3080-V01	Light-Duty Vehicle OBU	An LDV OBU (host) shall determine if the OBU-equipped (host) vehicle will be speeding in a school zone once per second, provided it is receiving a school zone RSM.	Demonstration	
CVE-FN3196-V01	Light-Duty Vehicle OBU	The LDV OBU shall prioritize alerts issued to LDV Operators in accordance with SAE J2395-2002.	Demonstration	
CVE-IF1218-V01	Light-Duty Vehicle OBU	An LDV OBU shall send BSMs (Part I) consistent with SAE J2735 to an LDV OBU	Demonstration	
CVE-IF1222-V01	Light-Duty Vehicle OBU	An LDV OBU shall communicate alerts to an LDV Operator	Demonstration	
CVE-IF1223-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive BSMs from an LDV OBU	Demonstration	
CVE-IF1225-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive SPaT messages from an RSU	Demonstration	
CVE-IF1229-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive MAP messages from an RSU	Demonstration	
CVE-IF1233-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive RTCM messages from an RSU	Demonstration	
CVE-IF1240-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive RSM messages from an RSU	Demonstration	
CVE-IF1242-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive position data from GNSS satellites	Demonstration	
CVE-IF1243-V01	Light-Duty Vehicle OBU	An LDV OBU shall receive security certificates from an SCMS via the RSU	Demonstration	
CVE-IF1246-V01	Light-Duty Vehicle OBU	An LDV OBU shall issue alerts to the LDV Operator via an HMI	Demonstration	
CVE-IF3019-V01	Light-Duty Vehicle OBU	The LDV OBU shall include both a visual and/or auditory interface for sharing traveler information (via the HMI).	Demonstration	
CVE-IF3197-V01	Light-Duty Vehicle OBU	The LDV OBU shall issue alerts to LDV Operators using iconography as specified in ISO 2575:2010	Inspection	
CVE-PR3017-V01	Light-Duty Vehicle OBU	The LDV OBU HMI shall present an alert to the LDV Operator in a succinct manner while the LDV Operator is engaged in the driving task to minimize the 'eyes off the road' time.	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-PR3020-V01	Light-Duty Vehicle OBU	The LDV OBU Auditory signals (via the HMI) shall be loud enough to overcome masking sounds from road noise, the cab environment, and other equipment.	Demonstration	
CVE-PY3016-V01	Light-Duty Vehicle OBU	The LDV OBU HMI shall be mounted or installed in a location where it does not obstruct the line of sight of the LDV Operator nor distract the LDV Operator from the primary task of driving.	Inspection	
CVE-PY3018-V01	Light-Duty Vehicle OBU	The LDV OBU shall be positioned in a location such that it can provide a visual output to the driver (via the HMI) that can be read from the driver's normal seated position, if visual alerts are used.	Inspection	
CVE-PY3215-V01	Light-Duty Vehicle OBU	An LDV OBU HMI may contain:	Inspection	
CVE-PY3216-V01	Light-Duty Vehicle OBU	An LDV OBU shall not use a wireless means of connecting its processor to the HMI.	Inspection	
CVE-PY3217-V01	Light-Duty Vehicle OBU	An LDV OBU shall not use an ancillary operating system for visual, audio, or haptic HMI outputs (e.g. smartphone, tablet)	Inspection	
CVE-PY3219-V01	Light-Duty Vehicle OBU	An LDV OBU HMI shall produce an audible output (e.g. waveform audio, text-to-speech, warning tone, beep, etc.) at a minimum, when issuing an alert or notification.	Inspection	
CVE-PY3220-V01	Light-Duty Vehicle OBU	An LDV OBU HMI shall contain speakers that can produce audible output	Inspection	
CVE-FN1206-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall transmit Transit Vehicle Interaction Events to the Transit CV Management System	Demonstration	
CVE-FN1208-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall use Coordinated Universal Time (UTC) time for all logged data (e.g., events logs, probe vehicle data) based on the format defined in J2735 section 6.19 and epoch of January 1st 1970.	Demonstration	
CVE-FN2954-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive BSMs from an HDV OBU	Demonstration	
CVE-FN2955-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive BSMs from a Transit Vehicle OBU	Demonstration	
CVE-FN2956-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive BSMs from an Emergency Vehicle OBU	Demonstration	
CVE-FN2960-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive position data from GNSS satellites	Demonstration	

ReqID	Sub-Component	Description	Verification Method	Integrator Response
CVE-FN2963-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive security certificates from an SCMS via the RSU	Demonstration	
CVE-FN2966-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall broadcast BSMs (Part I) consistent with SAE J2735 to a Transit Vehicle OBU	Demonstration	
CVE-FN2967-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall broadcast BSMs (Part I) consistent with SAE J2735 to an RSU	Demonstration	
CVE-FN2974-V01	Transit Vehicle OBU	An RSU shall broadcast MAP messages loaded on the RSU to a Transit Vehicle OBU	Demonstration	
CVE-FN2976-V01	Transit Vehicle OBU	An RSU shall send a SSM to a Transit Vehicle OBU containing the results of the requests made by one or more vehicles for a configurable period of time	Demonstration	
CVE-FN2997-V01	Transit Vehicle OBU	The Transit Vehicle OBU shall be able to send the SRM at a configurable rate	Demonstration	
CVE-IF1220-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall broadcast BSMs (Part I) consistent with SAE J2735 to an LDV OBU	Demonstration	
CVE-IF1224-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive BSMs from an LDV OBU	Demonstration	
CVE-IF1227-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive SPaT messages from an RSU	Demonstration	
CVE-IF1231-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive MAP messages from an RSU	Demonstration	
CVE-IF1235-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive RTCM messages from an RSU	Demonstration	
CVE-IF1238-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive SSM messages from an RSU	Demonstration	
CVE-IF1241-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall receive RSM messages from an RSU	Demonstration	
CVE-IF1250-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall send SRMs to an RSU	Demonstration	
CVE-IF3214-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall implement an interface to extract Transit Vehicle Interaction Event Data on-demand from the unit locally via wire or wireless	Demonstration	
CVE-PR2913-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall be capable of holding 4 GB of interaction event data.	Inspection	
CVE-PY3218-V01	Transit Vehicle OBU	A Transit Vehicle OBU shall contain an LED on its HMI (to indicate if signal preemption has been granted).	Inspection	

Figure 6: CVE Constraints

Constraint ID	Reference	Constraint
CVE-CN1645-V01	Constraint 1	DPS will provide deployment support
CVE-CN1647-V01	Constraint 3	Equipment, software, processes, and interfaces shall be tested for interoperability before deployment to ensure they meet those standards for interoperability.
CVE-CN1648-V01	Constraint 4	All CVE components that utilize DSRC shall comply with IEEE, SAE, and USDOT standards, as follows: 1. SAE J2735_201603 - Dedicated Short Range Communications (DSRC) Message Set Dictionary. 2. SAE J 2945/1 - On-Board System Requirements for V2V Safety Communications. 3. SAE J 2945/4 (draft) - DSRC Messages for Traveler Information and Basic Information Delivery. 4. IEEE 802.11p - Wireless Access in Vehicular Environments. 5. IEEE 1609.2 - IEEE Standard for Wireless Access in Vehicular Environments -- Security Services for Applications and Management Messages. 6. IEEE 1609.3 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Networking Services. 7. IEEE 1609.4 - IEEE Standard for Wireless Access in Vehicular Environments (WAVE) -- Multi-Channel Operation. 8. NTCIP 1202 - NTCIP Object Definitions for Actuated Traffic Controllers. 9. NTCIP 1211 - NTCIP Objects for Signal Control and Prioritization (SCP) 10. DSRC Roadside Unit (RSU) Specifications Document v4.1 (October 2016) 11. IEEE 1609.12-2016 - Standard for WAVE - Identifier Allocations 12. Title 47 if the Code of Federal Regulations Part 15 Subpart C and applicable FCC Regulations
CVE-CN1649-V01	Constraint 5	A DSRC-Enabled LDV OBU shall be installed in private vehicles
CVE-CN1650-V01	Constraint 6	A DSRC-Enabled LDV OBU shall be installed in DPS fleet vehicles
CVE-CN1651-V01	Constraint 7	A DSRC-Enabled LDV OBU shall be installed in COTA Supervisor vehicles
CVE-CN1652-V01	Constraint 8	A DSRC-Enabled HDV OBU shall be installed in (platooning) HDVs
CVE-CN1653-V01	Constraint 9	A DSRC-Enabled Transit Vehicle OBU shall be installed in Transit Vehicles
CVE-CN1654-V01	Constraint 10	A DSRC-Enabled Transit Vehicle OBU shall be installed in Paratransit Vehicles
CVE-CN1655-V01	Constraint 11	A DSRC-Enabled Transit Vehicle OBU shall be installed on CEAVs
CVE-CN1656-V01	Constraint 12	A DSRC-Enabled Emergency Vehicle OBU shall be installed in Police Vehicles
CVE-CN1657-V01	Constraint 13	A DSRC-Enabled Emergency Vehicle OBU shall be installed in Fire Vehicles
CVE-CN1658-V01	Constraint 14	A DSRC-Enabled Emergency Vehicle OBU shall be installed in EMS Vehicles
CVE-CN1660-V01	Constraint 16	Safety applications that output an alert from an OBU shall be commercial off the shelf software
CVE-CN1663-V01	Constraint 19	DPS will operate and maintain the CVE
CVE-CN1664-V01	Constraint 20	Performance measures will be used to assess the CVE
CVE-CN3088-V01	Constraint 22	Data that is used or stored in a center (e.g. TCVMS, TrCVMS) shall not contain PII
CVE-CN3106-V01	Constraint 23	A DSRC-Enabled LDV OBU shall be installed in COTA Police Response Unit vehicles

Appendix D: Vehicle Installation List

This appendix lists, by partner, the vehicle year, make and model of vehicles that are intended to be equipped with CV technology. This is not a complete list of vehicles, but includes those presently. A copy of Table 1 is included as a reminder of the quantities and configuration of each vehicle class/partner. Separate tables for each partner follow.

Vehicle Type	Partner / Source	Quantity	Characteristics
Light-Duty Vehicle	Private Vehicle	1,019	All V2X Safety Apps, HMI, No data logging, Integrator-led installation
	Public Service City Fleet Vehicle	198	All V2X Safety Apps, HMI, No data logging, coordination of installation with City fleets
	COTA Supervisor Vehicle	25	All V2X Safety Apps, HMI, No data logging, coordination with COTA maintenance
Emergency Vehicle	Public Safety Fire Truck/EMS	30	EVP Only, Minimal HMI (EVP granted), no data logging, integration with sire, coordination of installation with City fleet
	Public Safety Police Cruiser	80	EVP Only, Minimal HMI (EVP granted), no data logging, integration with siren, coordination of installation with City fleet
Heavy-Duty Vehicle	Private Freight Vehicle	10	BSM and FSP Only, no HMI, no data logging, coordination with fleet owner
	County Engineer	2	BSM Only, no HMI, no data logging, coordination with fleet owner
Transit Vehicle	AV Shuttle (CEAV)	6	All V2X Safety Apps, No HMI, data logging and offloading, coordination with AV operator
	COTA Transit Bus* (fixed-route)	350	All V2X Safety Apps, TSP, No HMI, data logging and offloading, coordination with COTA maintenance
	COTA Paratransit Bus	80	All V2X Safety Apps, No HMI, data logging and offloading, coordination with COTA maintenance
	Total	**~1,800**	

C-1. COTA Fixed Route Vehicles

Vehicle Number	Year	Description	Branding
2801	2008	Gillig LF 40FT	
2802	2008	Gillig LF 40FT	
2803	2008	Gillig LF 40FT	
2804	2008	Gillig LF 40FT	
2805	2008	Gillig LF 40FT	
2806	2008	Gillig LF 40FT	
2807	2008	Gillig LF 40FT	

Vehicle Number	Year	Description	Branding
2808	2008	Gillig LF 40FT	
2809	2008	Gillig LF 40FT	
2810	2008	Gillig LF 40FT	
2811	2008	Gillig LF 40FT	
2821	2008	Gillig LF 40FT	
2812	2008	Gillig LF 40FT	
2813	2008	Gillig LF 40FT	
2814	2008	Gillig LF 40FT	
2815	2008	Gillig LF 40FT	
2816	2008	Gillig LF 40FT	
2817	2008	Gillig LF 40FT	
2818	2008	Gillig LF 40FT	
2819	2008	Gillig LF 40FT	
2820	2008	Gillig LF 40FT	
2822	2008	Gillig LF 40FT	
2823	2008	Gillig LF 40FT	
2824	2008	Gillig LF 40FT	
2825	2008	Gillig LF 40FT	
2826	2008	Gillig LF 40FT	
2827	2008	Gillig LF 40FT	
2829	2008	Gillig LF 40FT	
2830	2008	Gillig LF 40FT	
2831	2008	Gillig LF 30FT	
2832	2008	Gillig LF 30FT	
2833	2008	Gillig LF 30FT	
2834	2008	Gillig LF 30FT	
2835	2008	Gillig LF 30FT	
2836	2008	Gillig LF 30FT	
2837	2008	Gillig LF 30FT	
2838	2008	Gillig LF 30FT	
2839	2008	Gillig LF 30FT	
2840	2008	Gillig LF 30FT	
2901	2009	Gillig LF 40FT	
2902	2009	Gillig LF 40FT	
2903	2009	Gillig LF 40FT	
2904	2009	Gillig LF 40FT	
2905	2009	Gillig LF 40FT	
2906	2009	Gillig LF 40FT	
2907	2009	Gillig LF 40FT	
2908	2009	Gillig LF 40FT	

Vehicle Number	Year	Description	Branding
2909	2009	Gillig LF 40FT	
2910	2009	Gillig LF 40FT	
2911	2009	Gillig LF 40FT	
2912	2009	Gillig LF 40FT	
2913	2009	Gillig LF 40FT	
2914	2009	Gillig LF 40FT	
2915	2009	Gillig LF 40FT	
2916	2009	Gillig LF 40FT	
2917	2009	Gillig LF 40FT	
2918	2009	Gillig LF 40FT	
2919	2009	Gillig LF 40FT	
2920	2009	Gillig LF 40FT	
2921	2009	Gillig LF 40FT	
2922	2009	Gillig LF 40FT	
2923	2009	Gillig LF 40FT	
2924	2009	Gillig LF 40FT	
2925	2009	Gillig LF 40FT	
2926	2009	Gillig LF 40FT	
2927	2009	Gillig LF 40FT	
2928	2009	Gillig LF 40FT	
2929	2009	Gillig LF 40FT	
2930	2009	Gillig LF 40FT	
2931	2009	Gillig LF 30FT	
2932	2009	Gillig LF 30FT	
2933	2009	Gillig LF 30FT	
2934	2009	Gillig LF 30FT	
2935	2009	Gillig LF 30FT	
2936	2009	Gillig LF 30FT	
2937	2009	Gillig LF 30FT	Air Connect
2938	2009	Gillig LF 30FT	Air Connect
2939	2009	Gillig LF 30FT	Air Connect
2940	2009	Gillig LF 30FT	Air Connect
1007	2010	2010 Gillig LF 40FT	
1004	2010	2010 Gillig Hybrid LF 40FT	
1005	2010	2010 Gillig Hybrid LF 40FT	
1006	2010	2010 Gillig Hybrid LF 40FT	
1008	2010	2010 Gillig LF 40FT	
1009	2010	2010 Gillig LF 40FT	
1010	2010	2010 Gillig LF 40FT	
1011	2010	2010 Gillig LF 40FT	

Vehicle Number	Year	Description	Branding
1012	2010	2010 Gillig LF 40FT	
1013	2010	2010 Gillig LF 40FT	
1014	2010	2010 Gillig LF 40FT	
1015	2010	2010 Gillig LF 40FT	
1016	2010	2010 Gillig LF 40FT	
1017	2010	2010 Gillig LF 40FT	
1018	2010	2010 Gillig LF 40FT	
1019	2010	2010 Gillig LF 40FT	
1020	2010	2010 Gillig LF 40FT	
1021	2010	2010 Gillig LF 40FT	
1022	2010	2010 Gillig LF 40FT	
1023	2010	2010 Gillig LF 40FT	
1024	2010	2010 Gillig LF 40FT	
1025	2010	2010 Gillig LF 40FT	
1026	2010	2010 Gillig LF 40FT	
1027	2010	2010 Gillig LF 40FT	
1028	2010	2010 Gillig LF 40FT	
1029	2010	2010 Gillig LF 40FT	
1030	2010	2010 Gillig LF 40FT	
1031	2010	2010 Gillig LF 40FT	
1032	2010	2010 Gillig LF 40FT	
1033	2010	2010 Gillig LF 40FT	
1034	2010	2010 Gillig LF 40FT	
1035	2010	2010 Gillig LF 40FT	
1036	2010	2010 Gillig LF 40FT	
1037	2010	2010 Gillig LF 40FT	
1038	2010	2010 Gillig LF 40FT	
1039	2010	2010 Gillig LF 40FT	
1040	2010	2010 Gillig LF 40FT	
1041	2010	2010 Gillig LF 40FT	
1042	2010	2010 Gillig LF 40FT	
1043	2010	2010 Gillig LF 40FT	
1044	2010	2010 Gillig LF 30FT	
1045	2010	2010 Gillig LF 30FT	
1046	2010	2010 Gillig LF 30FT	
1101	2011	2011 Gillig LF 40FT	
1102	2011	2011 Gillig LF 40FT	
1103	2011	2011 Gillig LF 40FT	
1104	2011	2011 Gillig LF 40FT	
1105	2011	2011 Gillig LF 40FT	

Vehicle Number	Year	Description	Branding
1106	2011	2011 Gillig LF 40FT	
1107	2011	2011 Gillig LF 40FT	
1108	2011	2011 Gillig LF 40FT	
1109	2011	2011 Gillig LF 40FT	
1110	2011	2011 Gillig LF 40FT	
1111	2011	2011 Gillig LF 40FT	
1112	2011	2011 Gillig LF 40FT	
1113	2011	2011 Gillig LF 40FT	
1114	2011	2011 Gillig LF 40FT	
1115	2011	2011 Gillig LF 40FT	
1116	2011	2011 Gillig LF 40FT	
1117	2011	2011 Gillig LF 40FT	
1118	2011	2011 Gillig LF 40FT	
1119	2011	2011 Gillig LF 40FT	
1120	2011	2011 Gillig LF 40FT	
1121	2011	2011 Gillig LF 40FT	
1122	2011	2011 Gillig LF 40FT	
1123	2011	2011 Gillig LF 40FT	
1124	2011	2011 Gillig LF 40FT	
1125	2011	2011 Gillig LF 40FT	
1126	2011	2011 Gillig LF 40FT	
1127	2011	2011 Gillig LF 40FT	
1128	2011	2011 Gillig LF 40FT	
1129	2011	2011 Gillig LF 40FT	
1130	2011	2011 Gillig LF 40FT	
1131	2011	2011 Gillig LF 40FT	
1132	2011	2011 Gillig LF 40FT	
1133	2011	2011 Gillig LF 40FT	
1134	2011	2011 Gillig LF 40FT	
1135	2011	2011 Gillig LF 40FT	
1136	2011	2011 Gillig LF 40FT	
1137	2011	2011 Gillig LF 40FT	
1138	2011	2011 Gillig LF 30FT	
1139	2011	2011 Gillig LF 30FT	
1140	2011	2011 Gillig LF 30FT	
1001	2010	2010 Gillig Hybrid LF 40FT	
1002	2010	2010 Gillig Hybrid LF 40FT	
1003	2010	2010 Gillig Hybrid LF 40FT	
1201	2012	2012 Gillig LF 40FT	
1202	2012	2012 Gillig LF 40FT	

Vehicle Number	Year	Description	Branding
1203	2012	2012 Gillig LF 40FT	
1204	2012	2012 Gillig LF 40FT	
1205	2012	2012 Gillig LF 40FT	
1206	2012	2012 Gillig LF 40FT	
1207	2012	2012 Gillig LF 40FT	
1208	2012	2012 Gillig LF 40FT	
1210	2012	2012 Gillig LF 40FT	
1211	2012	2012 Gillig LF 40FT	
1212	2012	2012 Gillig LF 40FT	
1213	2012	2012 Gillig LF 40FT	
1214	2012	2012 Gillig LF 40FT	
1215	2012	2012 Gillig LF 40FT	
1216	2012	2012 Gillig LF 40FT	
1217	2012	2012 Gillig LF 40FT	
1218	2012	2012 Gillig LF 40FT	
1219	2012	2012 Gillig LF 40FT	
1220	2012	2012 Gillig LF 40FT	
1221	2012	2012 Gillig LF 40FT	
1222	2012	2012 Gillig LF 40FT	
1223	2012	2012 Gillig LF 40FT	
1209	2012	2012 Gillig LF 40FT	
1319	2013	2013 Gillig CNG LF 35FT	
1301	2013	2013 Gillig CNG LF 40FT	
1303	2013	2013 Gillig CNG LF 40FT	
1304	2013	2013 Gillig CNG LF 40FT	
1302	2013	2013 Gillig CNG LF 40FT	
1305	2013	2013 Gillig CNG LF 40FT	
1306	2013	2013 Gillig CNG LF 40FT	
1307	2013	2013 Gillig CNG LF 40FT	
1308	2013	2013 Gillig CNG LF 40FT	
1309	2013	2013 Gillig CNG LF 40FT	
1310	2013	2013 Gillig CNG LF 40FT	
1311	2013	2013 Gillig CNG LF 40FT	
1312	2013	2013 Gillig CNG LF 40FT	
1313	2013	2013 Gillig CNG LF 40FT	
1314	2013	2013 Gillig CNG LF 40FT	
1315	2013	2013 Gillig CNG LF 40FT	
1316	2013	2013 Gillig CNG LF 40FT	
1317	2013	2013 Gillig CNG LF 40FT	
1318	2013	2013 Gillig CNG LF 40FT	

Vehicle Number	Year	Description	Branding
1320	2013	2013 Gillig CNG LF 35FT	
1321	2013	2013 Gillig CNG LF 35FT	
1322	2013	2013 Gillig CNG LF 35FT	
1323	2013	2013 Gillig CNG LF 35FT	
1324	2013	2013 Gillig CNG LF 35FT	
1325	2013	2013 Gillig CNG LF 35FT	
1326	2013	2013 Gillig CNG LF 35FT	
1327	2013	2013 Gillig CNG LF 35FT	
1328	2013	2013 Gillig CNG LF 35FT	
1329	2013	2013 Gillig CNG LF 35FT	
1330	2013	2013 Gillig CNG LF 35FT	
1401	2014	2014 Gillig CNG LF 30FT	CBUS
1402	2014	2014 Gillig CNG LF 30FT	CBUS
1403	2014	2014 Gillig CNG LF 30FT	CBUS
1404	2014	2014 Gillig CNG LF 30FT	CBUS
1405	2014	2014 Gillig CNG LF 30FT	CBUS
1406	2014	2014 Gillig CNG LF 30FT	CBUS
1407	2014	2014 Gillig CNG LF 30FT	
1408	2014	2014 Gillig CNG LF 30FT	
1409	2014	2014 Gillig CNG LF 35FT	
1410	2014	2014 Gillig CNG LF 35FT	
1411	2014	2014 Gillig CNG LF 35FT	
1412	2014	2014 Gillig CNG LF 35FT	
1413	2014	2014 Gillig CNG LF 35FT	
1414	2014	2014 Gillig CNG LF 35FT	
1415	2014	2014 Gillig CNG LF 35FT	
1416	2014	2014 Gillig CNG LF 40FT	
1417	2014	2014 Gillig CNG LF 40FT	
1418	2014	2014 Gillig CNG LF 40FT	
1419	2014	2014 Gillig CNG LF 40FT	
1423	2014	2014 Gillig CNG LF 40FT	
1420	2014	2014 Gillig CNG LF 40FT	
1421	2014	2014 Gillig CNG LF 40FT	
1422	2014	2014 Gillig CNG LF 40FT	
1424	2014	2014 Gillig CNG LF 40FT	
1425	2014	2014 Gillig CNG LF 40FT	
1426	2014	2014 Gillig CNG LF 40FT	
1427	2014	2014 Gillig CNG LF 40FT	
1428	2014	2014 Gillig CNG LF 40FT	
1429	2014	2014 Gillig CNG LF 40FT	

Vehicle Number	Year	Description	Branding
1430	2014	2014 Gillig CNG LF 40FT	
1431	2014	2014 Gillig CNG LF 40FT	
1432	2014	2014 Gillig CNG LF 40FT	
1433	2014	2014 Gillig CNG LF 40FT	
1434	2014	2014 Gillig CNG LF 40FT	
1435	2014	2014 Gillig CNG LF 40FT	
1436	2014	2014 Gillig CNG LF 40FT	
1501	2015	Gillig CNG LF 35FT	
1502	2015	Gillig CNG LF 35FT	
1503	2015	Gillig CNG LF 35FT	
1504	2015	Gillig CNG LF 35FT	
1505	2015	Gillig CNG LF 35FT	
1506	2015	Gillig CNG LF 40FT	
1507	2015	Gillig CNG LF 40FT	
1508	2015	Gillig CNG LF 40FT	
1509	2015	Gillig CNG LF 40FT	
1510	2015	Gillig CNG LF 40FT	
1511	2015	Gillig CNG LF 40FT	
1512	2015	Gillig CNG LF 40FT	
1513	2015	Gillig CNG LF 40FT	
1514	2015	Gillig CNG LF 40FT	
1515	2015	Gillig CNG LF 40FT	
1516	2015	Gillig CNG LF 40FT	
1517	2015	Gillig CNG LF 40FT	
1518	2015	Gillig CNG LF 40FT	
1519	2015	Gillig CNG LF 40FT	
1520	2015	Gillig CNG LF 40FT	
1521	2015	Gillig CNG LF 40FT	
1522	2015	Gillig CNG LF 40FT	
1523	2015	Gillig CNG LF 40FT	
1524	2015	Gillig CNG LF 40FT	
1525	2015	Gillig CNG LF 40FT	
1526	2015	Gillig CNG LF 40FT	
1527	2015	Gillig CNG LF 40FT	
1528	2015	Gillig CNG LF 40FT	
1529	2015	Gillig CNG LF 40FT	
1530	2015	Gillig CNG LF 40FT	
1531	2015	Gillig CNG LF 40FT	
1532	2015	Gillig CNG LF 40FT	
1533	2015	Gillig CNG LF 40FT	

Vehicle Number	Year	Description	Branding
1534	2015	Gillig CNG LF 40FT	
1535	2015	Gillig CNG LF 40FT	
1536	2015	Gillig CNG LF 40FT	
1537	2015	Gillig CNG LF 40FT	
1538	2015	Gillig CNG LF 40FT	
1601	2016	2016 Gillig CNG LF 40FT	
1602	2016	2016 Gillig CNG LF 40FT	
1603	2016	2016 Gillig CNG LF 40FT	
1604	2016	2016 Gillig CNG LF 40FT	
1605	2016	2016 Gillig CNG LF 40FT	
1606	2016	2016 Gillig CNG LF 40FT	
1607	2016	2016 Gillig CNG LF 40FT	
1608	2016	2016 Gillig CNG LF 40FT	
1609	2016	2016 Gillig CNG LF 40FT	
1610	2016	2016 Gillig CNG LF 40FT	
1611	2016	2016 Gillig CNG LF 40FT	
1612	2016	2016 Gillig CNG LF 40FT	
1613	2016	2016 Gillig CNG LF 40FT	
1614	2016	2016 Gillig CNG LF 40FT	
1615	2016	2016 Gillig CNG LF 35FT	
1616	2016	2016 Gillig CNG LF 35FT	
1617	2016	2016 Gillig CNG LF 35FT	
1618	2016	2016 Gillig CNG LF 35FT	
1702	2017	2017 Gillig CNG LF 30FT	
1619	2016	2016 Gillig CNG LF 40FT CMAX	CMAX
1620	2016	2016 Gillig CNG LF 40FT CMAX	CMAX
1701	2017	2017 Gillig CNG LF 30FT	
1703	2017	2017 Gillig CNG LF 30FT	
1704	2017	2017 Gillig CNG LF 30FT	
1705	2017	2017 Gillig CNG LF 30FT	
1706	2017	2017 Gillig CNG LF 30FT	
1707	2017	2017 Gillig CNG LF 35FT	
1708	2017	2017 Gillig CNG LF 35FT	
1709	2017	2017 Gillig CNG LF 35FT	
1710	2017	2017 Gillig CNG LF 35FT	
1711	2017	2017 Gillig CNG LF 35FT	
1712	2017	2017 Gillig CNG LF 35FT	
1713	2017	2017 Gillig CNG LF 35FT	
1714	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1715	2017	2017 Gillig CNG LF 40FT CMAX	CMAX

Vehicle Number	Year	Description	Branding
1716	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1717	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1718	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1719	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1720	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1721	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1722	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1723	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1724	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1725	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
1726	2017	2017 Gillig CNG LF 40FT CMAX	CMAX
	2018	TBD Qty (est. 30)	

C- 2. COTA Paratransit Vehicles

Vehicle Number	Make and Model	Year
1166	CHEVY 4500 CHAMPION	2011
1168	CHEVY 4500 CHAMPION	2011
1169	CHEVY 4500 CHAMPION	2011
1176	CHEVY 4500 CHAMPION	2011
1179	CHEVY 4500 CHAMPION	2011
1262	CHEVY 4500 CHAMPION	2012
1263	CHEVY 4500 CHAMPION	2012
1264	CHEVY 4500 CHAMPION	2012
1265	CHEVY 4500 CHAMPION	2012
1267	CHEVY 4500 CHAMPION	2012
1268	CHEVY 4500 CHAMPION	2012
1269	CHEVY 4500 CHAMPION	2012
1270	CHEVY 4500 CHAMPION	2012
1271	CHEVY 4500 CHAMPION	2012
1272	CHEVY 4500 CHAMPION	2012
1273	CHEVY 4500 CHAMPION	2012
1274	CHEVY 4500 CHAMPION	2012
1275	CHEVY 4500 CHAMPION	2012
1276	CHEVY 4500 CHAMPION	2012
1277	CHEVY 4500 CHAMPION	2012
1278	CHEVY 4500 CHAMPION	2012
1280	CHEVY 4500 CHAMPION	2012
1362	CHEVY 4500 CHAMPION	2013
1363	CHEVY 4500 CHAMPION	2013

Vehicle Number	Make and Model	Year
1364	CHEVY 4500 CHAMPION	2013
1365	CHEVY 4500 CHAMPION	2013
1366	CHEVY 4500 CHAMPION	2013
1367	CHEVY 4500 CHAMPION	2013
1369	CHEVY 4500 CHAMPION	2013
1461	CHEVY 4500 CHAMPION	2014
1462	CHEVY 4500 CHAMPION	2014
1463	CHEVY 4500 CHAMPION	2014
1464	CHEVY 4500 CHAMPION	2014
1465	CHEVY 4500 CHAMPION	2014
1466	CHEVY 4500 CHAMPION	2014
1467	CHEVY 4500 CHAMPION	2014
1468	CHEVY 4500 CHAMPION	2014
1469	CHEVY 4500 CHAMPION	2014
1470	CHEVY 4500 CHAMPION	2014
1471	CHEVY 4500 CHAMPION	2014
1472	CHEVY 4500 CHAMPION	2014
1473	VPG MV-1	2014
1474	VPG MV-1	2014
1475	VPG MV-1	2014
1476	VPG MV-1	2014
1477	VPG MV-1	2014
1478	VPG MV-1	2014
1479	VPG MV-1	2014
1480	VPG MV-1	2014
1481	VPG MV-1	2014
1482	VPG MV-1	2014
1483	VPG MV-1	2014
1484	VPG MV-1	2014
1661	CHEVY 4500 CHAMPION	2016
1662	CHEVY 4500 CHAMPION	2016
1663	CHEVY 4500 CHAMPION	2016
1664	CHEVY 4500 CHAMPION	2016
1665	CHEVY 4500 CHAMPION	2016
1666	CHEVY 4500 CHAMPION	2016
1667	CHEVY 4500 CHAMPION	2016
1668	CHEVY 4500 CHAMPION	2016
1669	CHEVY 4500 CHAMPION	2016
1670	CHEVY 4500 CHAMPION	2016
1671	CHEVY 4500 CHAMPION	2016

Vehicle Number	Make and Model	Year
1672	CHEVY 4500 CHAMPION	2016
1673	CHEVY 4500 CHAMPION	2016
1674	CHEVY 4500 CHAMPION	2016
1675	CHEVY 4500 CHAMPION	2016
1676	CHEVY 4500 CHAMPION	2016
1677	CHEVY 4500 CHAMPION	2016
1678	CHEVY 4500 CHAMPION	2016
1679	CHEVY 4500 CHAMPION	2016
1680	CHEVY 4500 CHAMPION	2016
1861	Ford Transit	2018
1862	Ford Transit	2018
1863	Ford Transit	2018
1864	Ford Transit	2018
1865	Ford Transit	2018
1866	Ford Transit	2018
1867	Ford Transit	2018
1868	Ford Transit	2018
1869	Ford Transit	2018
1870	Ford Transit	2018
1871	Ford Transit	2018
1872	Ford Transit	2018
1873	Ford Transit	2018
1874	Ford Transit	2018
1875	Ford Transit	2018
1876	Ford Transit	2018
1877	Ford Transit	2018
1878	Ford Transit	2018
1879	Ford Transit	2018
1880	Ford Transit	2018

C-3. COTA Supervisor Vehicles

Vehicle Number	Year	Make	Model	Body Style
77	2002	Chevrolet	C2500	Utility Body
82	1996	Ford	F-800	Dump
271	2010	Ford	Crown Victoria	Police Sedan
272	2012	Ford	Crown Victoria	Police Sedan
278	2013	Ford	F-550	Motor Home
4009	2009	Chevrolet	Malibu Hybrid	Sedan

Vehicle Number	Year	Make	Model	Body Style
4011	2009	Chevrolet	Malibu Hybrid	Sedan
4012	2009	Chevrolet	Malibu Hybrid	Sedan
4013	2009	Chevrolet	Malibu Hybrid	Sedan
4015	2009	Chevrolet	Malibu Hybrid	Sedan
4018	2009	Chevrolet	Malibu Hybrid	Sedan
4019	2009	Chevrolet	Malibu Hybrid	Sedan
4022	2012	Chevrolet	Equinox	SUV
4023	2012	Chevrolet	Equinox	SUV
4026	2012	Chevrolet	Malibu LS	Sedan
4027	2014	Ford	Explorer AWD	Police SUV
4028	2015	Ford	Explorer AWD	SUV
4029	2015	Ford	Explorer AWD	SUV
4030	2015	Ford	Explorer AWD	SUV
4031	2015	Ford	Explorer AWD	SUV
4032	2015	Ford	Explorer AWD	SUV
4033	2015	Ford	Explorer AWD	SUV
4034	2012	Honda	Civic CNG	SDN
4035	2016	Ford	Explorer AWD	SUV
4036	2016	Ford	Explorer AWD	SUV
4037	2016	Ford	Explorer AWD	SUV
4038	2016	Ford	Explorer AWD	SUV
4039	2016	Ford	Explorer AWD	SUV
4040	2016	Ford	Explorer AWD	SUV
4041	2016	Ford	Explorer AWD	SUV
4042	2016	Ford	Explorer AWD	SUV
4043	2016	Ford	Explorer AWD	SUV
4044	2016	Ford	Explorer AWD	SUV
4045	2018	Ford	Explorer AWD	SUV
4046	2018	Ford	Explorer AWD	SUV
4047	2018	Ford	Explorer AWD	SUV
4048	2018	Ford	Explorer AWD	SUV
4049	2018	Ford	Explorer AWD	SUV
6002	2008	Chevrolet	Silverado	Pickup Ext. Cab
6003	2008	Chevrolet	Uplander	Cargo Minivan
6004	2009	Chevrolet	C3500	Utility Body
6005	2009	Chevrolet	C4500	Utility Dump
6006	2011	International	4200	Dump
6007	2012	Chevrolet	C2500	Pickup
6008	2012	Chevrolet	C2500	Pickup
6009	2012	Ford	E-350	Van

Vehicle Number	Year	Make	Model	Body Style
6010	2012	Ford	E-350	Van
6011	2012	Ford	F-150	Pick up
6013	2012	Ford	F-350	Utility Body
6014	2011	Ford	F-450	Box Truck
6016	2010	International	4700	Serv Truck
6017	2012	Ford	F-550	Utility Body
6018	2012	Ford	F-550	Utility Body
6019	2012	Ford	F-550	Utility Body
6020	2013	Ford	F-250	Pickup
6021	2012	Ford	F-550	Bucket truck
6022	2014	Ford	F-250	Pickup
6023	2018	Dodge	Grand Caravan SE	Minivan
6024	2018	Dodge	Grand Caravan SE	Minivan
6025	2018	Dodge	Grand Caravan SE	Minivan
6026	2018	Dodge	Grand Caravan SE	Minivan
6027	2018	Dodge	Grand Caravan SE	Minivan
6028	2018	Dodge	Grand Caravan SE	Minivan
6029	2018	Dodge	Grand Caravan SE	Minivan
6030	2018	Dodge	Grand Caravan SE	Minivan
6031	2018	Dodge	Grand Caravan SE	Minivan
6032	2018	Dodge	Grand Caravan SE	Minivan
6033	2018	Ford	F-350 CC/W/ Reading Body	Utility Body
6051	2015	Ford	Transit Connect XLT	Cargo Minivan
6052	2015	Ford	Transit Connect XLT	Cargo Minivan
6053	2015	Ford	Transit Connect XLT	Cargo Minivan
6054	2015	Ford	Transit Connect XLT	Cargo Minivan
6055	2015	Ford	F-550	Utility/CNG

C- 4. Police Vehicles

Brass Tag	Year	Make	Model	Color	Type	Assigned To
26543	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - 6 PCT
26604	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - 6 PCT
27446	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 6 PCT
27429	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 6 PCT
27436	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 6 PCT
27020	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 6 PCT
26424	2015	FORD	TRANSIT 250	WHITE	M	Zone 1 - 6 PCT
26230	2015	FORD	INT UTILITY	WHITE	M	Zone 1 - 6 PCT
26556	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - 18 PCT

Brass Tag	Year	Make	Model	Color	Type	Assigned To
26550	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - 18 PCT
27443	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 18 PCT
27408	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 18 PCT
27397	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 18 PCT
26986	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 18 PCT
27449	2017	FORD	TRANSIT 250	WHITE	M	Zone 1 - 18 PCT
26599	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 4 PCT
26614	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 4 PCT
26568	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 4 PCT
26171	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - 4 PCT
26172	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - 4 PCT
27405	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - 4 PCT
28020	2016	FORD	TRANSIT 250	WHITE	M	Zone 4 - 4 PCT
26238	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - 4 PCT
26183	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - 5 PCT
26598	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 5 PCT
26582	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 5 PCT
26548	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 5 PCT
26989	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - 5 PCT
28023	2017	FORD	TRANSIT 250	WHITE	M	Zone 4 - 5 PCT
26184	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - 5 PCT
26608	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - 1 PCT
27411	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 1 PCT
26583	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - 1 PCT
27428	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 1 PCT
27423	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 1 PCT
27412	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - 1 PCT
26724	2016	FORD	TRANSIT 250	WHITE	M	Zone 1 - 1 PCT
26163	2015	FORD	INT UTILITY	WHITE	M	Zone 1 - 1 PCT
26203	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
26574	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
26594	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
26978	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
26977	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
26592	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
26976	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
27451	2017	FORD	TRANSIT 250	WHITE	M	Zone 4 - 2 PCT
26224	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - 2 PCT
26988	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
27003	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - MW

Brass Tag	Year	Make	Model	Color	Type	Assigned To
27435	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
27394	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
27419	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
27019	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
26564	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
26596	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
26615	2016	FORD	INT UTILITY	WHITE	M	Zone 1 - MW
27010	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - CRT
27016	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - CRT
27021	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - CRT
27015	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - CRT
27012	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - CRT
27022	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - CRT
27017	2017	FORD	INT UTILITY	WHITE	M	Zone 1 - CRT
26257	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
27395	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
26551	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
27415	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
27447	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
26979	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
27396	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
27456	2017	FORD	TRANSIT 250	WHITE	M	Zone 4 - EMW
26626	2016	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
26174	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
26987	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
26258	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - MW
26188	2015	FORD	INT UTILITY	WHITE	M	Zone 4 - CWC
27400	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - CWC
27393	2017	FORD	INT UTILITY	WHITE	M	Zone 4 - CWC
27392	2017	FORD	INT UTILITY	WHITE	M	Zone 4 -CWC

C- 5. Fire Vehicles

Vehicle Designation	Brass Tag	Make	Model	Year
Medic 6	27854	Horton	Medic	2018
Medic 806	27811	Ford	Medic	2018
Ems12	27475	Ford	Explorer	2017
Battalion 2	27470	Ford	Explorer	2017
Engine 7	24632	Sutphen	Engine	2011

Vehicle Designation	Brass Tag	Make	Model	Year
Medic 7	26076	Horton	Medic	2014
Engine 8	26418	Sutphen	Engine	2015
Ladder 8	23052	American Lefrance	Aerial Ladder	2008
Engine 16	25867	Sutphen	Engine	2014
Medic 16	27479	Horton	Medic	2018
Engine 18	24628	Sutphen	Engine	2011
Medic 18	27891	Ford	Medic	2018
Engine 19	24629	Sutphen	Engine	2011
Medic 19	27892	Ford	Medic	2018
Isu 19	26779		Air Supply	2015
Rsu 19	25789	International	Rescue Support	2014
Engine 24	26441	Sutphen	Engine	2015
Ladder 24	26838	Pierce	Aerial Ladder	2016
Medic 24	28074	Horton	Medic	2016
Engine 28	26467	Sutphen	Engine	2015
Ladder 28	23054	American Lefrance	Aerial Ladder	2008
Medic 28	26072	Horton	Medic	2014
Engine 29	24336	Ferrera	Engine	2011

C- 6. Public Service Fleet

Equipment No.	Year	Manufacturer	Model	Description
26088	2014	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
27090	2016	FORDX	F150	F150 XL 2DR SPR CAB 4WD
27781	2018	FORDX	F150	18-FORD-F150-3.3-6C-4WD-UNL
27780	2018	FORDX	F150	18-FORD-F150-3.3-6C-4WD-UNL
27664	2018	FORDX	F350	18-FORD-F350XL DUMP 4WD
24958	2012	FORDX	F150	F150 XL 2DR REG CAB 2WD
21982	2007	CHVRL	1500	1500 EXP CARGO VAN 2WD
24670	2012	FORDX	XLT WAGON	TRANSIT CONNECT XLT WAGON
24671	2012	FORDX	XLT WAGON	TRANSIT CONNECT XLT WAGON
24622	2011	FORDX	F250	F250 XL SD STYSIDE REG CAB 4WD
23205	2008	FORDX	F250	F250 XL SD STYSIDE REG CAB 4WD
27088	2016	FORDX	F150	F150 XL 2DR SPR CAB 4WD
21976	2007	CHVRL	COLORADO	COLORADO 2DR REG CAB 2WD
26834	2016	FORDX	F150	F150 XL 2DR SPR CAB 4WD
25691	2013	FORDX	F150	F150 XL 2DR SPR CAB 4WD
26824	2016	FORDX	F150	F150 XL 2DR SPR CAB 4WD
26856	2016	FORDX	F450	F450 XL SD RC STAKE BODY 2WD

Equipment No.	Year	Manufacturer	Model	Description
26857	2016	FORDX	F450	F450 XL SD RC STAKE BODY 2WD
25731	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
25713	2013	FORDX	F150	F150 XL 2DR SPR CAB 4WD
27089	2016	FORDX	F150	F150 XL 2DR SPR CAB 4WD
24592	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
25732	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
27087	2016	FORDX	F150	F150 XL 2DR SPR CAB 4WD
26828	2016	FORDX	F150	F150 XL 2DR SPR CAB 4WD
24994	2012	FORDX	F250	F250 XL SD STYSIDE REG CAB 4WD
25747	2013	FORDX	F150	F150 XL 2DR SPR CAB 4WD
24992	2012	FORDX	E150	E150 ECONO CARGO VAN 2WD
21957	2007	FORDX	F450	F450 LCF FLATBED DRW
24644	2011	FORDX	F450XL	CNG 4X2 REG CAB F-450XL STAKE BODY
24645	2011	FORDX	F450XL	CNG 4X2 REG CAB F-450XL STAKE BODY
25768	2013	FORDX	F450	KNAP STAKE TK LIFTGATE DRW
24647	2011	FORDX	F450XL	CNG 4X2 REG CAB F-450XL STAKE BODY
25486	2013	FORDX	F450	KNAP STAKE TK LIFTGATE DRW
25767	2013	FORDX	F450	KNAP STAKE TK LIFTGATE DRW
21956	2007	FORDX	F450	F450 LCF FLATBED DRW
24646	2011	FORDX	F450XL	CNG 4X2 REG CAB F-450XL STAKE BODY
26321	2015	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT PVAN FWD
21939	2007	CHVRL	MALIBU	MALIBU LS 4DR SEDAN FWD
25318	2013	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25914	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25299	2013	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
24512	2012	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
28025	2016	FORDX	FOCUS	FOCUS SE 4DR SEDAN FWD
26263	2014	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
26090	2014	HONDA	CIVIC	CIVIC 4DR SEDAN CNG FWD
28026	2016	FORDX	FOCUS	FOCUS SE 4DR SEDAN FWD
24986	2012	FORDX	FUSION	FUSION S 4DR SEDAN FWD
23225	2007	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
24987	2012	FORDX	FUSION	FUSION S 4DR SEDAN FWD
26760	2016	FORDX	FUSION	FUSION S 4DR SEDAN FWD
24985	2012	FORDX	FUSION	FUSION S 4DR SEDAN FWD
25378	2013	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25515	2013	FORDX	E150	E150 ECONO CARGO VAN 2WD

Equipment No.	Year	Manufacturer	Model	Description
25889	2014	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT PVAN FWD
25964	2014	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25970	2014	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25514	2013	FORDX	E150	E150 ECONO CARGO VAN 2WD
25322	2013	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
27102	2016	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XL CVAN FWD
24675	2012	FORDX	XLT WAGON	TRANSIT CONNECT XLT WAGON
24676	2012	FORDX	XLT WAGON	TRANSIT CONNECT XLT WAGON
26665	2015	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25775	2014	FORDX	F250	F250 XL SD 2DR SPR CAB 2WD SRW
27107	2016	FORDX	F150	F150 XL 2DR REG CAB 2WD
25837	2014	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25273	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25838	2014	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25272	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25271	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25258	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25257	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25256	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25255	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
27222	2017	FORDX	FUSION	FUSION SE 4DR SEDAN FWD
27703	2018	NISSN	LEAF	18-NISSAN-LEAF-4DR-SEDAN-EV
25845	2014	FORDX	E350	E350 XL SD PASS VAN 2WD
25955	2014	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT PVAN FWD
25888	2014	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT PVAN FWD
23707	2008	FORDX	E150	E150 ECONO CARGO VAN 2WD
23704	2008	FORDX	E250	E250 SD CARGO VAN 2WD
27223	2017	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XL CVAN FWD
25783	2014	FORDX	ESCAPE	ESCAPE S 4DR SUV FWD
25784	2014	FORDX	ESCAPE	ESCAPE S 4DR SUV FWD
25785	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
27263	2017	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
27264	2017	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
25301	2013	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
25776	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
25127	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25128	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25129	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25134	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
25135	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD

Equipment No.	Year	Manufacturer	Model	Description
25136	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
25171	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
25172	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
25173	2012	FORDX	F350	F350 XL SD STYSIDE SPR CAB 4WD
25174	2013	FORDX	F150	F150 XL 4DR SPR CAB 4WD
25182	2012	FORDX	F350	F350 XL SD 2DR REG CAB 4WD
25738	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25741	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25746	2013	FORDX	F150	F150 XL 2DR REG CAB 2WD
25770	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25773	2014	FORDX	F250	F250 XL SD 2DR SPR CAB 2WD SRW
25835	2014	FORDX	F350	F350 XL STYSIDE REG CAB 4WD SRW
25854	2014	FORDX	F350	F350 XL STYSIDE SPR CAB 2WD SRW
25909	2014	FORDX	F150	F150 XL 2DR CRW CAB 4WD
26091	2014	FORDX	F150	F150 XL 4DR SPR CAB 2WD
26107	2014	FORDX	F150	F150 XL 4DR SPR CAB 2WD
26139	2014	FORDX	F150	F150 XL 4DR SPR CAB 2WD
27302	2017	FORDX	F350	F350 XL REG CAB 4WD PLOW
27323	2017	FORDX	F350	F350 XL REG CAB 4WD
27324	2017	FORDX	F350	F350 XL REG CAB 4WD
27325	2017	FORDX	F350	F350 XL REG CAB 4WD
27326	2017	FORDX	F350	F350 XL REG CAB 4WD
27327	2017	FORDX	F350	F350 XL REG CAB 4WD PLOW
23231	2007	FORDX	F150	F150 XL STYLESIDE REG CAB 2WD
23235	2007	FORDX	F150	F150 XL STYLESIDE REG CAB 2WD
23292	2008	FORDX	F250	F250 XL SD STYSIDE REG CAB 2WD
23295	2008	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
23512	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
23580	2008	FORDX	RANGER	RANGER XL 2DR REG CAB 2WD
23592	2008	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
23593	2008	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
23722	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
23723	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
23724	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
23725	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
23726	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
23727	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
23728	2008	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24214	2011	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24215	2011	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD

Equipment No.	Year	Manufacturer	Model	Description
24216	2011	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24217	2011	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24242	2011	FORDX	RANGER	RANGER XLT 4DR SPR CAB 2WD
24581	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24582	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24583	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24584	2012	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
24585	2012	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
24586	2012	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
24587	2012	FORDX	F350	F350 XL SD STYSIDE CRW CAB DRW
24588	2012	FORDX	F350	F350 XL SD STYSIDE CRW CAB DRW
24633	2012	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
24634	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24639	2012	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
24648	2011	FORDX	F450XL	CNG 4X2 REG CAB F-450XL STAKE BODY
24530	2012	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25101	2013	FORDX	FOCUS	FOCUS S 4DR SEDAN FWD
25475	2013	FORDX	E150	E150 ECONO CARGO VAN 2WD
25450	2013	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25449	2013	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25447	2013	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
26853	2016	FORDX	TRANSIT	TRANSIT 150 CARGO VAN 2WD
27799	2018	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
28028	2017	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
24950	2012	FORDX	EXPEDITION	EXPEDITION XL EL 4DR SUV 2WD
25102	2013	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25103	2013	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25474	2013	FORDX	EXPEDITION	EXPEDITION XL 4DR SUV 2WD
27798	2018	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
27086	2017	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
27032	2017	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
26954	2017	FORDX	ESCAPE	ESCAPE SE 4DR SUV 4WD
26016	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25997	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25994	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25992	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25993	2014	FORDX	ESCAPE	ESCAPE SE 4DR SUV FWD
25975	2014	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25976	2014	FORDX	F150	F150 XL 2DR SPR CAB 2WD
23570	2008	FORDX	RANGER	RANGER XL 2DR REG CAB 2WD

Equipment No.	Year	Manufacturer	Model	Description
23571	2008	FORDX	RANGER	RANGER XL 2DR REG CAB 2WD
23573	2008	FORDX	RANGER	RANGER XL 2DR REG CAB 2WD
23574	2008	FORDX	RANGER	RANGER XL 2DR REG CAB 2WD
23575	2008	FORDX	RANGER	RANGER XL 2DR REG CAB 2WD
23577	2008	FORDX	RANGER	RANGER XL 2DR REG CAB 2WD
24621	2011	FORDX	F150	F150 2DR REG CAB 2WD
24635	2011	FORDX	F150	F150 2DR REG CAB 4WD
24637	2011	FORDX	F150	F150 2DR REG CAB 4WD
25079	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25080	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25084	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25085	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25097	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25098	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25099	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25100	2012	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25180	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25181	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25207	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25208	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25209	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25210	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25211	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25313	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25314	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25315	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25382	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25383	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25385	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25386	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25387	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25388	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25389	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25390	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25393	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25394	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25395	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25396	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25397	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25398	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD

Equipment No.	Year	Manufacturer	Model	Description
25403	2013	FORDX	F150	F150 XL 4DR SPR CAB 2WD
25472	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25473	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25476	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25478	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25479	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25480	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25481	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25491	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25972	2014	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25973	2014	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25974	2014	FORDX	F150	F150 XL 2DR SPR CAB 2WD
21259	2000	CHVRL	3500	3500 EXP PASS VAN 2WD
26435	2015	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25961	2014	FORDX	TRANSIT CONNECT	TRANSIT CONNECT XLT CVAN FWD
25865	2014	FORDX	E350	E350 SD ECONO CARGO VAN 2WD
26807	2016	FORDX	TRANSIT	TRANSIT 150 CARGO VAN 2WD
23232	2007	FORDX	F150	F150 XL STYLESIDE REG CAB 2WD
27987	2019	FORDX	F250	19-FORD F250 XL SUPERCAB 4WD-E85
23234	2007	FORDX	F150	F150 XL STYLESIDE REG CAB 2WD
23500	2008	FORDX	F350	F350 XL SD UTILITY TK DRW
23502	2008	FORDX	F350	F350 XL SD STYSIDE SPR CAB 4WD
24545	2011	FORDX	F150	F150 2DR REG CAB 2WD
24580	2011	FORDX	F150	F150 2DR REG CAB 4WD
24636	2011	FORDX	F150	F150 2DR REG CAB 4WD
24638	2011	FORDX	F150	F150 2DR REG CAB 4WD
25126	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25130	2012	FORDX	F250	F250 XL SD STYSIDE CRW CAB 2WD
25132	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25133	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25169	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25170	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25179	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25212	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25733	2013	FORDX	F150	F150 XL 2DR REG CAB 4WD
25734	2013	FORDX	F150	F150 XL 2DR SPR CAB 2WD
25745	2013	FORDX	F150	F150 XL 2DR SPR CAB 4WD
25771	2014	FORDX	F250	F250 XL SD 2DR SPR CAB 2WD SRW
25772	2014	FORDX	F250	F250 XL SD 2DR SPR CAB 2WD SRW
25834	2014	FORDX	F350	F350 XL STYSIDE SPR CAB 2WD SRW

Equipment No.	Year	Manufacturer	Model	Description
25842	2014	FORDX	F350	F350 XL STYSIDE SPR CAB 2WD SRW
25846	2014	FORDX	F350	F350 XL STYSIDE REG CAB 2WD SRW
25859	2014	FORDX	F150	F150 XL 2DR SPR CAB 2WD
23228	2007	FORDX	F150	F150 XL STYLESIDE REG CAB 2WD
21909	2006	FORDX	F350	F350 XL SD STYSIDE REG CAB 4WD
21900	2006	CHVRL	3500	3500 SILVERADO UTY TK 2WD
25861	2013	FORDX	F150	F150 XL 2DR REG CAB 2WD
23233	2007	FORDX	F150	F150 XL STYLESIDE REG CAB 2WD
21770	2005	CHVRL	C4500-KODIAK	C4500 KODIAK 4 WD BUCKET RUCK
23702	2008	CHVRL	C5500-KODIAK	C5500 KODIAK BUCKET TRUCK 4 WD
23703	2008	CHVRL	C5500-KODIAK	C5500 KODIAK 4X4 BUCKET
24329	2011	FORDX	F450XL SD	4X2 CREW CAB CANOPY W/LIFT GATE
24330	2011	FORDX	F450XL SD	CREW CAB CANOPY W/LIFT GATE 4X2
24331	2011	FORDX	F450XL SD	4X2 CREW CAB CANOPY W/LIFT GATE
26109	2015	FORDX	F450	F450 XL SD 4DR CRW CAB SRW

C- 7. Franklin County Engineers Office Fleet

ID	Year	Make	Model	VIN
987	2018	International	Tandem Dump Truck	1HTWHTAT8JH438722
992	2012	International	Tandem Dump Truck	1HTWHAZT5CH043621

Appendix E: Interface Control Document

Following is an excerpt of the draft Interface Control Document that defines the external interfaces within the CVE (listed in Table E-1), and reflected in Figure 7, and includes details of the specific message content and temporal components of expected message exchanges. A revised (Final) ICD will be provided to the Offeror when available.

E-1. CV Environment High-Level Interface Overview

Interface	*Data Flows*	*Communication Details*
Interface 1 TrCVMS → TrCVMS Staff	Archived Data Return	*N/A (human interface)*
TrCVMS Staff → TrCVMS	Transit Vehicle Interaction Event Data Parameters, Archived Data Query	
Interface 2 TCVMS → TCVMS Staff	Archived Data Return, Performance Measure, RSU Status (DSRC Channel Traffic/Utilization, RSU Transmit Power, etc.), RSU Limited Connectivity Alert, RSU Channel Congestion Alert, Cabinet Tamper Status, Cabinet Tamper Alert, OBU Tamper Alert, Unauthorized Access Alert	*N/A (human interface)*
TCVMS Staff → TCVMS	MAP Data, RSM Data, Signal Priority Authorization List, Archived Data Query, Performance Measure Parameters, Channel Congestion Parameter, RSU Status Query, Cabinet Status Query	
Interface 3 TrCVMS → COTA Garage Communications	Transit Vehicle Interaction Event Data Parameters	Session Layer: IETF TLS Transport Layer: IETF TCP Network Layer: IETF IPv6 Data Link Layer: Wide Area Wireless WAN Physical Layer: Wide Area Wireless WAN Security Plane: HTTP Auth, IETF TLS
COTA Garage Communications → TrCVMS	Transit Vehicle Interaction Event Data	
Interface 4 TrCVMS → Smart Columbus OS	Transit Vehicle Interaction Event Data	*TBD*
Interface 5 TCVMS → Smart Columbus OS	MAP Data RSM Data Logged Messages (BSM, SRM, SSM, SPaT)	*TBD*
Interface 7 RSU → Traffic CV Management System	All logged messages (BSM, SPaT, SRM, SSM), Priority Authorization Query, RSU Status (DSRC Channel Traffic/Utilization, RSU Transmit Power, etc.), Cabinet Tamper Status, OBU Tamper Status, Network Communications Metadata	ITS Application Information Layer: Undefined Application Layer: HTTPS Session Layer: IETF TLS, IETF DTLS Transport Layer: IETF UDP, IETF TCP Network Layer: IETF IPv6 Data Link Layer: LLC and MAC compatible with Physical and Network Physical Layer: IEEE 802.3 (fiber-optic backhaul) Security Plane: IEEE 1609.2, IETF TLS, IETF, DTLS
Traffic CV Management System → RSU	Priority Authorization Result, MAP Data, RSM Data	

Interface	*Data Flows*	*Communication Details*	
Interface 8 RSU → SCMS	RSU Enrollment Request, OBU Enrollment Request, RSU Application Certificate Request, OBU Pseudonym Certificate Request, OBU Identification Certificate Request, Misbehavior Report	Application Layer	IETF SNMP
		Presentation Layer	ISO ASN.1 BER
		Session Layer	IETF TLS, IETF DTLS
		Transport Layer	IETF UDP, IETF TCP
		Network Layer	IETF IPv6
SCMS → RSU	RSU Enrollment Certificate, OBU Enrollment Certificate, RSU Application Certificate, OBU Pseudonym Certificate, OBU Identification Certificate, Revocation List	Data Link Layer	LLC and MAC compatible with Physical and Network
		Physical Layer	IEEE 802.3 (fiber-optic backhaul, Internet)
		Security Plane	IEEE 1609.2, IETF DTLS, IETF TLS
Interface 9 Ohio CORS → RSU	RTCM Data	ITS Application Information Layer	RTCM 10410.1
		Application Layer	HTTPS
		Session Layer	IETF TLS, IETF DTLS
		Transport Layer	IETF UDP, IETF TCP
		Network Layer	IETF IPv6
		Data Link Layer	LLC and MAC compatible with Physical and Network
		Physical Layer	IEEE 802.3 (fiber-optic backhaul, Internet)
		Security Plane	IEEE 1609.2, IETF TLS, IETF, DTLS
Interface 11a RSU → Traffic Signal Controller	SRM Data	ITS Application Information Layer	NTCIP 1202-ASC
Traffic Signal Controller → RSU	SPaT Data, SSM Data	Presentation Layer	ISO ASN.1 UPER
		Transport Layer	IETF UDP, IETF TCP
		Network Layer	IETF IPv6
		Data Link Layer	LLC and MAC compatible with Physical and Network
		Physical Layer	IEEE 802.3 (local Ethernet)
		Security Plane	IEEE 1609.2
Interface 11b School Zone Signal → RSU	School Zone Indicator (0/24V)	*N/A*	
Interface 12 RSU → Transit Vehicle OBU	SPaT, MAP, RTCM, SSM, RSM, OBU Enrollment Certificate, OBU Pseudonym Certificate, OBU Identification Certificate, Revocation List	ITS Application Information Layer	SAE J2735_201603, Section 5.12
		Presentation Layer	ISO ASN.1 UPER
		Transport Layer	IEEE 1609.3 WSMP
		Network Layer	IEEE 1609.3 WSMP
		Data Link Layer	IEEE 1609.4, IEEE 802.11
		Physical Layer	IEEE 802.11
		Security Plane	IEEE 1609.2
Transit Vehicle OBU → RSU	BSM, SRM, OBU Tamper Status, OBU Enrollment Request, OBU Pseudonym Certificate Request, OBU Identification Certificate Request, Misbehavior Report		
Interface 13 RSU → LDV OBU	SPaT, MAP, RTCM, RSM OBU, Enrollment Certificate, OBU Pseudonym Certificate, OBU Identification Certificate, Revocation List	ITS Application Information Layer	SAE J2735_201603, Section 5.12
		Presentation Layer	ISO ASN.1 UPER
		Transport Layer	IEEE 1609.3 WSMP
		Network Layer	IEEE 1609.3 WSMP
		Data Link Layer	IEEE 1609.4, IEEE 802.11

Interface	*Data Flows*	*Communication Details*	
LDV OBU → RSU	BSM, OBU Tamper Status, OBU Enrollment Request, OBU Pseudonym Certificate Request, OBU Identification Certificate Request, Misbehavior Report	Physical Layer Security Plane	IEEE 802.11 IEEE 1609.2
Interface 14 RSU → Emergency Vehicle OBU	SPaT, MAP, RTCM, SSM, OBU Enrollment Certificate, OBU Pseudonym Certificate, OBU Identification Certificate, Revocation List	ITS Application Information Layer Presentation Layer Transport Layer Network Layer Data Link Layer Physical Layer Security Plane	SAE J2735_201603, Section 5.12 ISO ASN.1 UPER IEEE 1609.3 WSMP IEEE 1609.3 WSMP IEEE 1609.4, IEEE 802.11 IEEE 802.11 IEEE 1609.2
Emergency Vehicle OBU → RSU	BSM, SRM, OBU Tamper Status, OBU Enrollment Request, OBU Pseudonym Certificate Request, OBU Identification Certificate Request, Misbehavior Report		
Interface 15 RSU → HDV OBU	SPaT, MAP, RTCM, SSM, OBU Enrollment Certificate, OBU Pseudonym Certificate, OBU Identification Certificate, Revocation List	ITS Application Information Layer Presentation Layer Transport Layer Network Layer Data Link Layer Physical Layer Security Plane	SAE J2735_201603, Section 5.12 ISO ASN.1 UPER IEEE 1609.3 WSMP IEEE 1609.3 WSMP IEEE 1609.4, IEEE 802.11 IEEE 802.11 IEEE 1609.2
HDV OBU → RSU	BSM, BSM*, SRM, OBU Tamper Status, OBU Enrollment Request, OBU Pseudonym Certificate Request, OBU Identification Certificate Request, Misbehavior Report		
Interface 16 HDV OBU → Platooning Provider Central Management System	Platoon Query	Session Layer Transport Layer Network Layer	IETF TLS IETF TCP IETF IPv6
Platooning Provider Central Management System → HDV OBU	Platoon Data	Data Link Layer Physical Layer Security Plane	Wide Area Wireless WAN Wide Area Wireless WAN HTTP Auth, IETF TLS
Interface 17 LDV OBU → LDV Operator	Alert Application Availability, System Status Information, Pending Updates, Power Status (LDV OBU Only)	*N/A (human interface)*	
LDV Operator → LDV OBU	OBU Start-Up Indication, Setting Adjustment		
Interface 18 Emergency Vehicle OBU → Emergency Vehicle Operator	Notification	*N/A (human interface)*	
Interface 19 Transit Vehicle OBU → Remote OBU	BSM	ITS Application Information Layer Presentation Layer Transport Layer Network Layer Data Link Layer Physical Layer Security Plane	SAE J2735_201603, Section 5.12 ISO ASN.1 UPER IEEE 1609.3 WSMP IEEE 1609.3 WSMP IEEE 1609.4, IEEE 802.11 IEEE 802.11 IEEE 1609.2
Remote OBU → Transit Vehicle OBU	BSM, BSM*		

Interface	*Data Flows*	*Communication Details*
Interface 20 LDV OBU → Remote OBU	BSM	ITS Application Information Layer: SAE J2735_201603, Section 5.12 Presentation Layer: ISO ASN.1 UPER Transport Layer: IEEE 1609.3 WSMP Network Layer: IEEE 1609.3 WSMP Data Link Layer: IEEE 1609.4, IEEE 802.11 Physical Layer: IEEE 802.11 Security Plane: IEEE 1609.2
Remote OBU → LDV OBU	BSM, BSM*	
Interface 21 Vehicle Databus → Transit Vehicle OBU	CAN Bus Data (optional)	Controller Area Network (CAN) - ISO 11898 SAE J1939
Interface 22 Vehicle Databus → LDV OBU	CAN Bus Data (optional)	Controller Area Network (CAN) - ISO 11898 SAE J1939
Interface 23 Vehicle Databus → Emergency Vehicle OBU	CAN Bus Data (optional)	Controller Area Network (CAN) - ISO 11898 SAE J1939
Interface 24 Vehicle Databus → HDV OBU	CAN Bus Data (optional)	Controller Area Network (CAN) - ISO 11898 SAE J1939
Interface 25 GNSS → Transit Vehicle OBU	Time and Location Data	NMEA 0183 - serial interface for marine electronics devices including global positioning system (GPS)
Interface 26 GNSS → LDV OBU	Time and Location Data	NMEA 0183 - serial interface for marine electronics devices including global positioning system (GPS)
Interface 26 GNSS → RSU	Time and Location Data	NMEA 0183 - serial interface for marine electronics devices including global positioning system (GPS)
Interface 28 GNSS → Emergency Vehicle OBU	Time and Location Data	NMEA 0183 - serial interface for marine electronics devices including global positioning system (GPS)
Interface 29 GNSS → HDV OBU	Time and Location Data	NMEA 0183 - serial interface for marine electronics devices including global positioning system (GPS)

Figure 7: Physical View of the Smart Columbus CVE

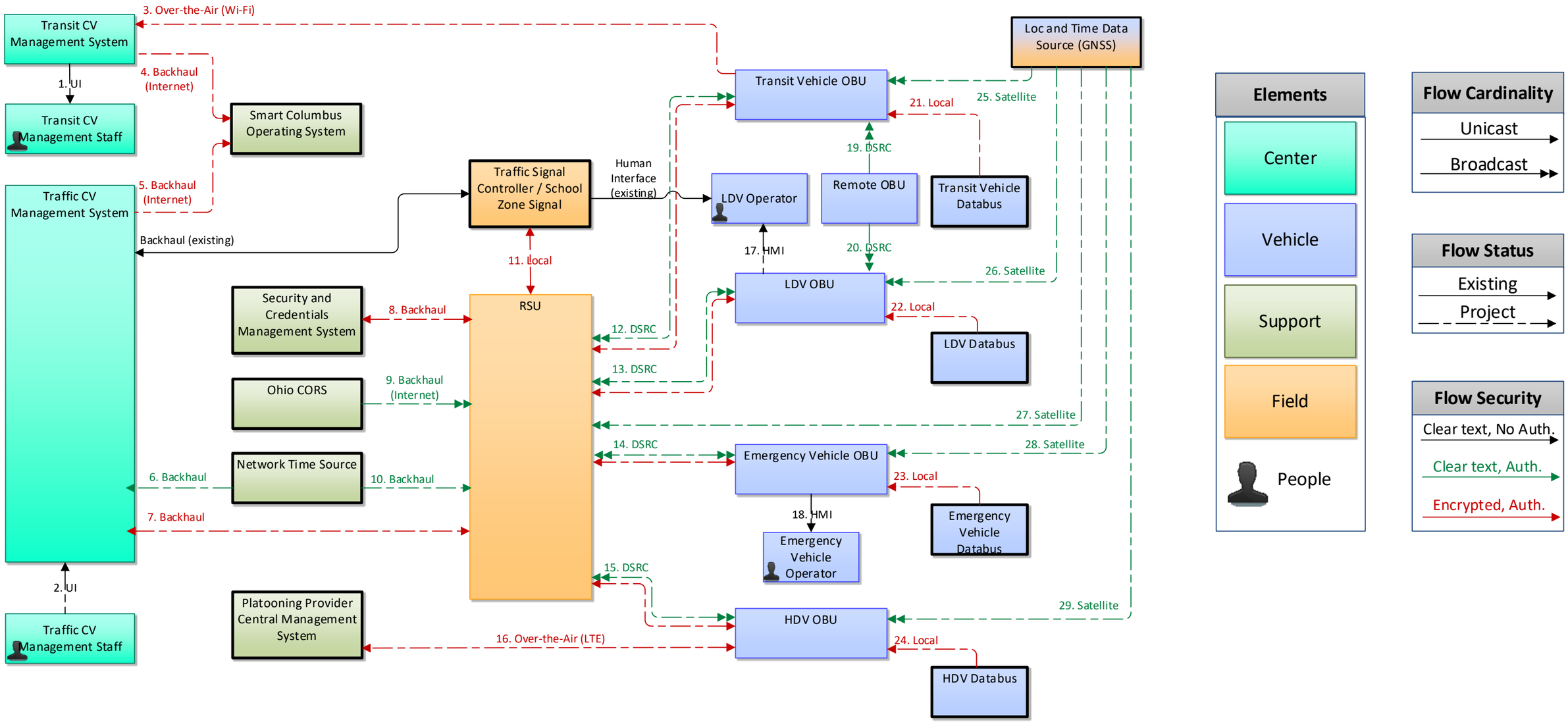


Figure 8: Interface 1 Sequence Diagram – Input Parameters, Query Data, and Return Transit Vehicle Interaction Data from Archive

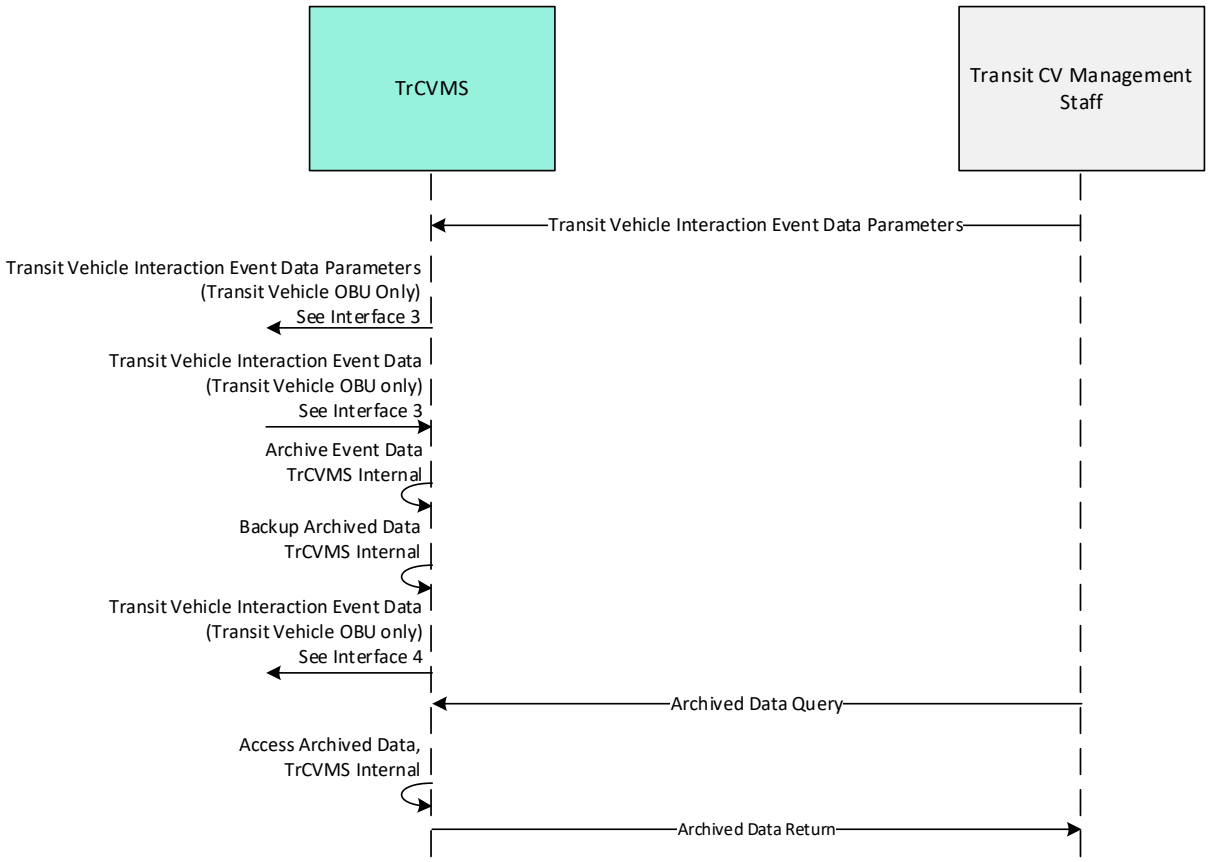


Figure 9: Interface 2 Sequence Diagram - MAP Data Input

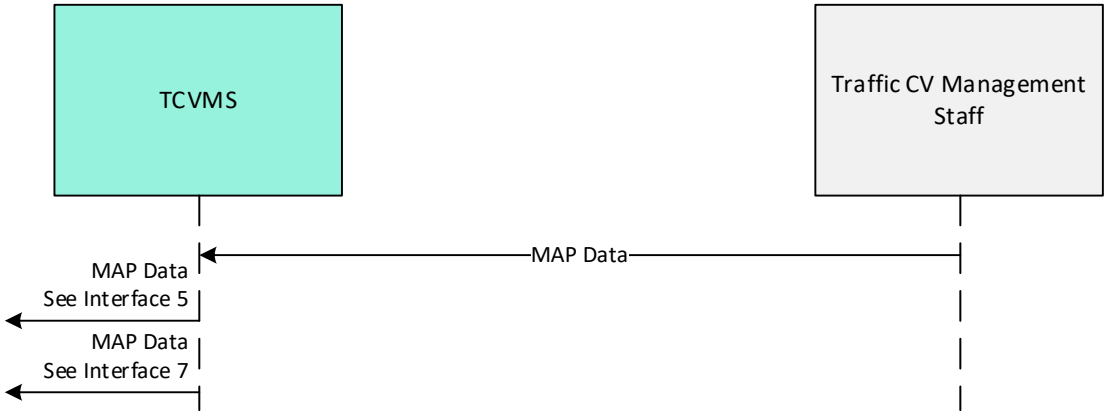


Figure 10: Interface 2 Sequence Diagram – RSM Data Input

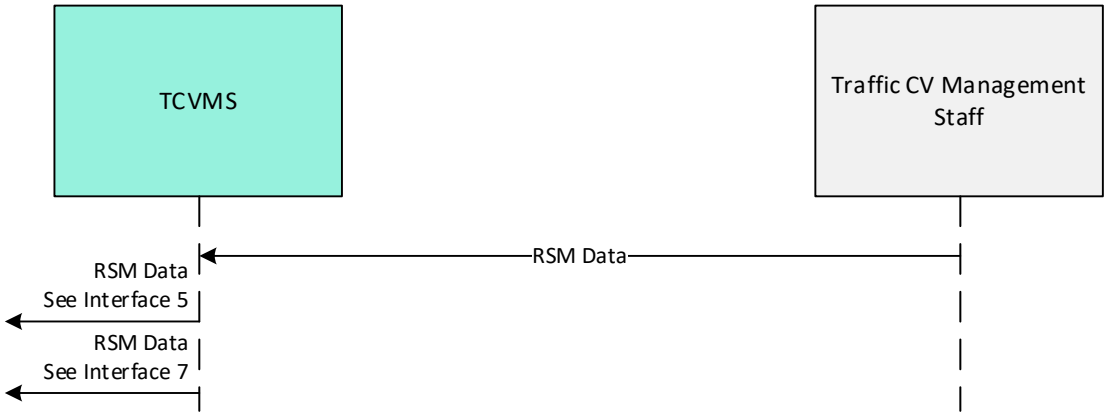


Figure 11: Interface 2 Sequence Diagram – Signal Priority Authorization List Input

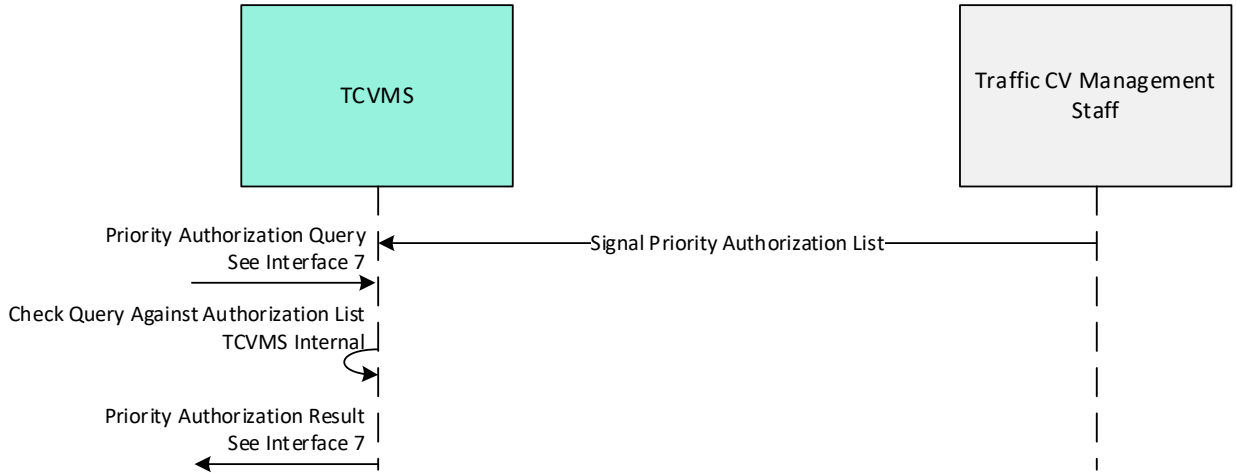


Figure 12: Interface 2 Sequence Diagram – Query Data and Return Data from Archive

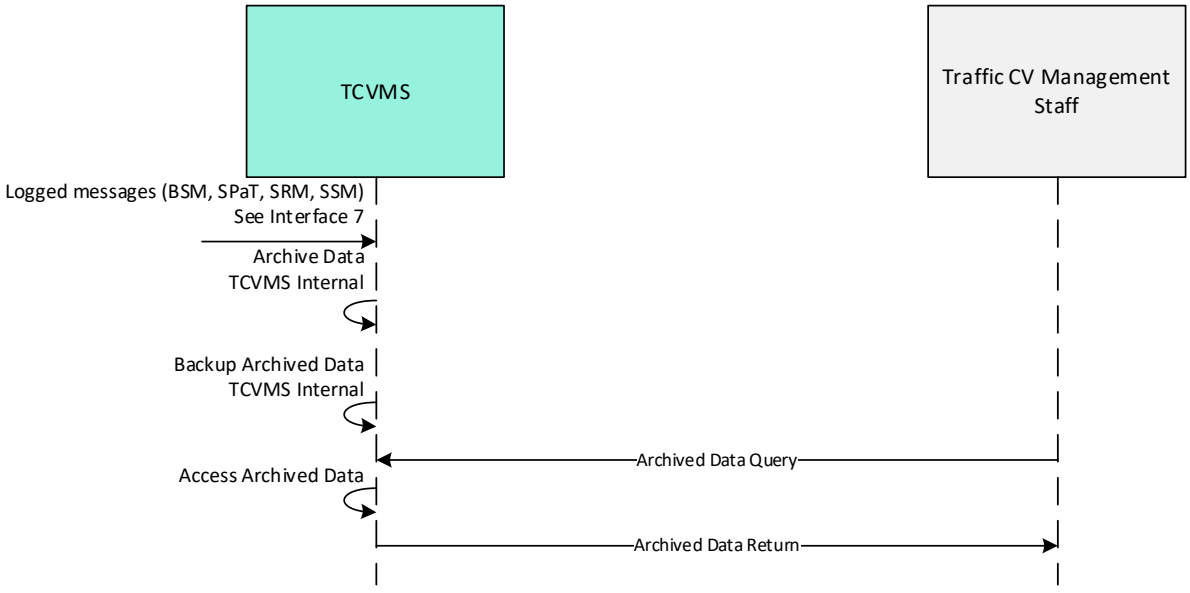


Figure 13: Interface 2 Sequence Diagram – Input Performance Measure Parameters and Receive Performance Measures

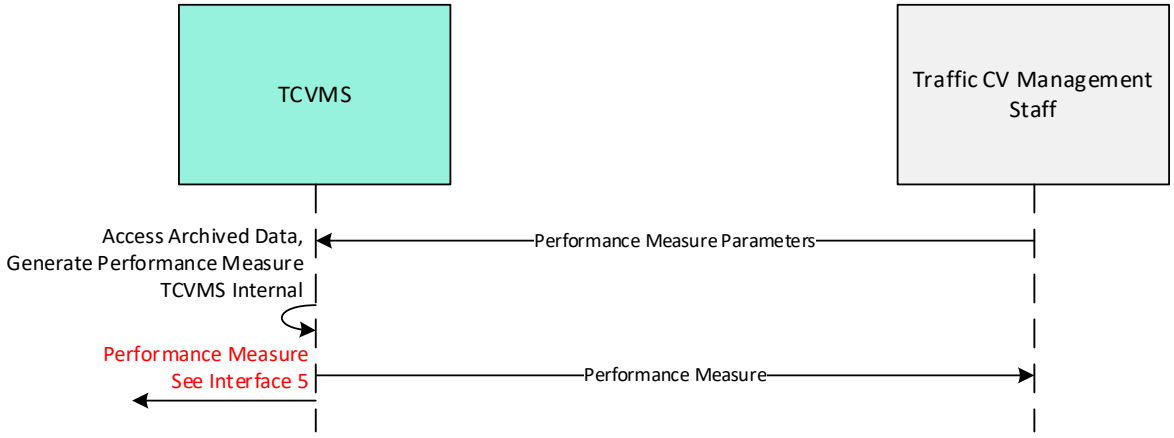


Figure 14: Interface 2 Sequence Diagram – RSU Status Query and Return RSU Status

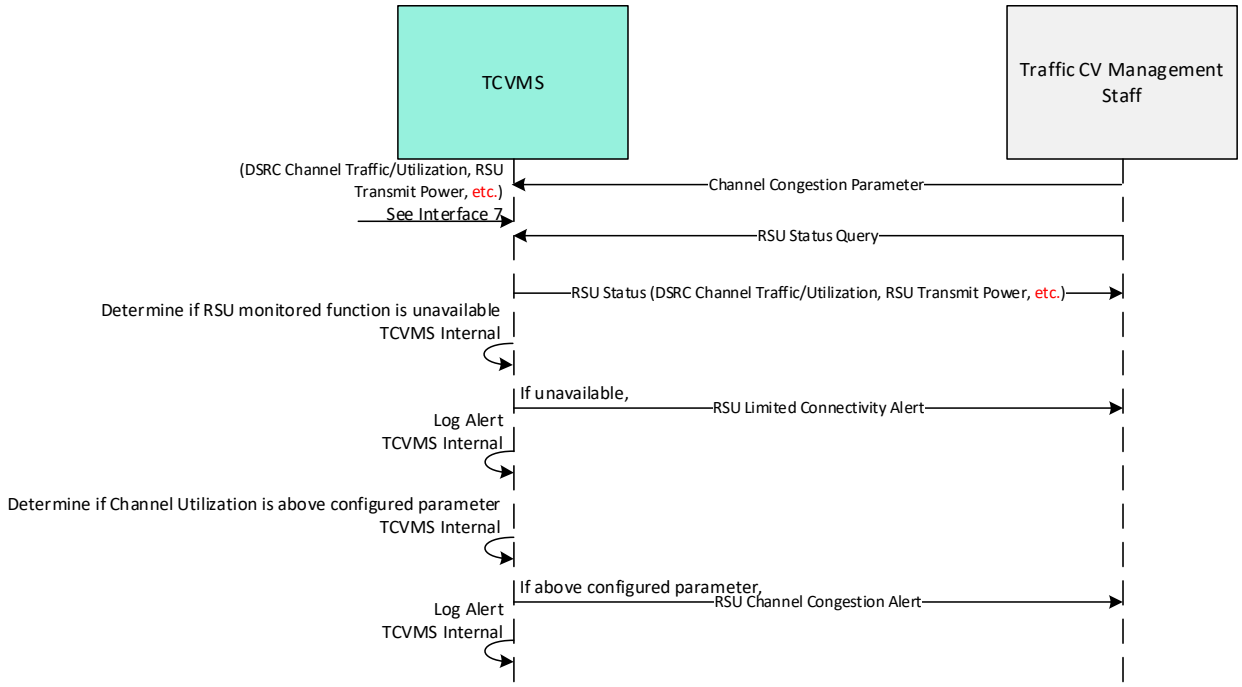


Figure 15: Interface 2 Sequence Diagram - Cabinet Status Query and Return Cabinet Status

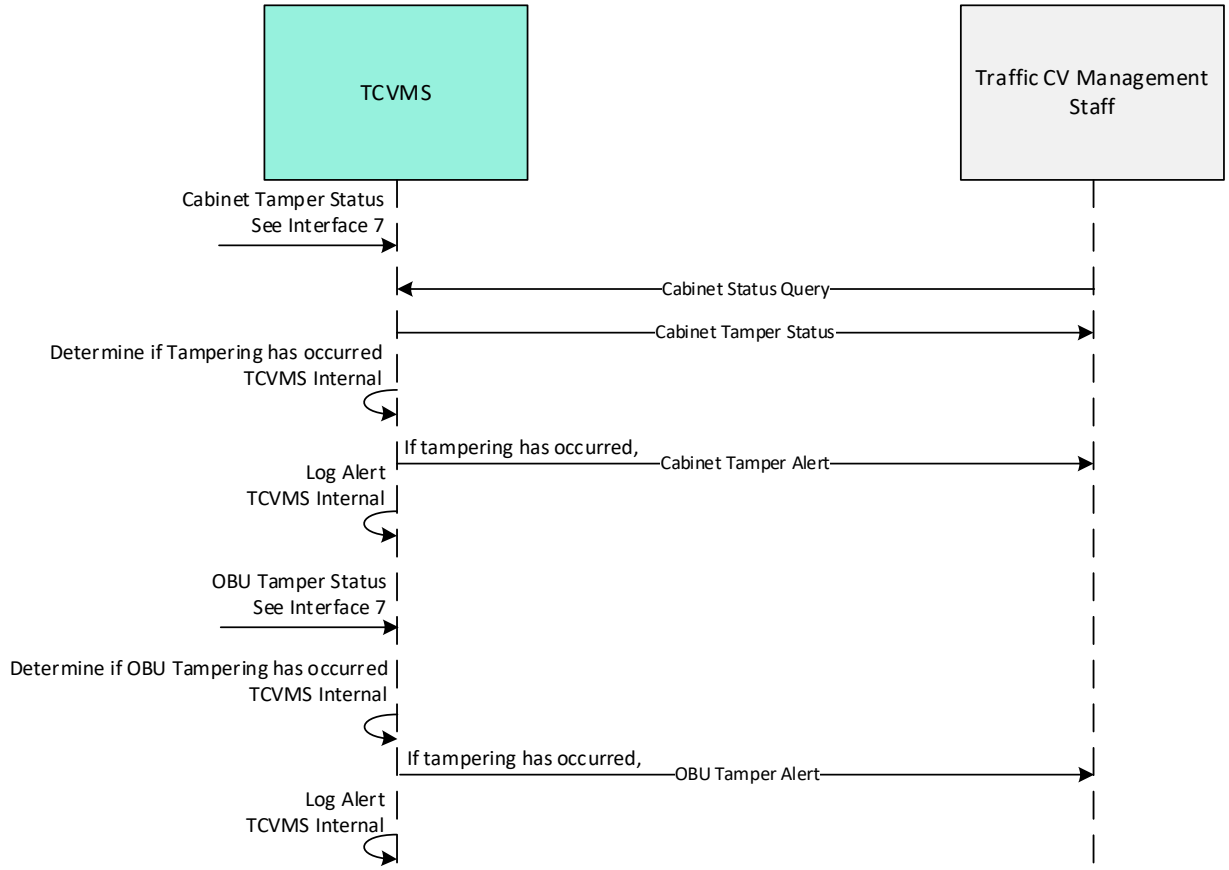


Figure 16: Interface 2 Sequence Diagram – Providing Alert for Unauthorized Network Access

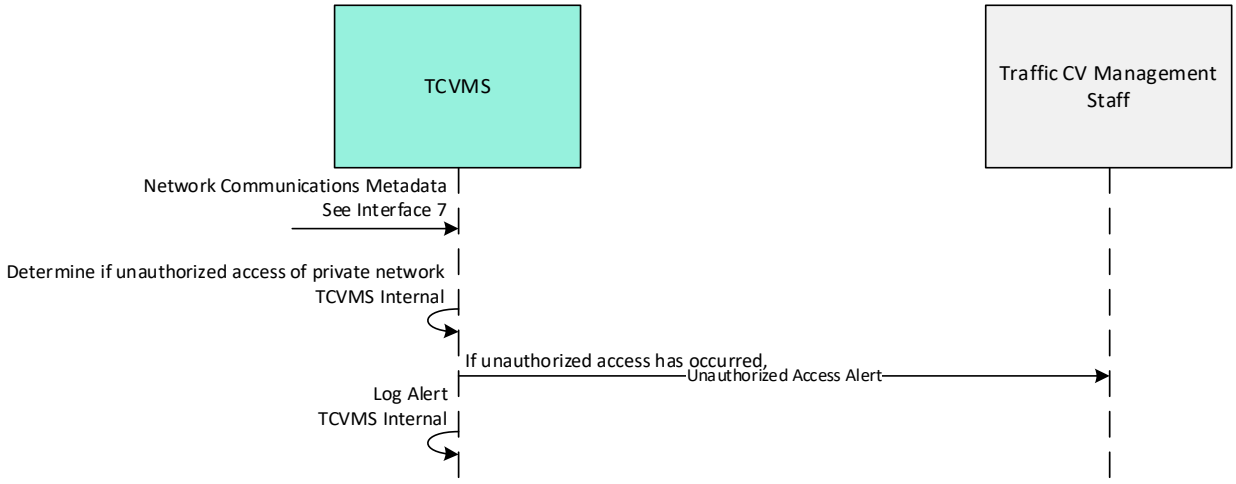


Figure 17: Interface 3 Sequence Diagram – Input Transit Vehicle Interaction Event Data Parameters and Receive Transit Vehicle Interaction Event Data

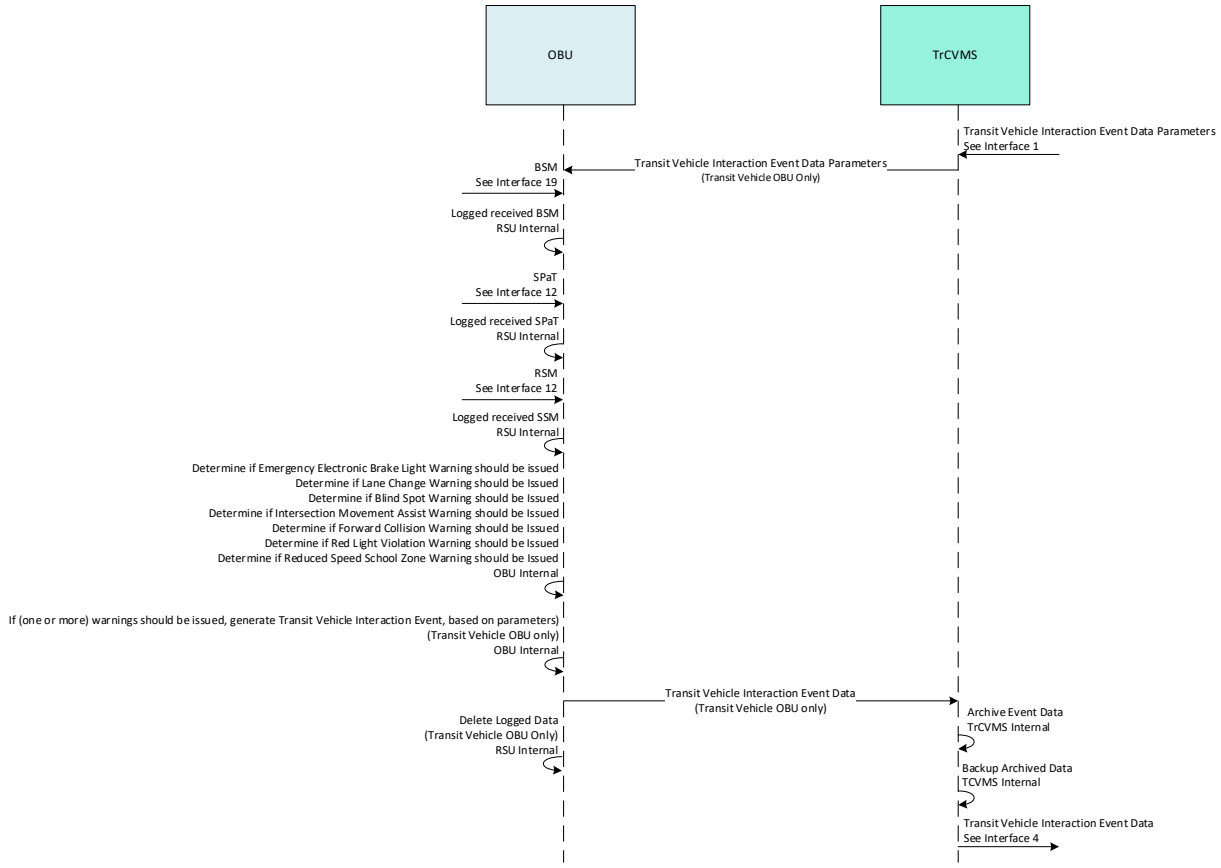


Figure 18: Interface 4 Sequence Diagram – Sending Transit Vehicle Interaction Event Data to Smart Columbus Operating System

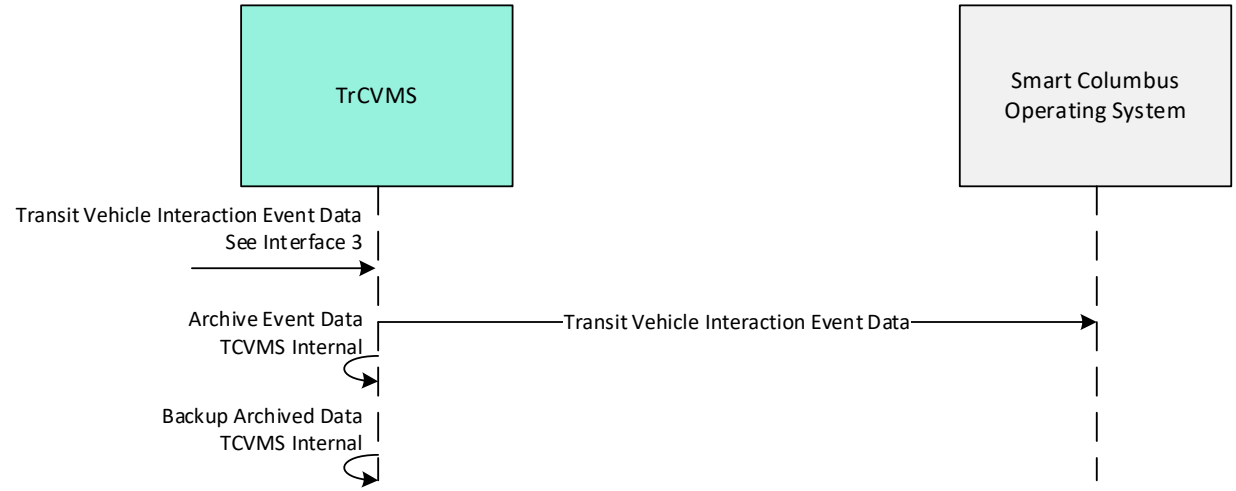


Figure 19: Interface 5 Sequence Diagram - Sending Logged Messages to Smart Columbus Operating System

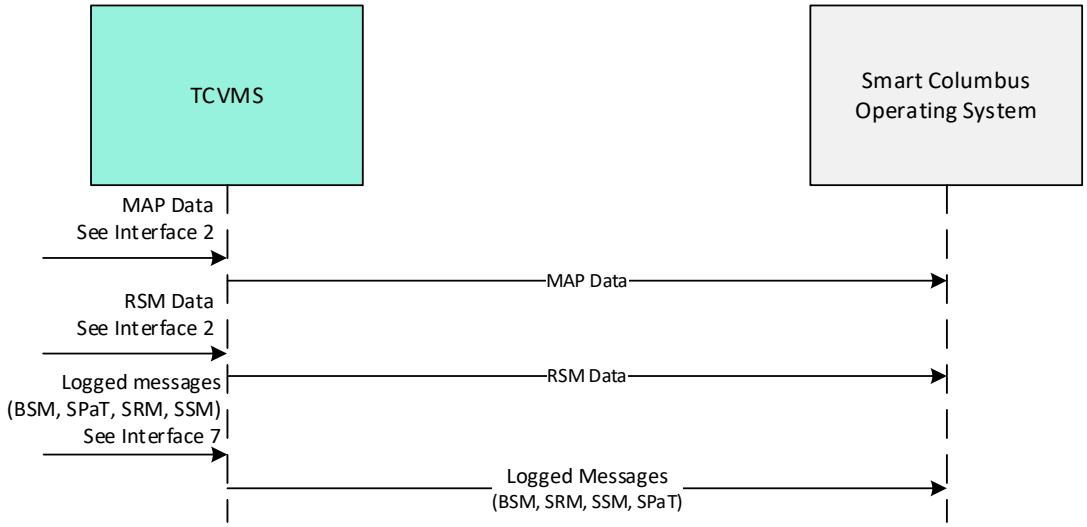


Figure 20: Interface 7 Sequence Diagram – Sending Messages Logged on RSU to Traffic CV Management System

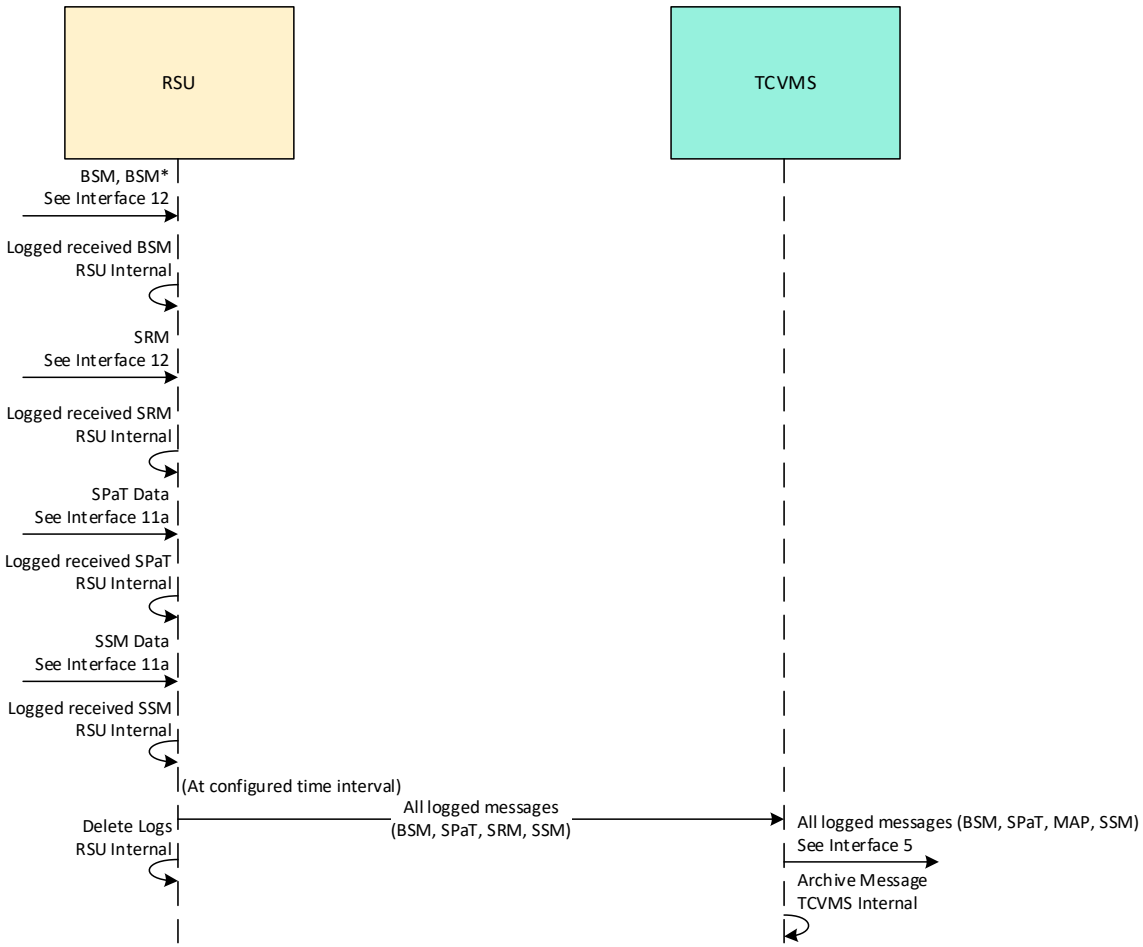


Figure 21: Interface 7 Sequence Diagram – RSU Determine if Requesting Vehicle is Authorized to Receive Priority

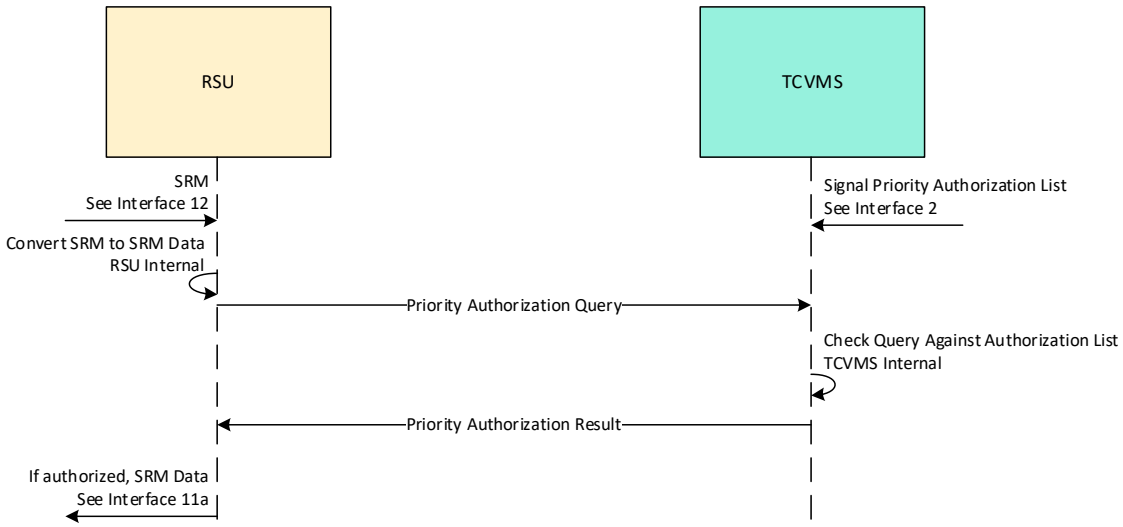


Figure 22: Interface 7 Sequence Diagram – Send MAP Data to RSU and Converting to MAP Message

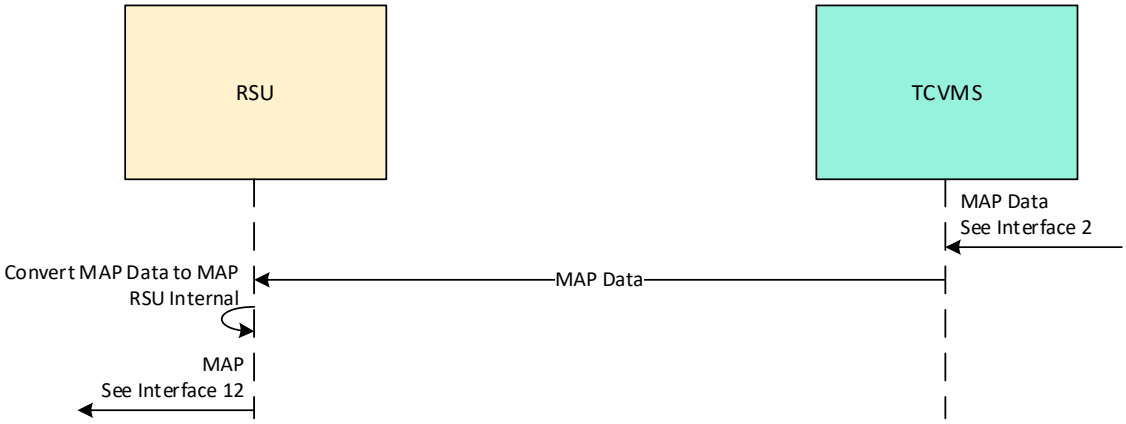


Figure 23: Interface 7 Sequence Diagram – Send RSM Data to RSU and Converting to a RSM Message

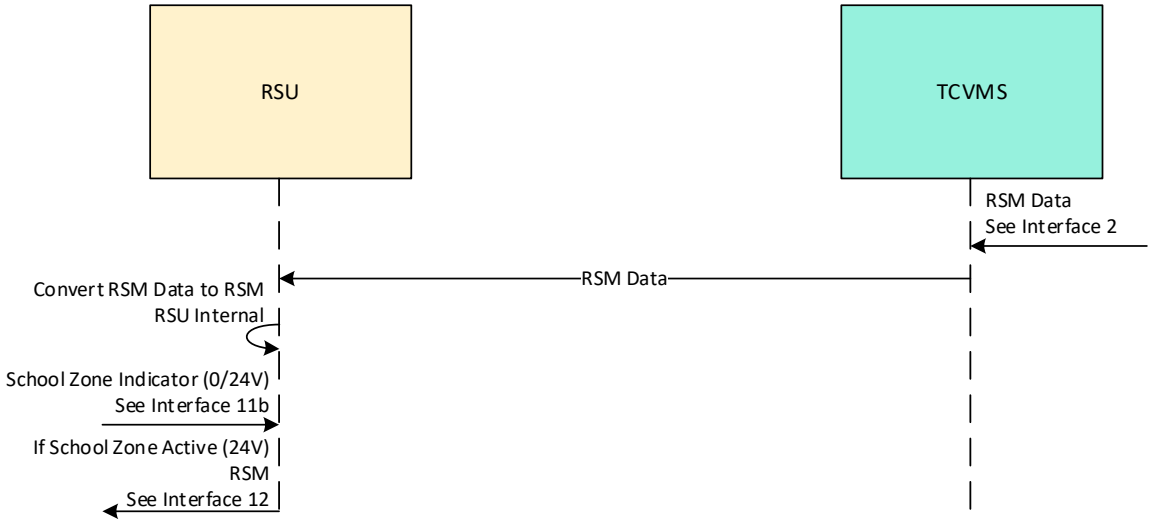


Figure 24: Interface 7 Sequence Diagram – Communication of RSU Status Data

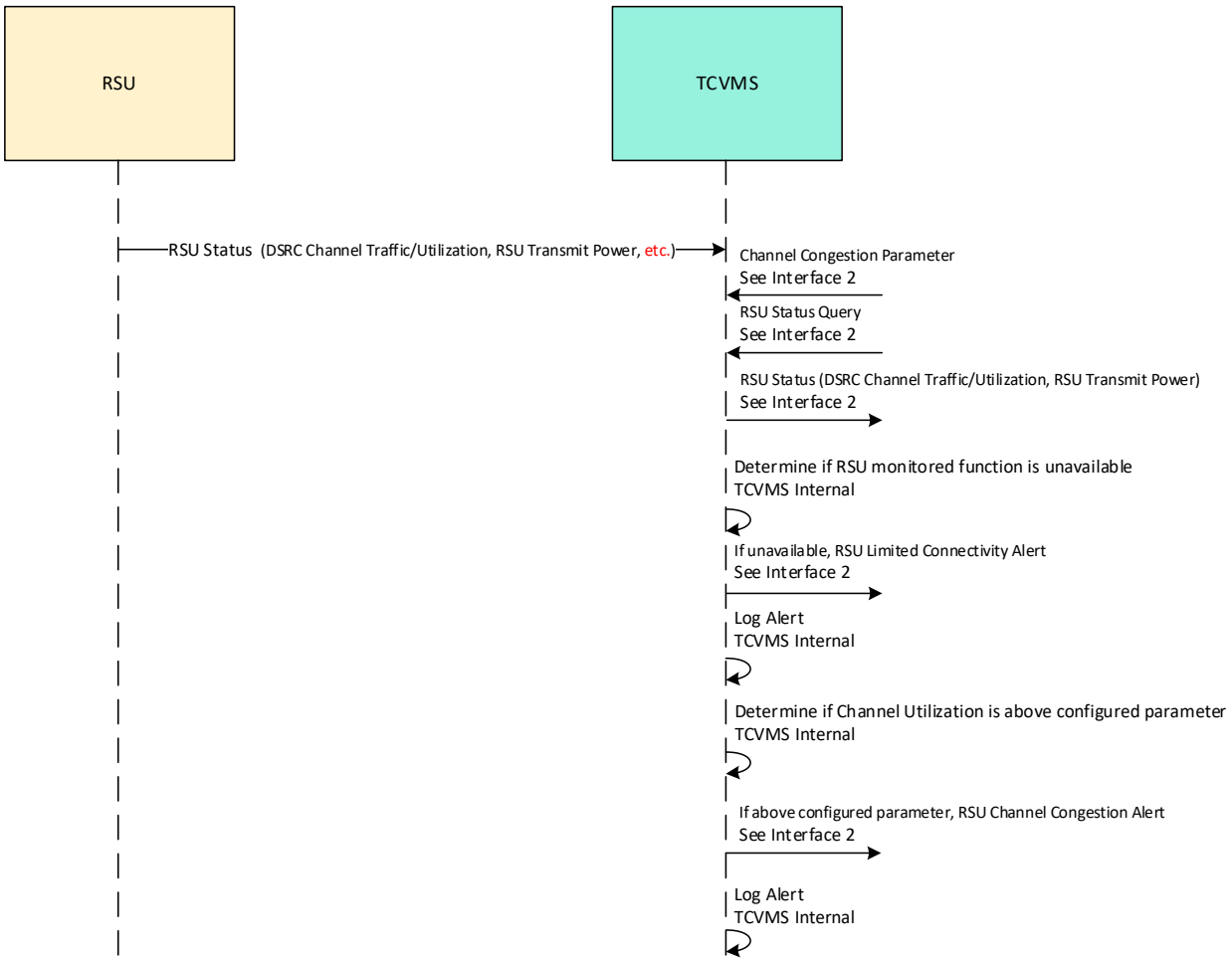


Figure 25: Interface 7 Sequence Diagram – Communication of Cabinet Tamper Status and OBU Tamper Status Data

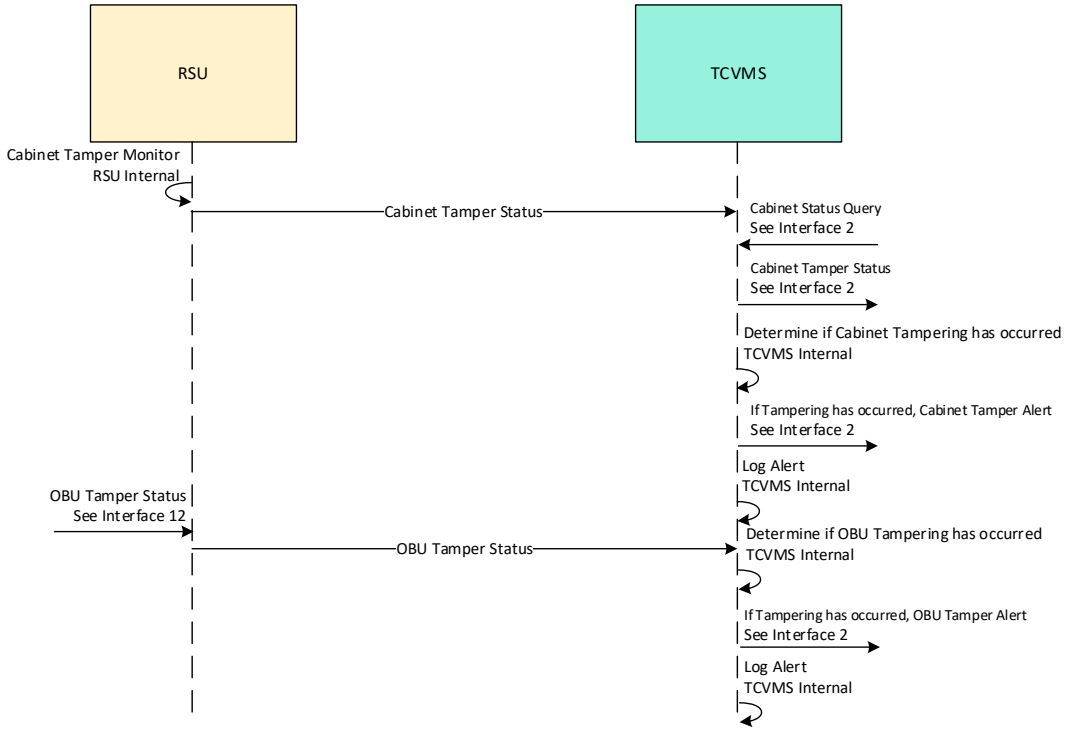


Figure 26: Interface 7 Sequence Diagram – Communication of Network Communications Status Metadata

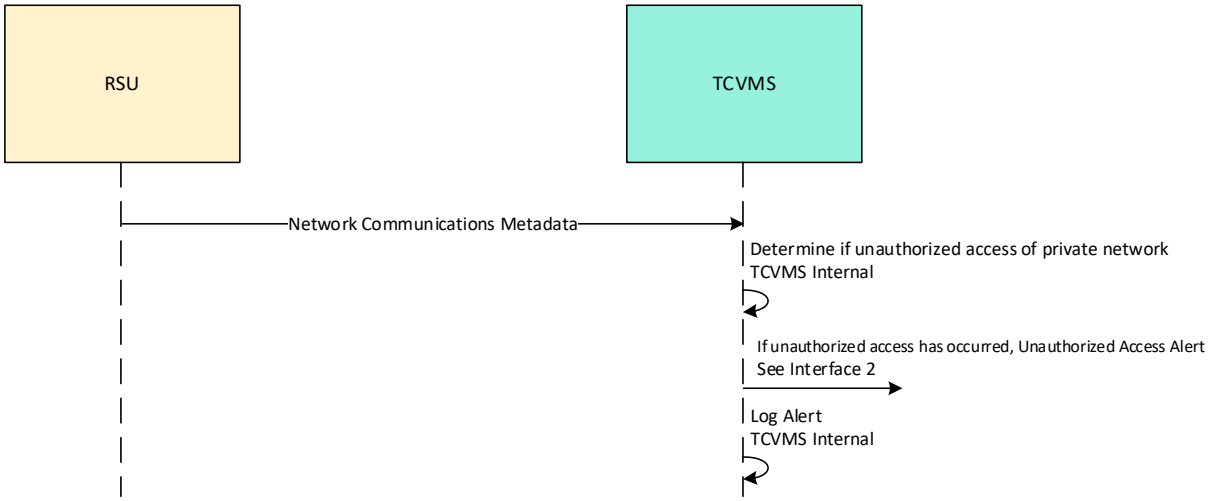


Figure 27: Interface 8 Sequence Diagram – RSU Enrollment and Forwarding OBU Enrollment Messages

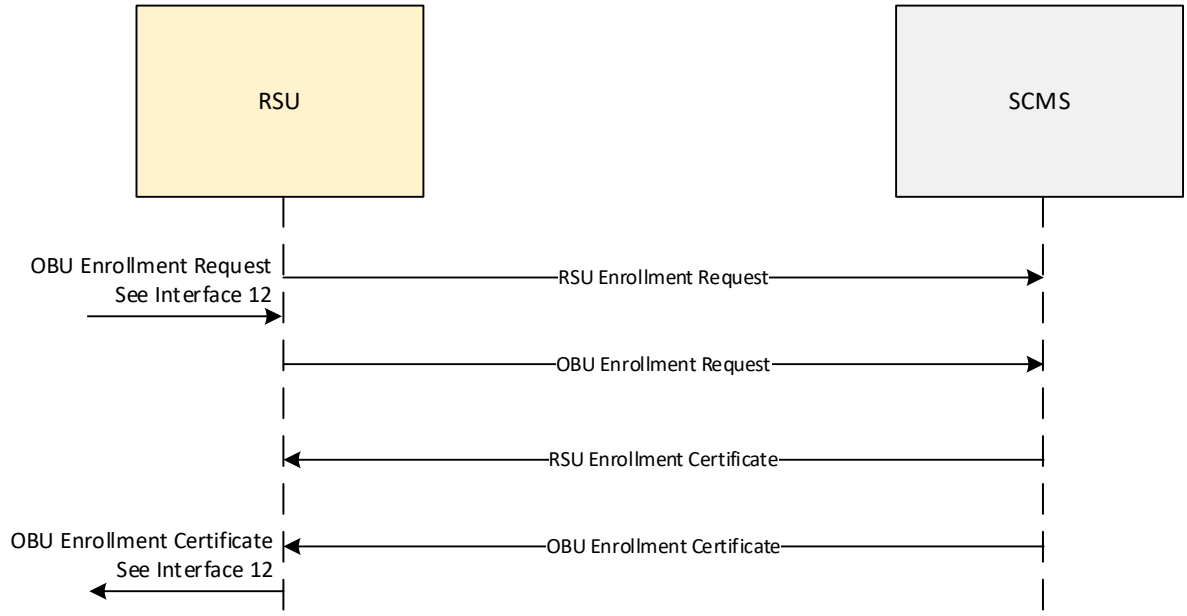


Figure 28: Interface 8 Sequence Diagram –RSU Application Certificates and Forwarding OBU Pseudonym Certificates and OBU Identification Certificates

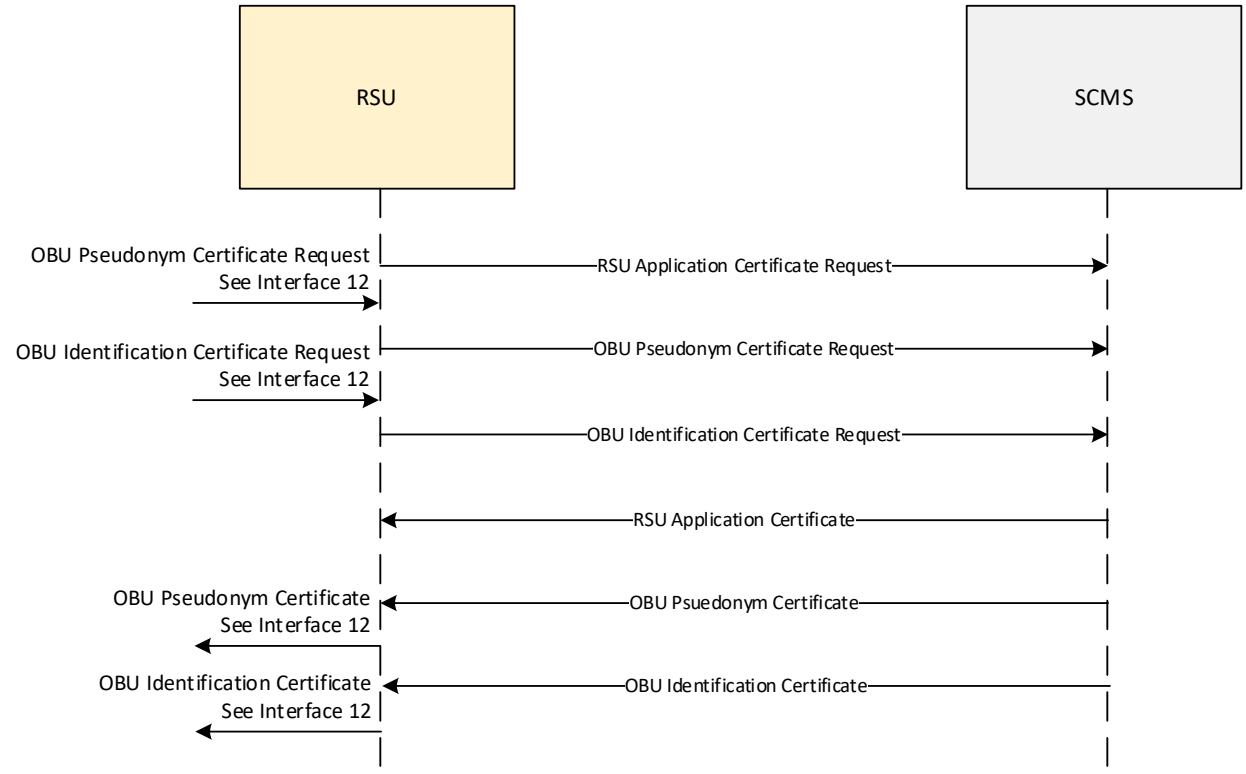


Figure 29: Interface 8 Sequence Diagram – RSU Misbehavior Detection, Misbehavior Reporting, and Transmitting the Revocation List

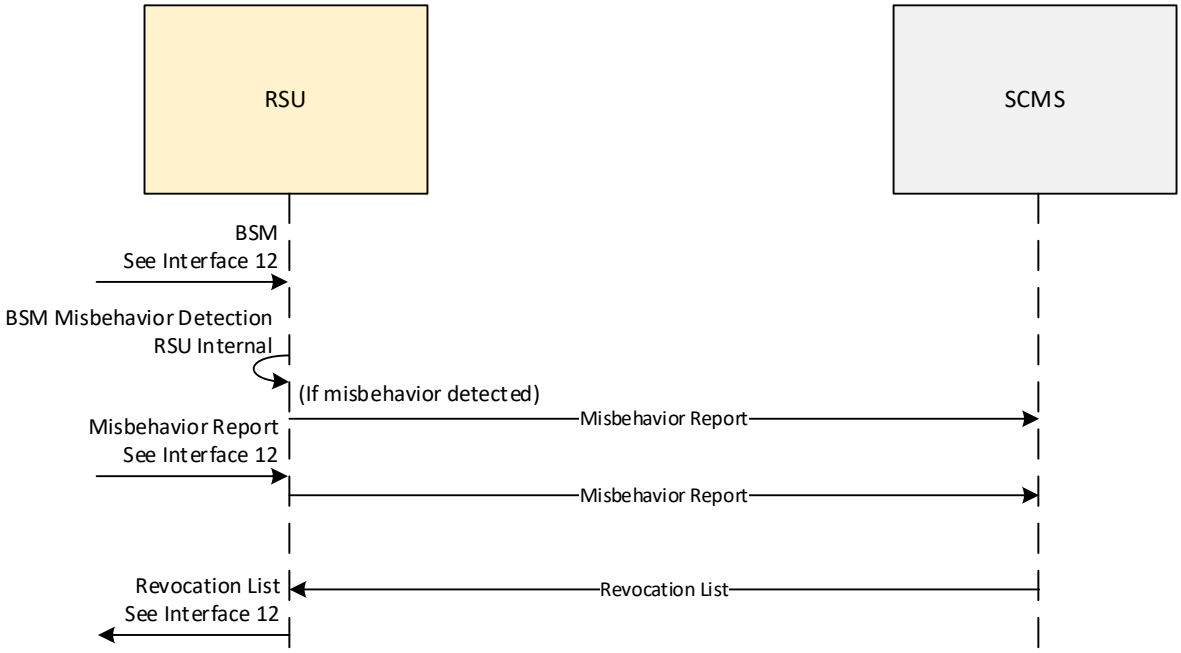


Figure 30: Interface 9 Sequence Diagram – Sending RTCM Data to RSU and Converting to a RTCM Message

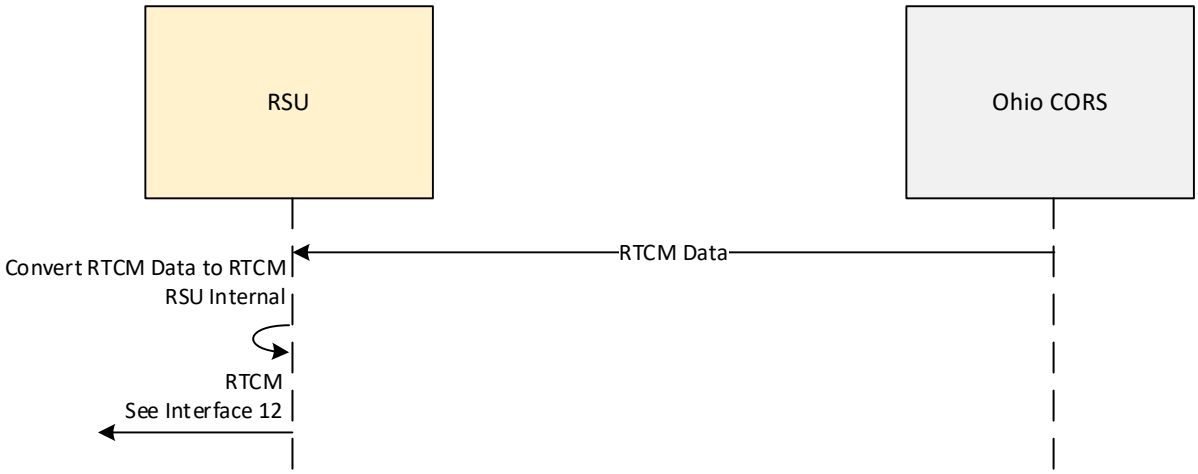


Figure 31: Interface 11a Sequence Diagram – Sending SPaT Data to RSU and Converting to a SPaT Message

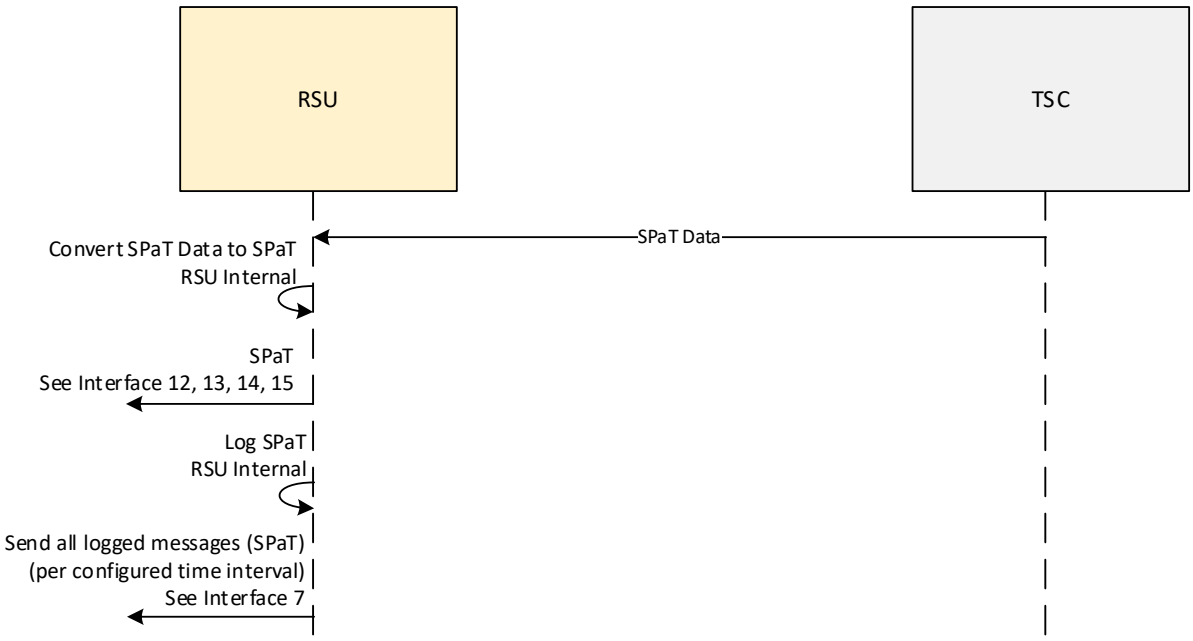


Figure 32: Interface 11a Sequence Diagram – Sending SRM Data to and Receiving SSM Data from a Traffic Signal Controller

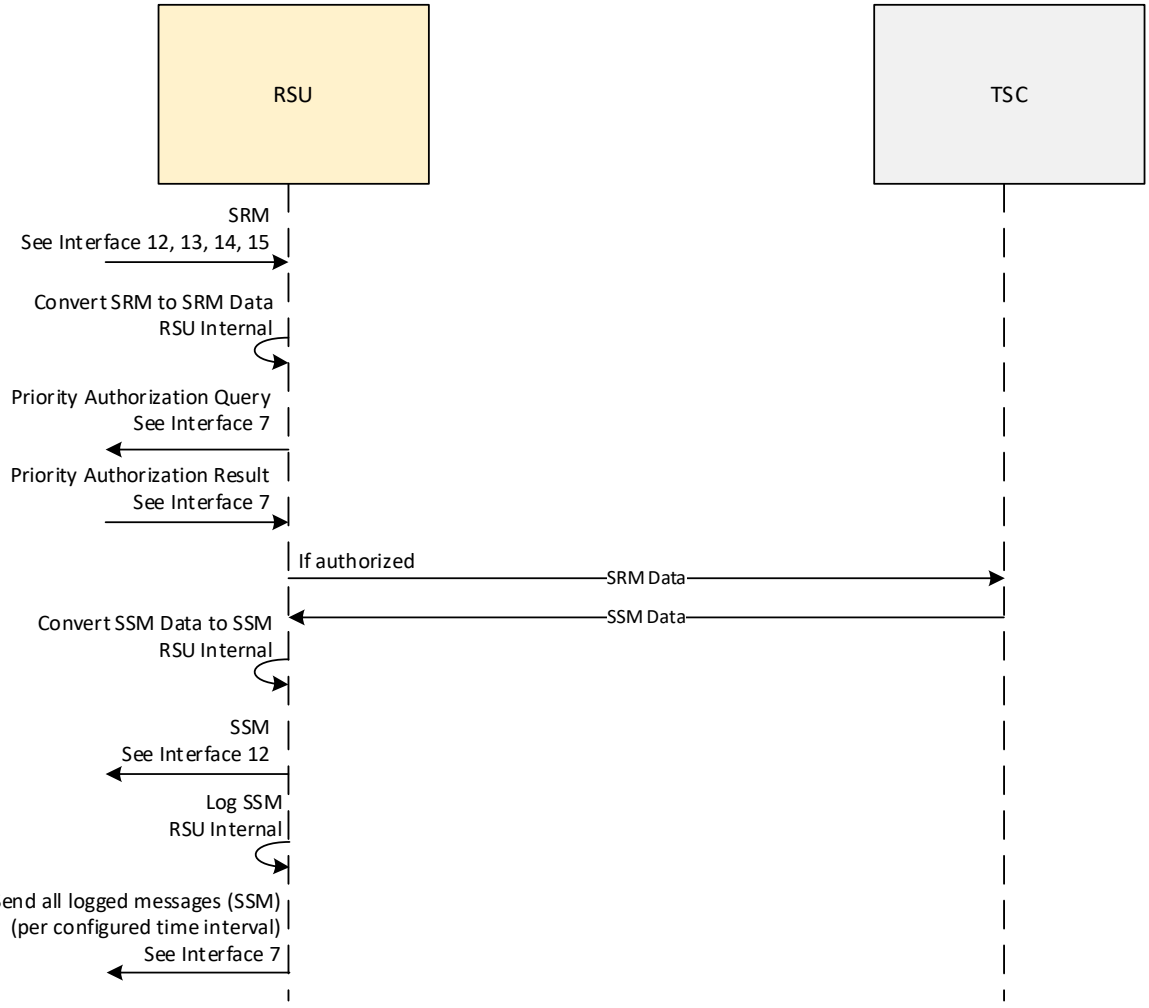


Figure 33: Interface 11b Sequence Diagram – Determine when School Zone is Active

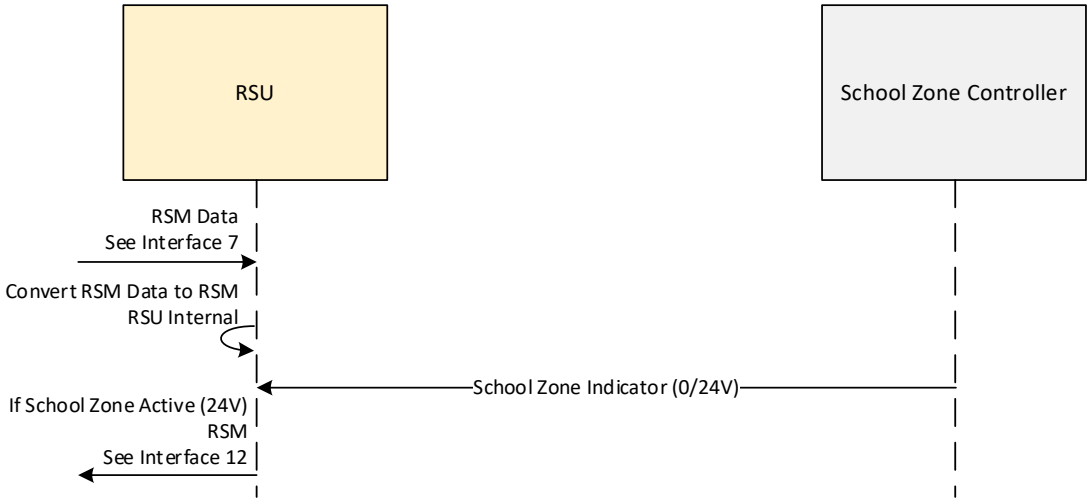


Figure 34: Interface 12, 13, 14, 15 Sequence Diagram – Message Exchanges that Support Signal Priority

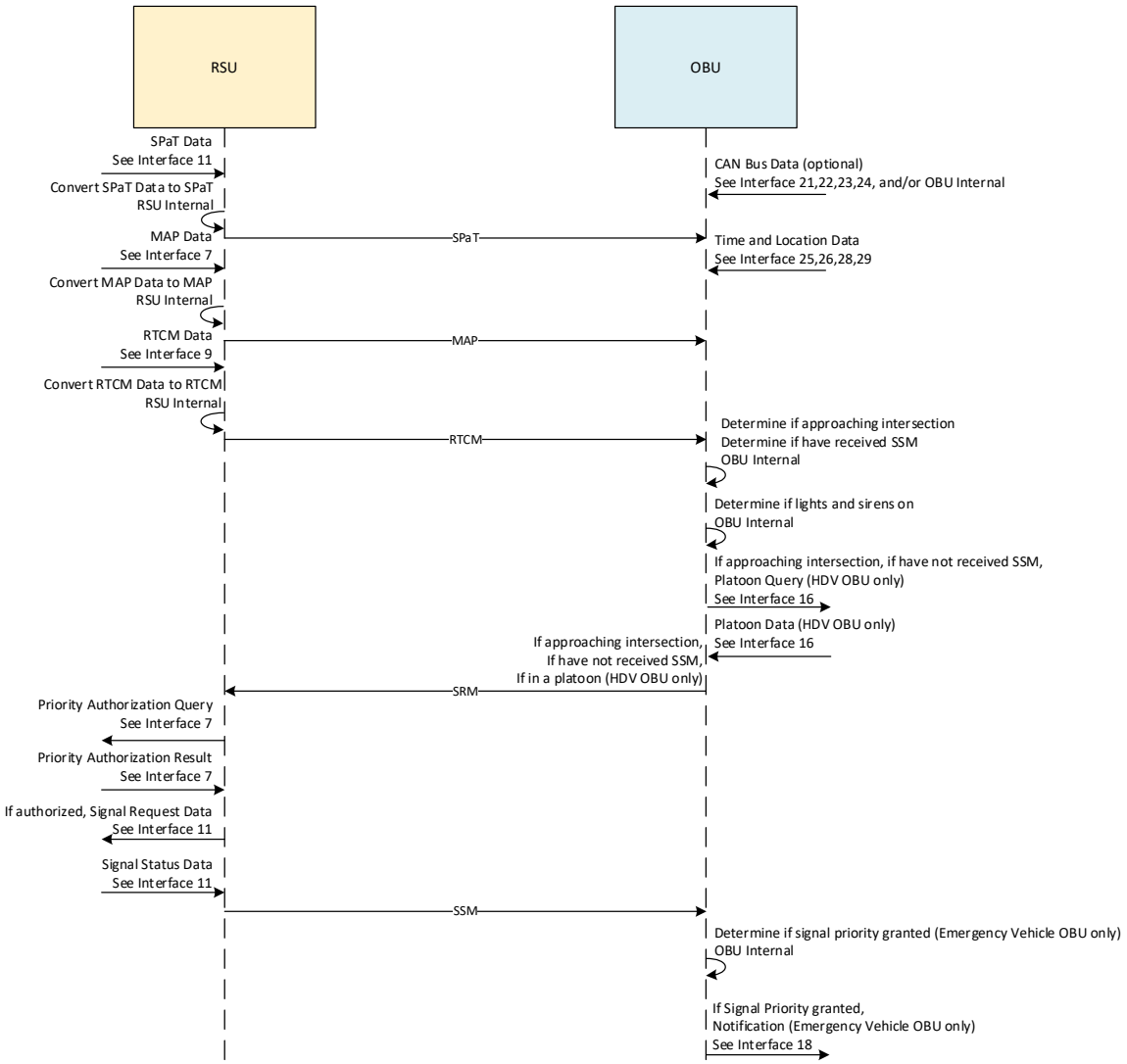


Figure 35: Interface 12, 13, 14, 15 Sequence Diagram – Message Exchanges that Support Red Light Violation Warning

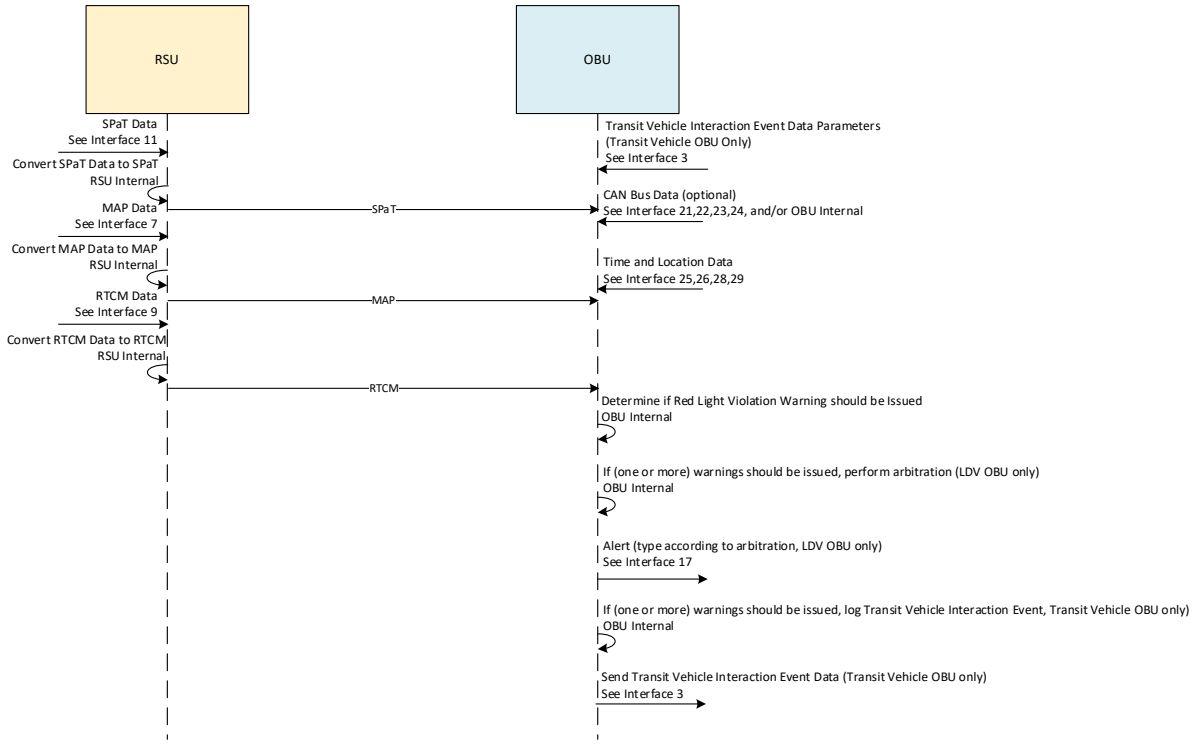


Figure 36: Interface 12, 13, 14, 15 Sequence Diagram – Message Exchanges that Support Transit Vehicle Interaction Event Recording

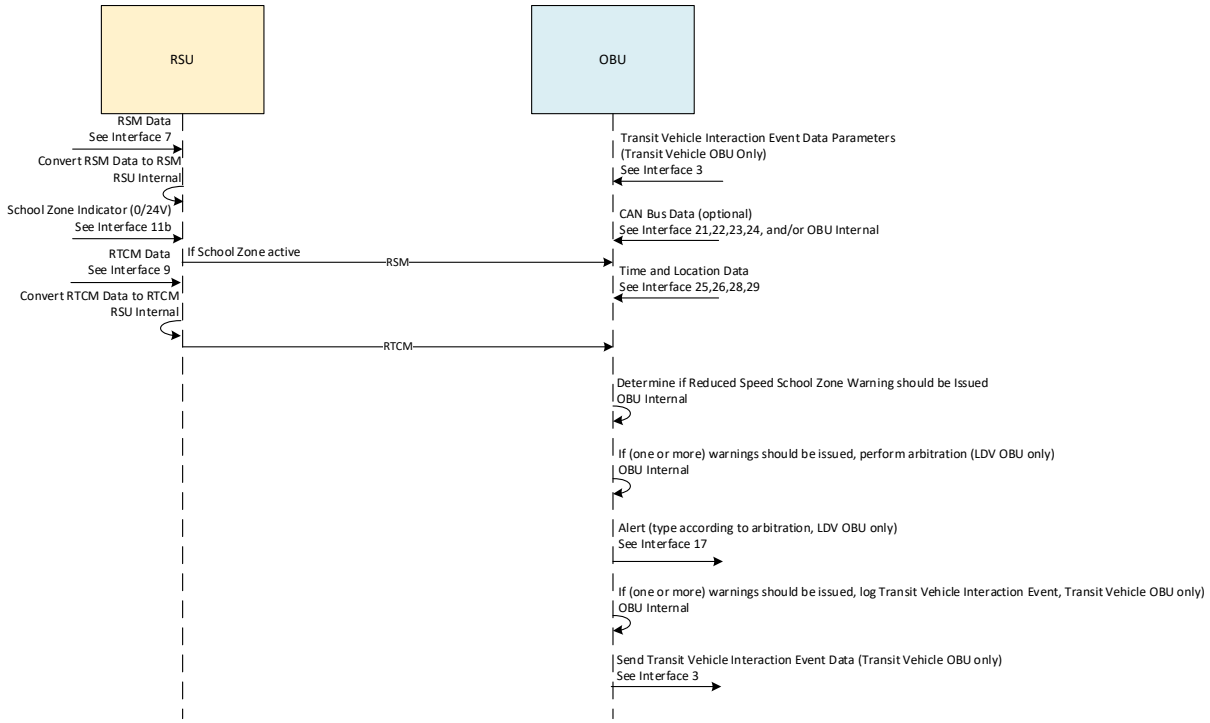


Figure 37: Interface 12, 13, 14, 15 Sequence Diagram – Message Exchanges that Support Vehicle Data for Traffic Operations

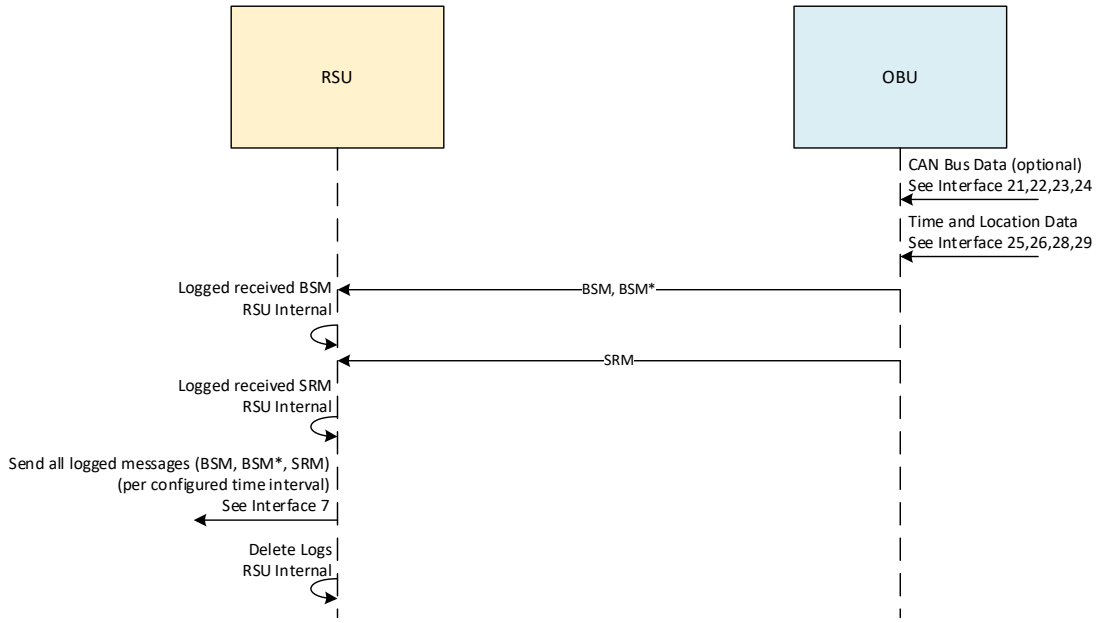


Figure 38: Interface 12, 13, 14, 15 Sequence Diagram – OBU Enrollment (with SCMS via RSU)

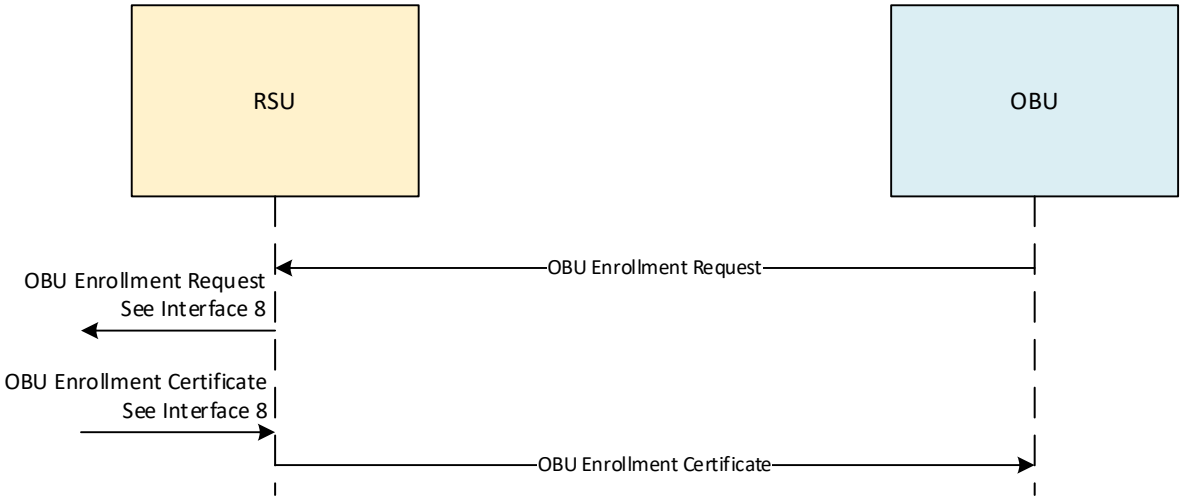


Figure 39: Interface 12, 13, 14, 15 Sequence Diagram – OBU Pseudonym Certificates and OBU Identification Certificates (SCMS via RSU)

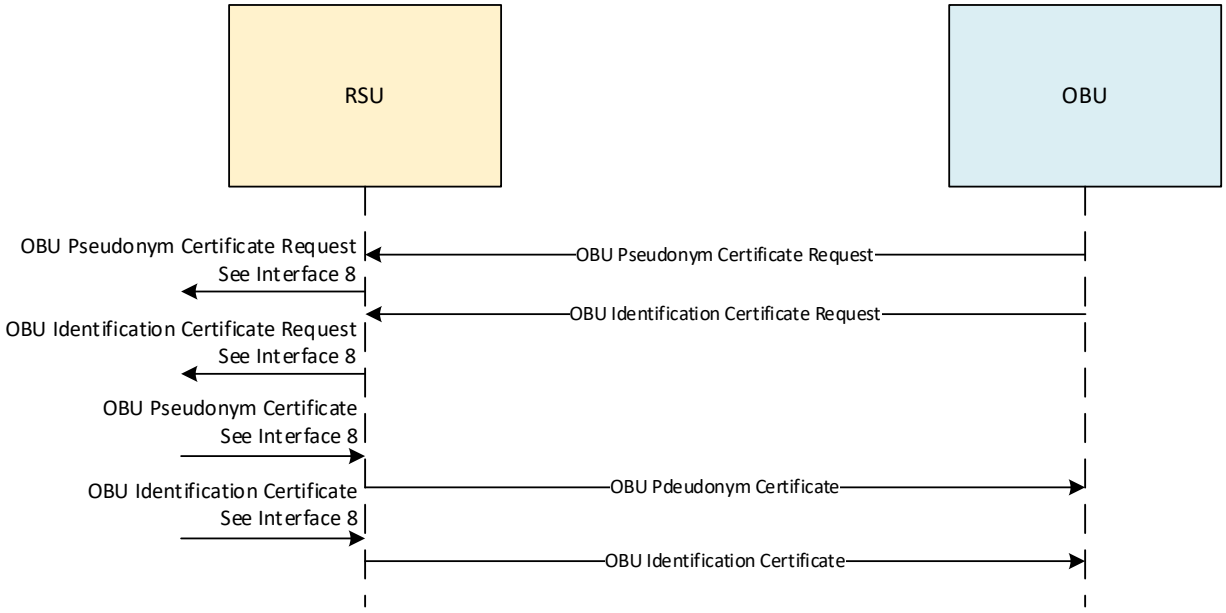


Figure 40: Interface 12, 13, 14, 15 Sequence Diagram – OBU Misbehavior Detection, Misbehavior Reporting, and Transmitting the Revocation List (SCMS via RSU)

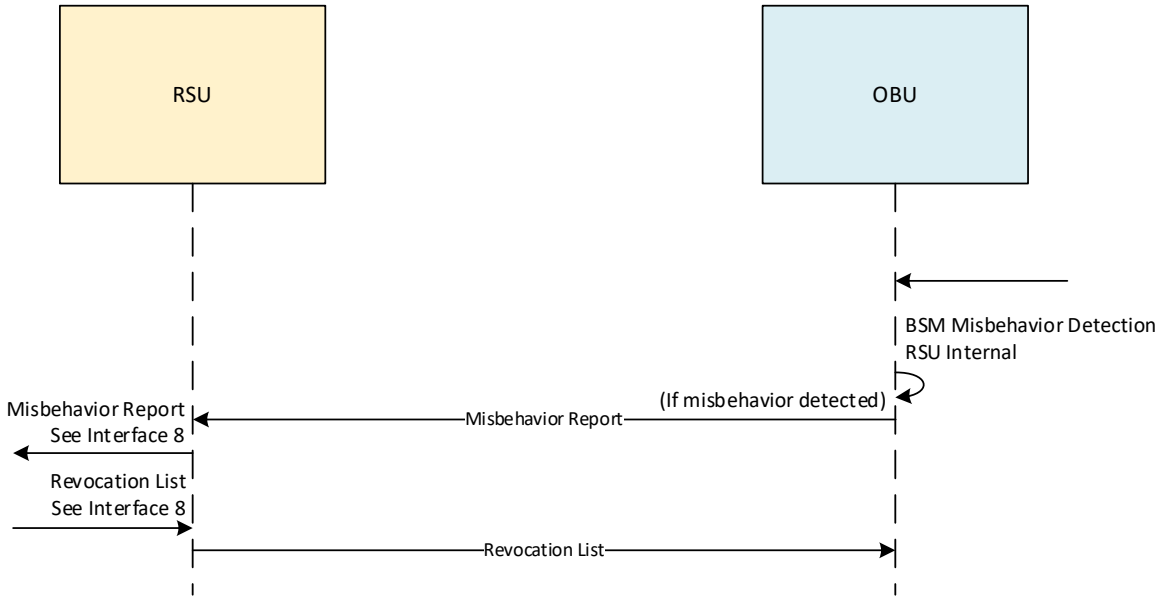


Figure 41: Interface 12, 13, 14, 15 Sequence Diagram – OBU Tamper Status Data Transmission

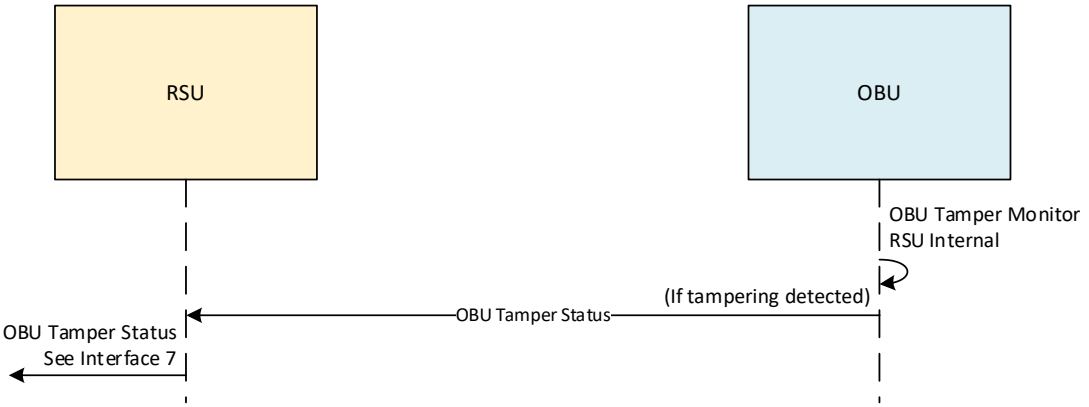


Figure 42: Interface 16 Sequence Diagram – Determining if HDV is in an Intended Platoon

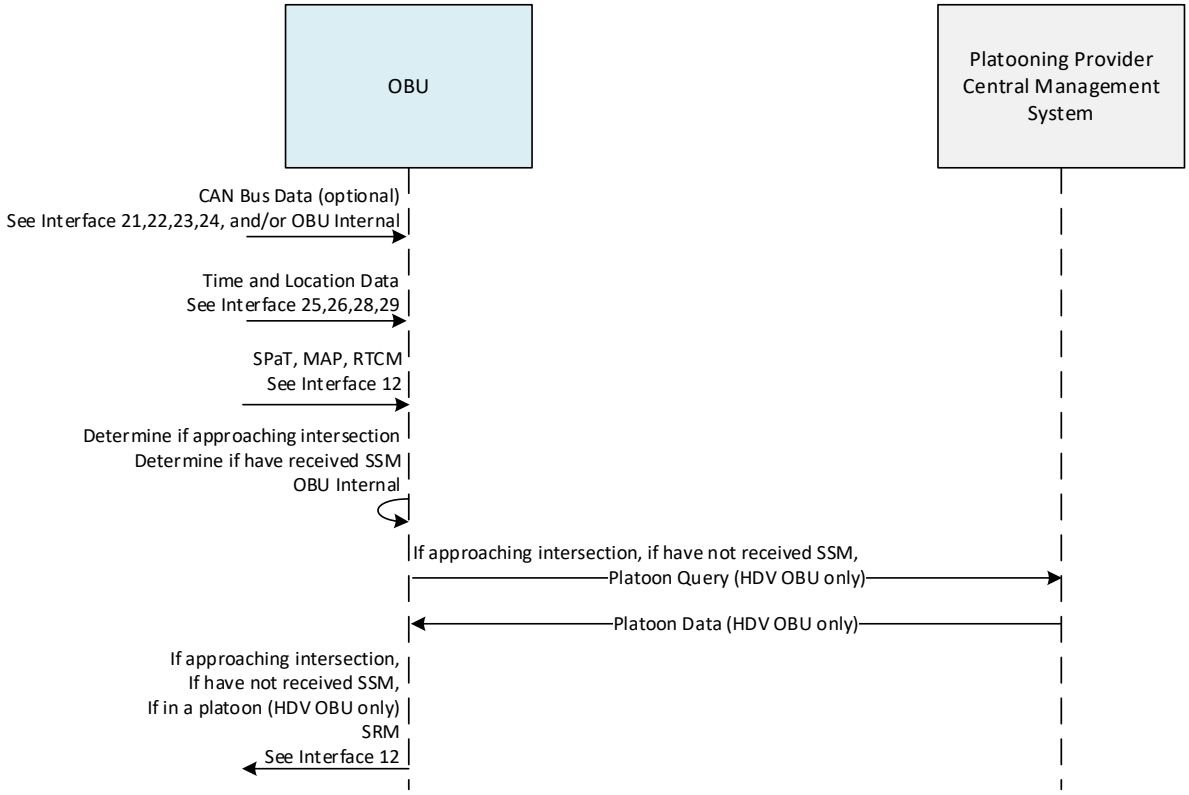


Figure 43: Interface 17, 18 Sequence Diagram – Issuing V2V Safety Alert to LDV Operator

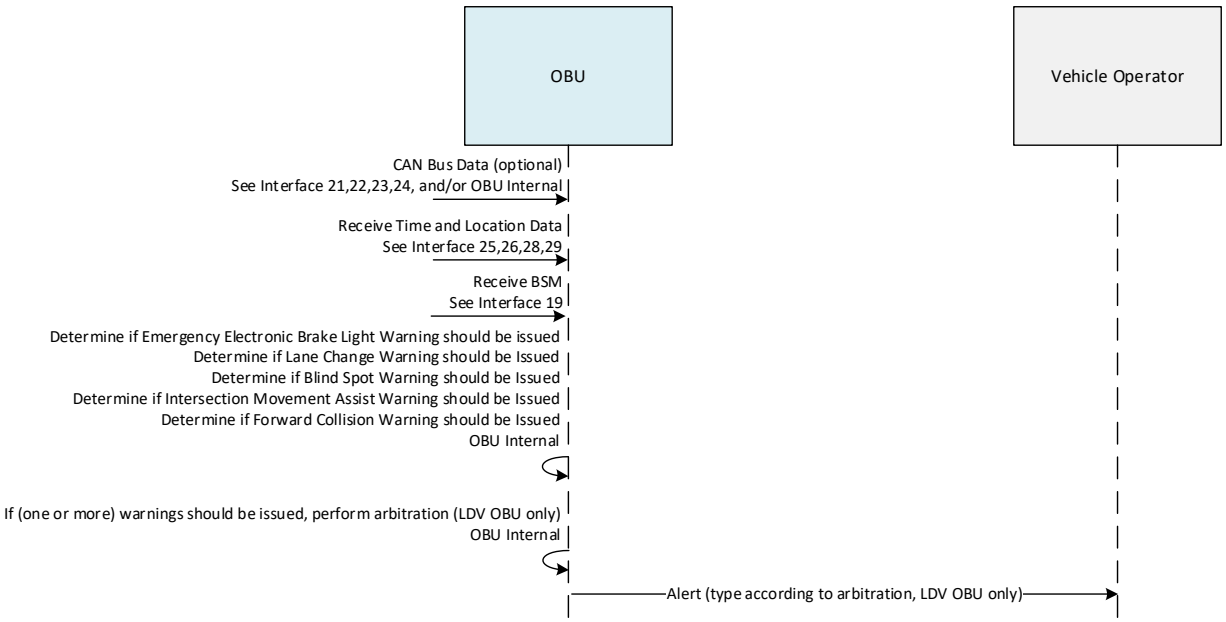


Figure 44: Interface 17, 18 Sequence Diagram – Issuing Red Light Violation Warning Alert to LDV Operator

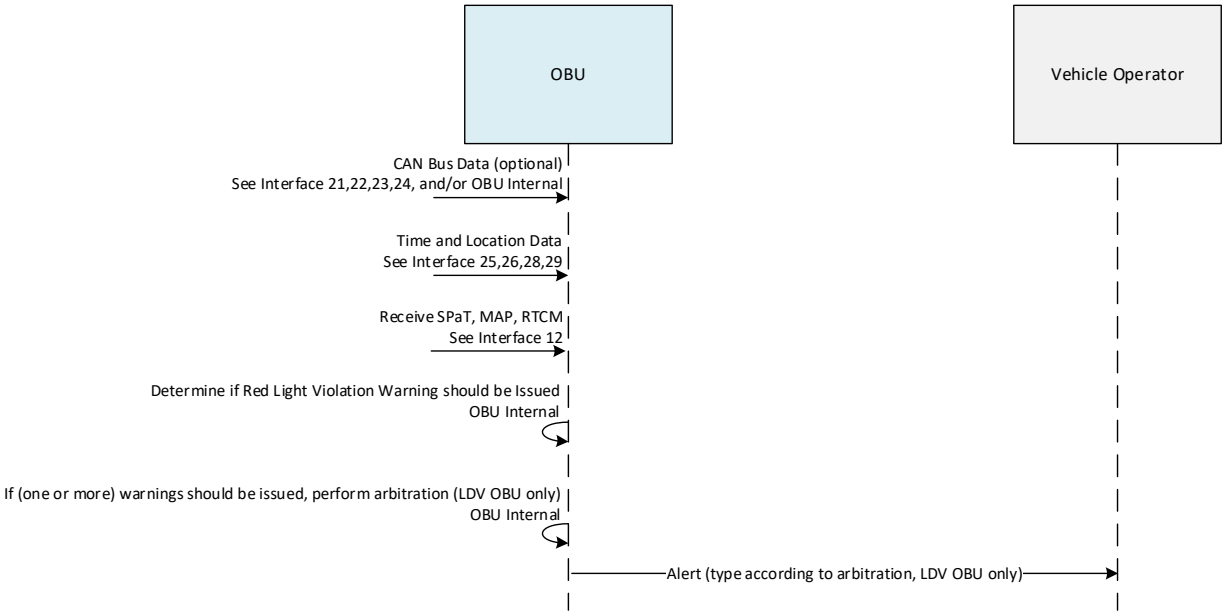


Figure 45: Interface 17, 18 Sequence Diagram – Issuing Reduced Speed School Zone Alert to LDV Operator

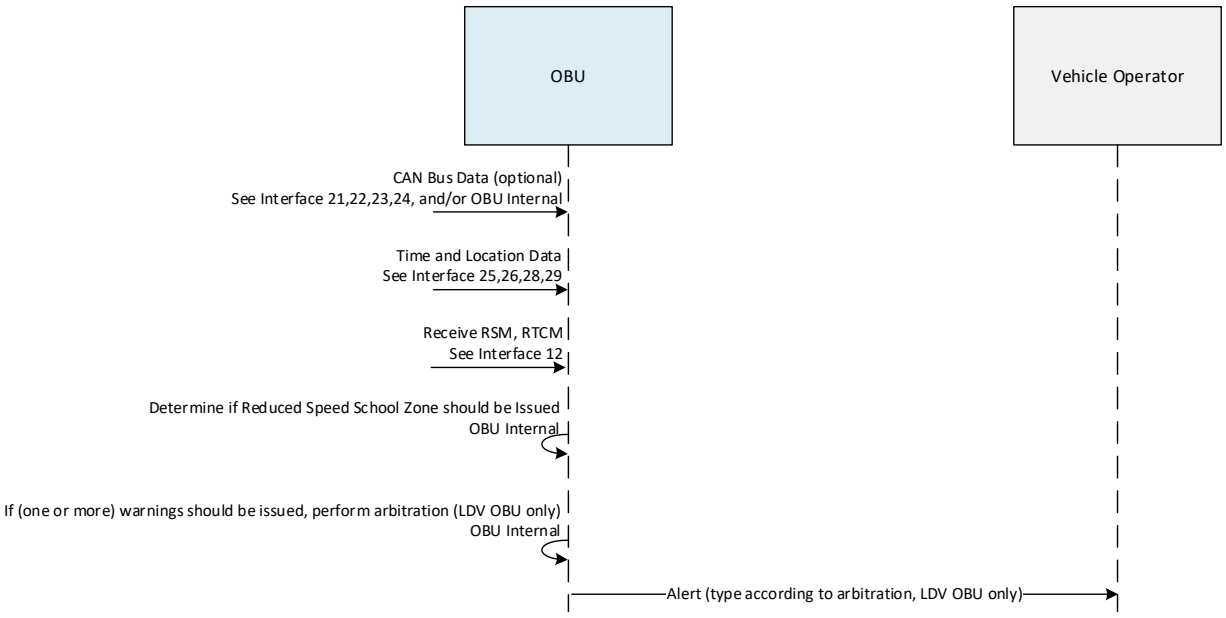


Figure 46: Interface 17, 18 Sequence Diagram – Providing OBU Status Information to LDV Operator

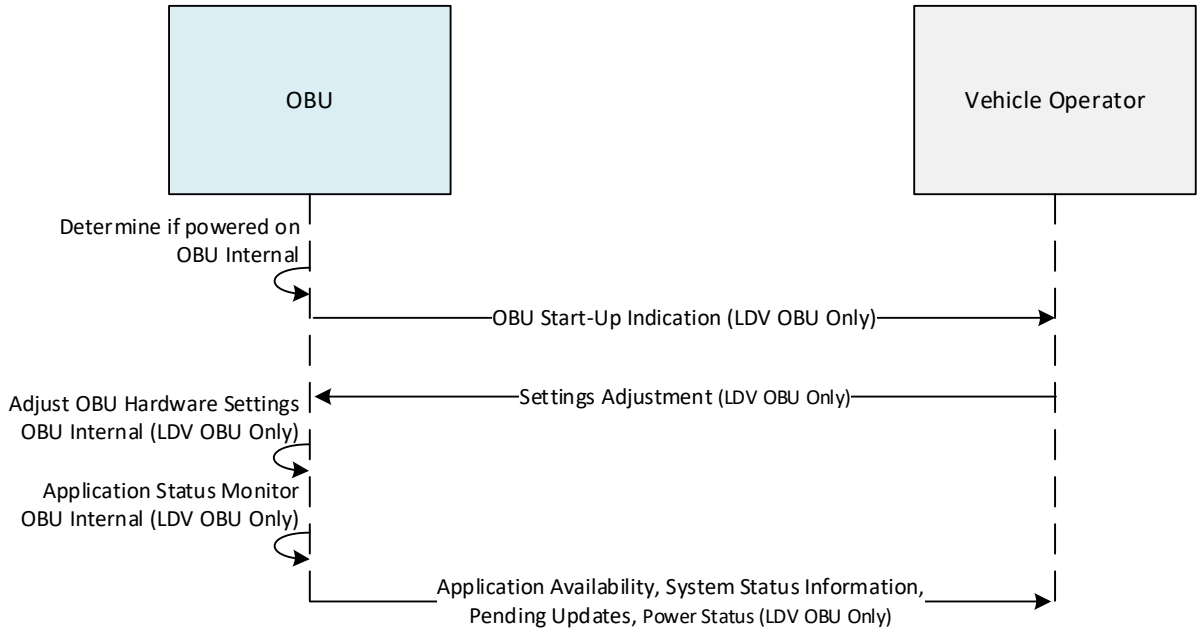


Figure 47: Interface 17, 18 Sequence Diagram – Issuing Notification that Preemption was granted to Emergency Vehicle Operator

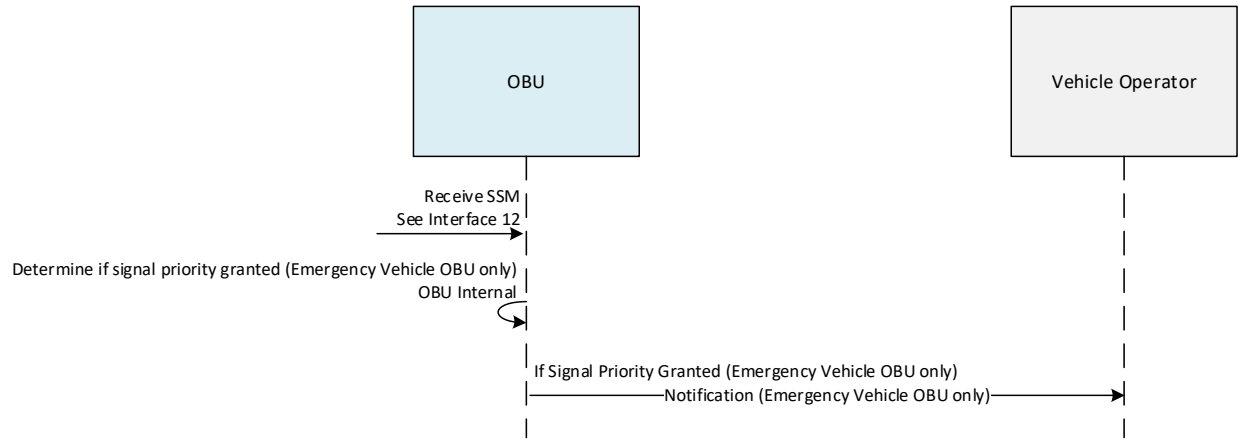


Figure 48: Interface 19, 20 Sequence Diagram – Message Exchange that Supports V2V Safety Applications

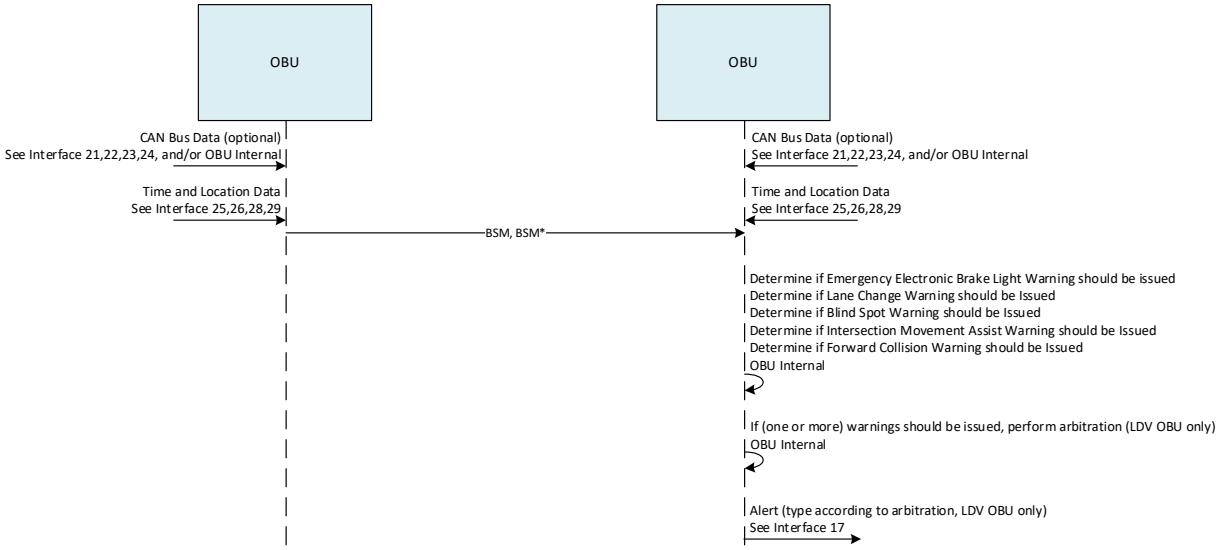


Figure 49: Interface 19, 20 Sequence Diagram – Message Exchange that Supports Transit Vehicle Interaction Event Recording

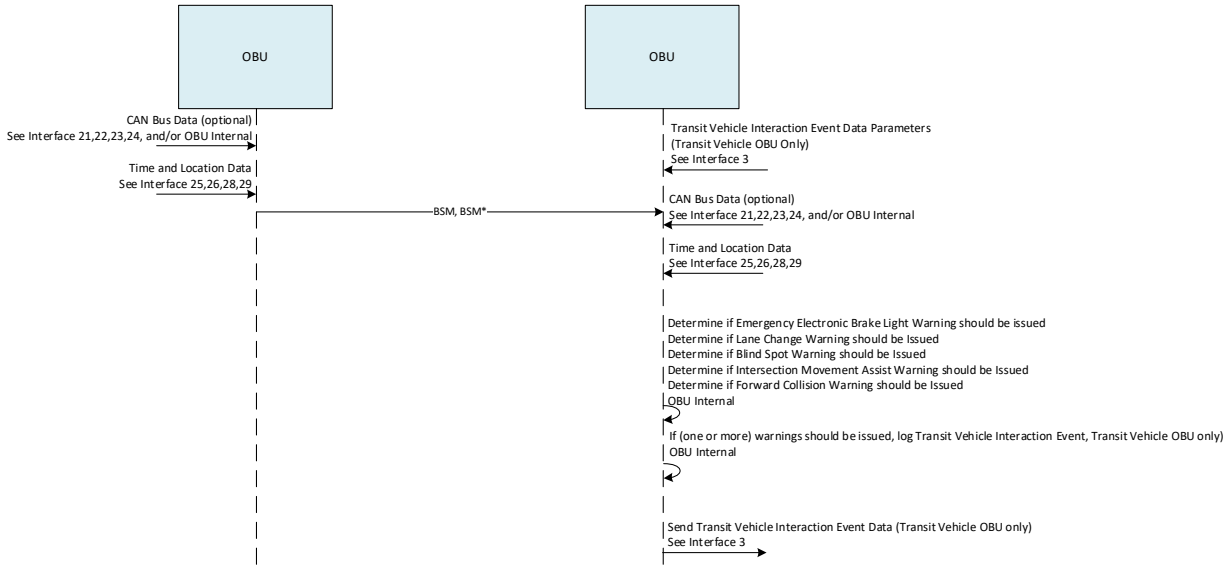


Figure 50: Interface 21, 22, 23, 24 Sequence Diagram – Populating a BSM using CAN Bus Data

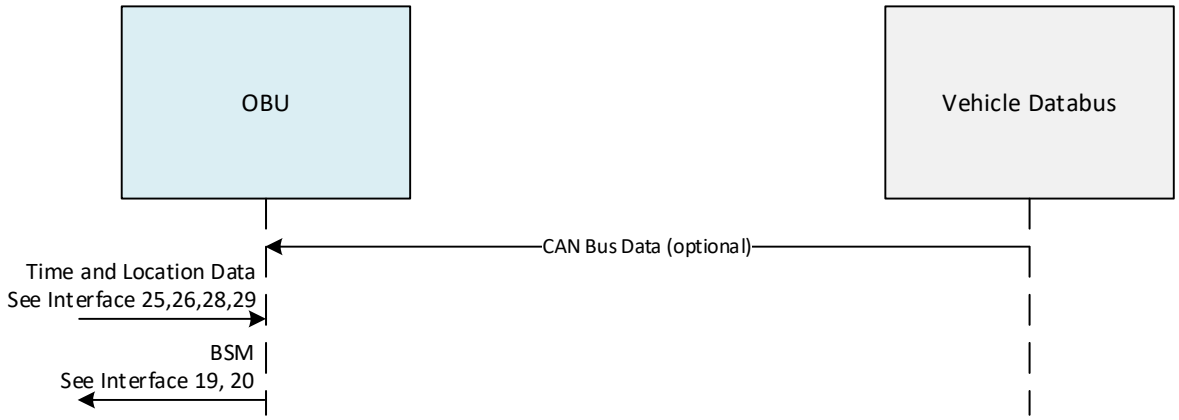


Figure 51: Interface 21, 22, 23, 24 Sequence Diagram – Using CAN Bus Data to support V2V Safety Applications

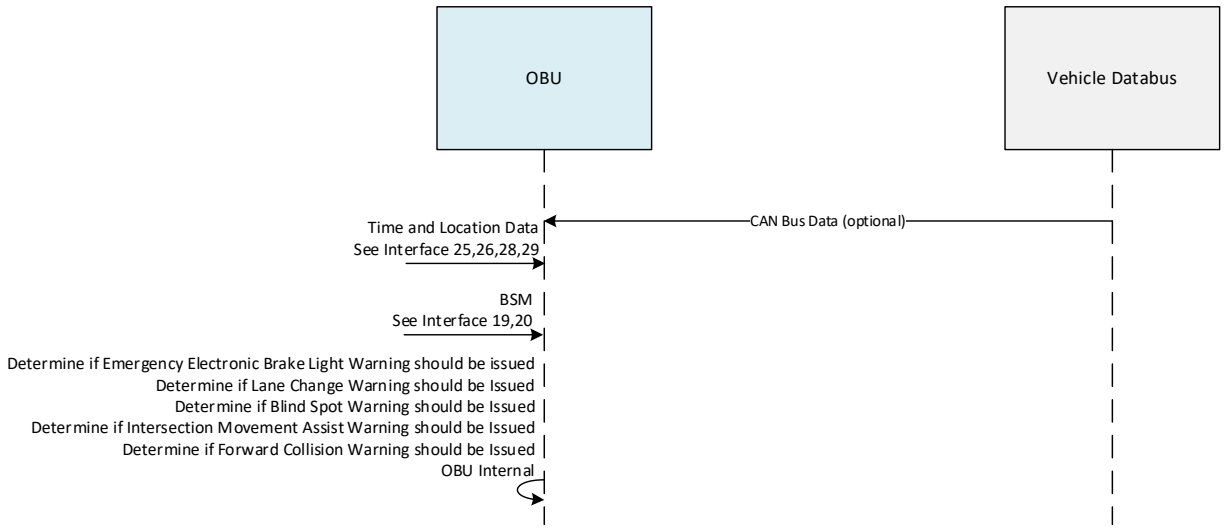


Figure 52: Interface 21, 22, 23, 24 Sequence Diagram – Using CAN Bus Data to support Red Light Violation Warning

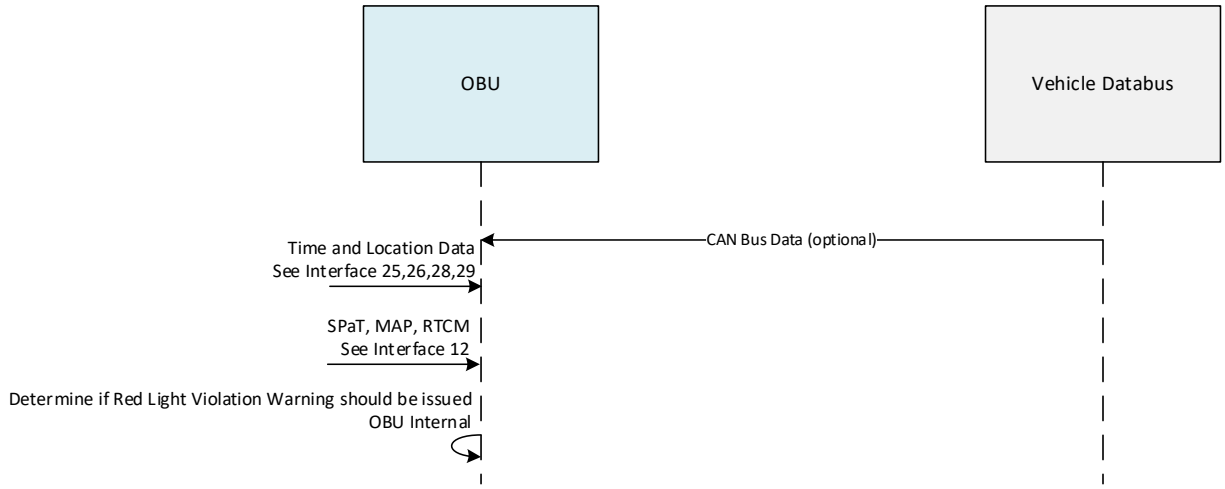


Figure 53: Interface 21, 22, 23, 24 Sequence Diagram – Using CAN Bus Data to support Reduced Speed School Zone

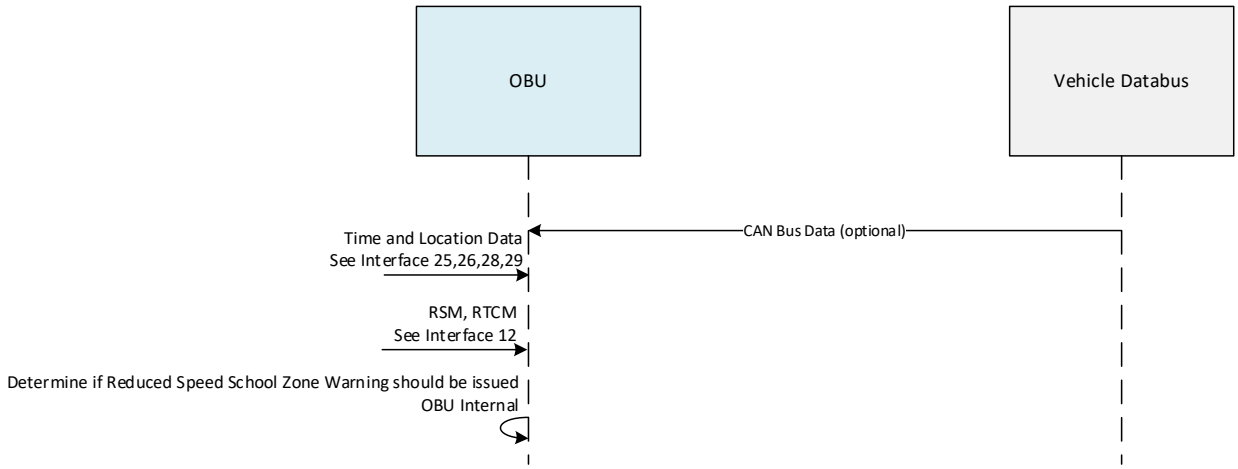


Figure 54: Interface 21, 22, 23, 24 Sequence Diagram – Using CAN Bus Data to Support Signal Priority Applications

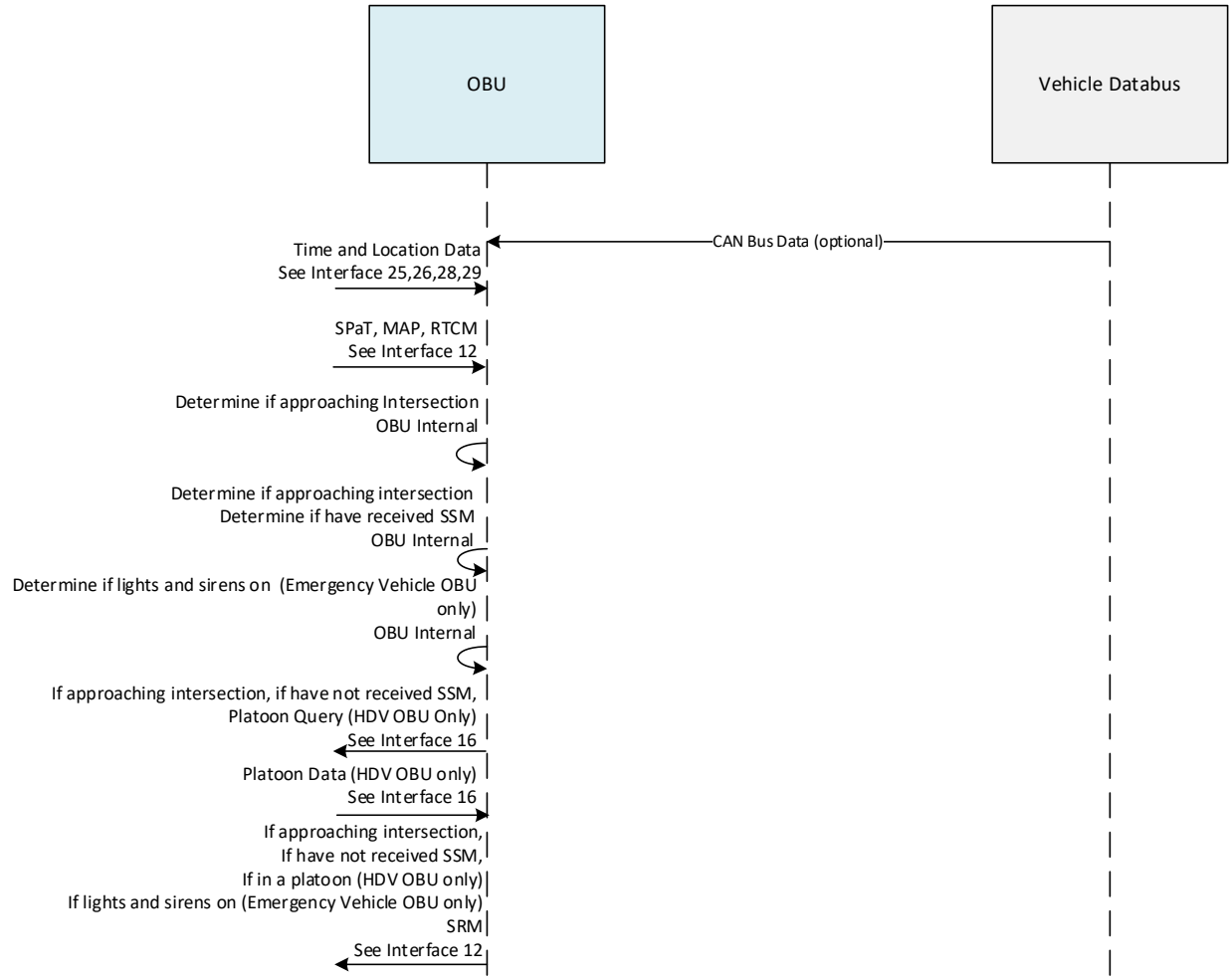


Figure 55: Interface 25, 26, 28, 29 Sequence Diagram – Using GNSS Data to Populate BSM

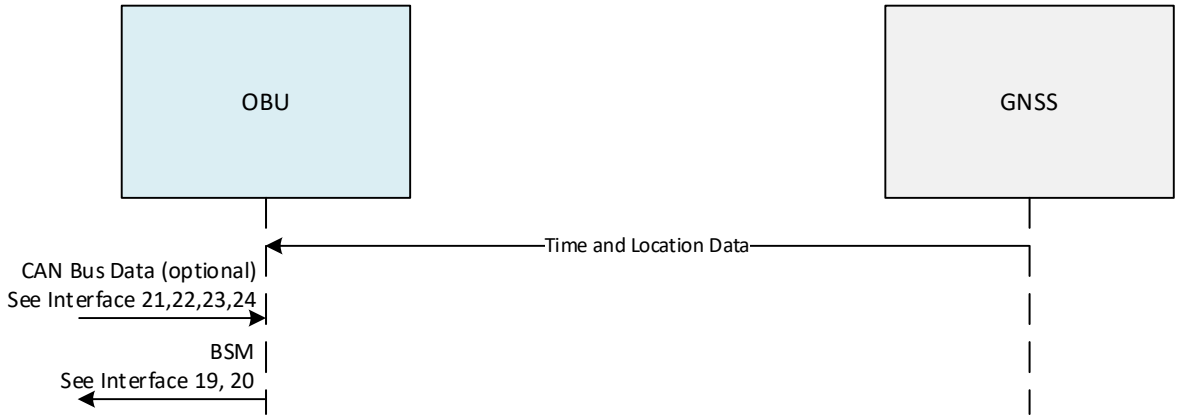


Figure 56: Interface 25, 26, 28, 29 Sequence Diagram – Using GNSS Data to support V2V Safety Applications

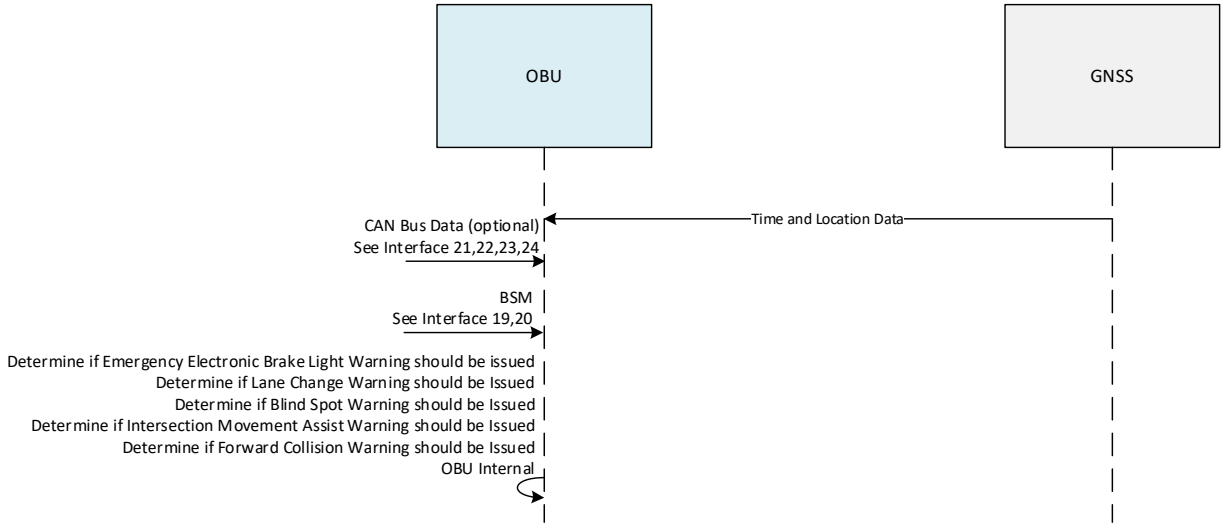


Figure 57: Interface 25, 26, 28, 29 Sequence Diagram – Using GNSS Data to support Red Light Violation Warning

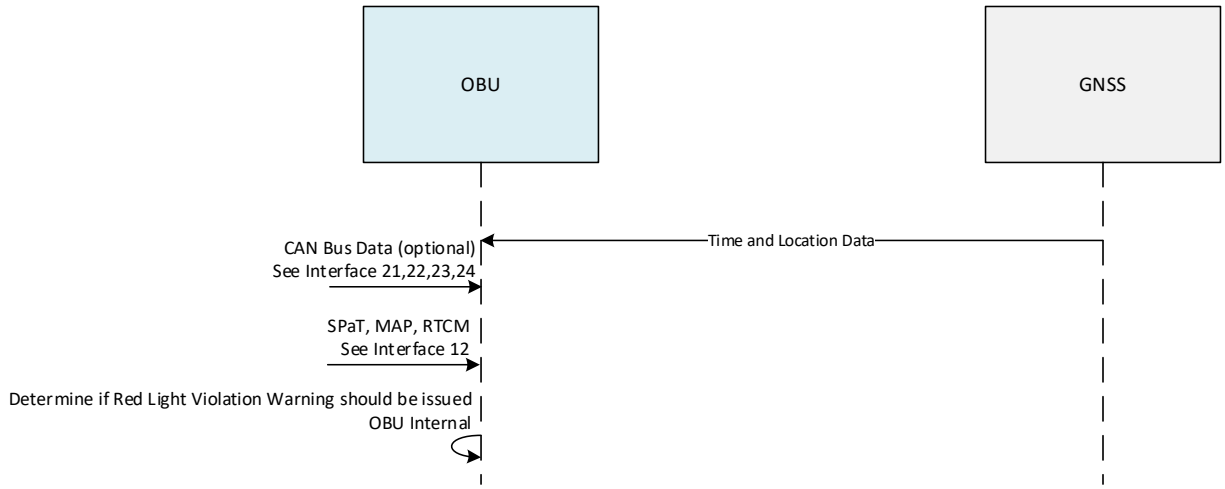


Figure 58: Interface 25, 26, 28, 29 Sequence Diagram – Using GNSS Data to support Reduced Speed School Zone

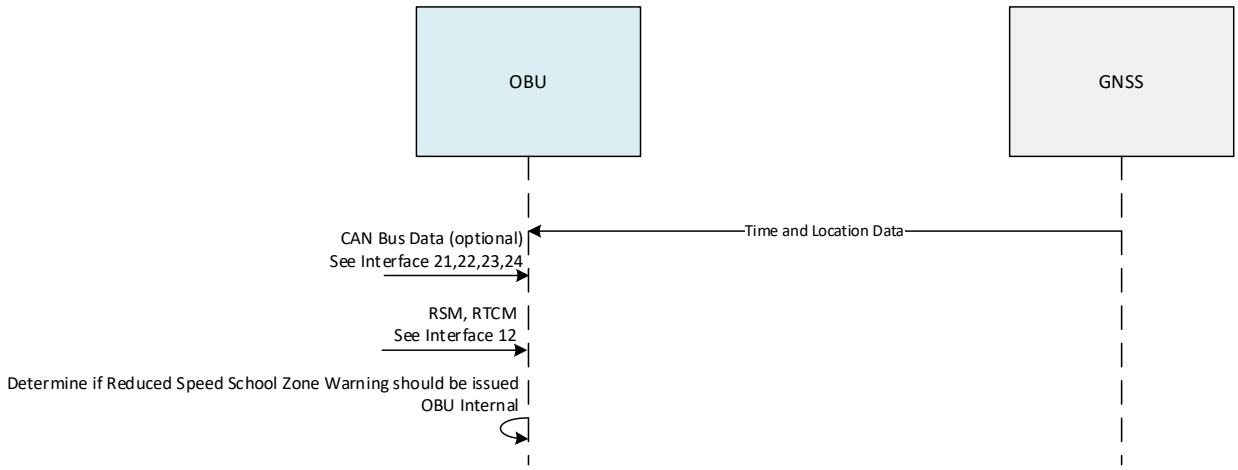


Figure 59: Interface 25, 26, 28, 29 Sequence Diagram – Using CAN Bus Data to determine if Vehicle is approaching Intersection (Signal Priority)

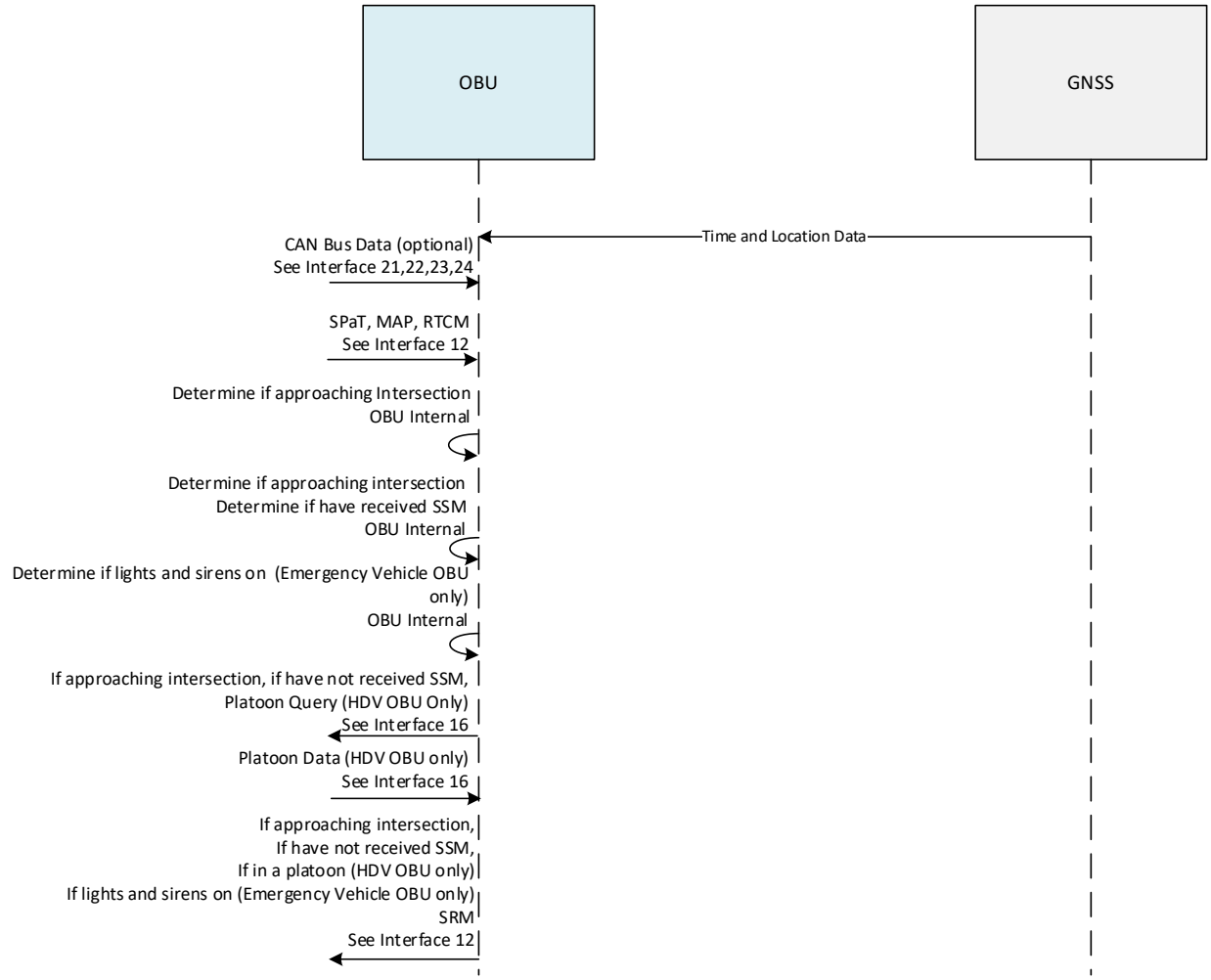


Table 11: Basic Safety Message Part I

<table>
<tr><td>Message</td><td colspan="5">Basic Safety Message (BSM) Part I</td></tr>
<tr><td>Applicable Interface(s)</td><td colspan="5">Interface 7, Interface 12, Interface 13, Interface 14, Interface 15, Interface 19, Interface 20</td></tr>
<tr><td>Applicable Standards</td><td colspan="5">ITS Application Information Layer: SAE J2735_201603, Section 5.2
Presentation Layer: ISO ASN.1 UPER
Transport Layer: IEEE 1609.3 WSMP
Network Layer: IEEE 1609.3 WSMP
Data Link Layer: IEEE 1609.4, IEEE 802.11
Physical Layer: IEEE 802.11
Security Plane: IEEE 1609.2</td></tr>
<tr><td>Description</td><td colspan="5">The basic safety message (BSM) is used in a variety of applications to exchange safety data regarding vehicle state. This message is broadcast frequently to surrounding vehicles with data content as required by safety and other applications. Part I data shall be included in every BSM.</td></tr>
<tr><td>Required Data</td><td colspan="5">
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>coreData</td><td>BSMcoreData</td><td>Contains the critical core data elements deemed to be needed with every BSM issued</td><td>N/A (Data Frame)</td><td>SAE J2735_201603, Section 6.8</td></tr>
<tr><td>msgCnt</td><td>MsgCount</td><td>A sequence number within a stream of messages with the same DSRCmsgID and from the same sender.</td><td>INTEGER (0..127)</td><td>SAE J2735_201603, Section 7.104</td></tr>
<tr><td>id</td><td>TemporaryID</td><td>4 octet random device identifier. Changes periodically to ensure the overall anonymity of the vehicle</td><td>OCTET STRING (SIZE(4))</td><td>SAE J2735_201603, Section 7.187</td></tr>
<tr><td>secMark</td><td>DSecond</td><td>Represents the milliseconds within a minute.
units of milliseconds</td><td>INTEGER (0..65535)</td><td>SAE J2735_201603, Section 7.39</td></tr>
<tr><td>lat</td><td>Latitude</td><td>The geographic latitude of an object, expressed in 1/10th integer microdegrees,</td><td>INTEGER (-900000000..900000001)</td><td>SAE J2735_201603, Section 7.91</td></tr>
<tr><td>lon</td><td>Longitude</td><td>The geographic longitude of an object, expressed in 1/10th integer microdegrees,</td><td>INTEGER (-1799999999..1800000001)</td><td>SAE J2735_201603, Section 7.95</td></tr>
<tr><td>elev</td><td>Elevation</td><td>Geographic position above or below the reference ellipsoid (typically WGS-84). The number has a resolution of 1 decimeter</td><td>INTEGER (-4096..61439)</td><td>SAE J2735_201603, Section 7.44</td></tr>
<tr><td>accuracy</td><td>PositionalAccuracy</td><td>various parameters of quality used to model the accuracy of the</td><td></td><td>SAE J2735_201603, Section 6.88</td></tr>
</table>
</td></tr>
</table>

Required Data (cont.)

		positional determination with respect to each given axis		
semiMajor	SemiMajorAxisAccuracy	radius (length) of the semi-major axis of an ellipsoid representing the accuracy which can be expected from a GNSS system in 5cm steps, typically at a one sigma level of confidence. range 0-12.7 meter, LSB = .05m	INTEGER (0..255)	SAE J2735_201603, Section 7.168
semiMinor	SemiMinorAxisAccuracy	radius of the semi-minor axis of an ellipsoid representing the accuracy which can be expected from a GNSS system in 5cm steps, typically at a one sigma level of confidence. range 0-12.7 meter, LSB = .05m	INTEGER (0..255)	SAE J2735_201603, Section 7.170
orientation	SemiMajorAxisOrientation	orientate the angle of the semi-major axis of an ellipsoid. relative to true north (0~359.9945078786 degrees) LSB units of 360/65535 deg	INTEGER (0..65535)	SAE J2735_201603, Section 7.169
transmission	TransmissionState	current state of the vehicle transmission	ENUMERATED{ neutral (0), park (1), forwardGears (2), reverseGears (3), unavailable (7)}	SAE J2735_201603, Section 7.201
speed	Speed	vehicle speed expressed in unsigned units of 0.02 meters per second	INTEGER (0..8191)	SAE J2735_201603, Section 7.179
heading	Heading	current heading of the sending device, expressed in unsigned units of 0.0125 degrees from North	INTEGER (0..28800)	SAE J2735_201603, Section 7.53
angle	SteeringWheelAngle	The angle of the driver's steering wheel, with LSB units of 1.5 degrees	INTEGER (-126..127)	SAE J2735_201603, Section 7.185

Required Data (cont.)

		+127 to be used for unavailable		
accelSet	AccelerationSet4Way	Set of acceleration values in 3 orthogonal directions of the vehicle and with yaw rotation rates	N/A (Data Frame)	SAE J2735_201603, Section 6.1
long	Acceleration	Signed acceleration of the vehicle along some known axis in units of 0.01 meters per second squared along the Vehicle Longitudinal axis	INTEGER (-2000..2001)	SAE J2735_201603, Section 7.1
lat	Acceleration	Signed acceleration of the vehicle along some known axis in units of 0.01 meters per second squared along the Vehicle Lateral axis	INTEGER (-2000..2001)	SAE J2735_201603, Section 7.1
vert	VerticalAcceleration	Signed vertical acceleration of the vehicle along the vertical axis in units of 0.02 G	INTEGER (-127..127)	SAE J2735_201603, Section 7.217
yaw	YawRate	Yaw Rate of the vehicle, a signed value (to the right being positive) expressed in 0.01 degrees per second	INTEGER (-32767..32767)	SAE J2735_201603, Section 7.229
brakes	BrakeSystemStatus	Information about the current brake and system control activity of the vehicle		SAE J2735_201603, Section 6.7
wheelBrakes	BrakeAppliedStatus	Independently for each of four wheels whether braking is currently active. Set to 1 if brakes are active on that wheel, or to 0 if brakes are inactive on that wheel	BIT STRING { unavailable (0), leftFront (1), leftRear (2), rightFront (3), rightRear (4) }	SAE J2735_201603, Section 7.18
traction	TractionControlStatus	Status of the vehicle traction control system	ENUMERATED { unavailable (0), off (1), on (2), engaged (3)}	SAE J2735_201603, Section 7.196
abs	AntiLockBrakeStatus	Status of the vehicle ABS	ENUMERATED { unavailable (0), off (1), on (2), engaged (3)}	SAE J2735_201603, Section 7.10
scs	StabilityControlStatus	Current state of the	ENUMERATED	SAE

Required Data (cont.)

		stability control system	{ unavailable (0), off (1), on (2), engaged (3)}	J2735_201603, Section 7.181
brakeBoost	BrakeBoostApplied	When set to the "on" state, indicates emergency braking	ENUMERATED { unavailable (0), off (1), on (2)}	SAE J2735_201603, Section 7.19
auxBrakes	AuxilliaryBrakeStatus	status of the auxiliary brakes (sometimes referred to as the parking brake) of the vehicle	ENUMERATED { unavailable (0), off (1), on (2), reserved (3)}	SAE J2735_201603, Section 7.14
size	VehicleSize	vehicle length and vehicle width	N/A (Data Frame)	SAE J2735_201603, Section 6.149
width	VehicleWidth	Width of the vehicle expressed in centimeters	INTEGER (0..1023)	SAE J2735_201603, Section 7.214
length	VehicleLength	Length of the vehicle measured from the edge of the front bumper to the edge of the rear bumper expressed in centimeters, unsigned.	INTEGER (0.. 4095)	SAE J2735_201603, Section 7.210

Table 12: Basic Safety Message Part II

Message	Basic Safety Message (BSM) Part II				
Applicable Interface(s)	Interface 15, Interface 19, Interface 20				
Applicable Standards	ITS Application Information Layer: SAE J2735_201603, Section 5.2 Presentation Layer: ISO ASN.1 UPER Transport Layer: IEEE 1609.3 WSMP Network Layer: IEEE 1609.3 WSMP Data Link Layer: IEEE 1609.4, IEEE 802.11 Physical Layer: IEEE 802.11 Security Plane: IEEE 1609.2				
Description	BSM Part II data items are optional for a given BSM and are included as needed, as specified in the System Requirements				
Required Data	Name	Type	Description	Values	Reference
	specialVehicleExt	SpecialVehicleExtensions	various additional optional information elements for special vehicles. For example, a heavy truck sending content about the trailer it was hauling	N/A (Data Frame)	SAE J2735_201603, Section 6.128
	trailers	TrailerData	describe trailers pulled by a motor vehicle and/or other equipped devices	N/A (Data Frame)	SAE J2735_201603, Section 6.135
	sspRights	SSPindex	Used to control the data elements that follow the occurrence of the index. In the absence of a matching index in the message sender's CERT, the message contents are not valid	INTEGER (0..31)	SAE J2735_201603, Section 7.180
	connection	PivotPointDescription	describes the geometric relationship between a vehicle and a	N/A (Data Frame)	SAE J2735_201603, Section 6.86

Required Data (cont.)			trailer		
	pivotOffset	Offset-B11	Offset is with respect to the length and tangential to the width of the object in question and is the distance from the edge of the outline measured from the edge of the length of this unit. An 11-bit delta offset in X or Y direction from some known point. a range of +-10.23 meters	INTEGER (-1024..1023)	SAE J2735_201603, Section 7.119
	pivotAngle	Angle	The current angle between the two objects. This is the only dynamic value when the vehicle is underway. Heading and reported positions of the trailers are given with respect to the object in front of them. The current heading of the sending device is expressed in unsigned units of 0.0125 degrees.	INTEGER (0..28800)	SAE J2735_201603, Section 7.7
	pivots	PivotingAllowed	Flag set to true when the described connection point allows	BOOLEAN	SAE J2735_201603, Section 7.138

Required Data (cont.)			pivoting to occur		
	units	TrailerUnitDescriptionList	Sequence of trailer descriptions	SEQUENCE (SIZE(1..8)) OF TrailerUnitDescription	SAE J2735_201603, Section 6.138
		TrailerUnitDescritption	Provides a physical description for one trailer	N/A (Data Frame)	SAE J2735_201603, Section 6.139
	isDolley	IsDolley	Set to False when false indicates a trailer unit	BOOLEAN	SAE J2735_201603, Section 7.58
	width	VehicleWidth	Trailer Width expressed in centimeters, unsigned. Units are 1 cm	INTEGER (0..1023)	SAE J2735_201603, Section 7.215
	length	VehicleLength	Trailer Width expressed in centimeters, unsigned. Units are 1 cm	INTEGER (0..1023)	SAE J2735_201603, Section 7.210
	frontPivot	PivotPointDescription	describes the geometric relationship between a vehicle and a trailer	N/A (Data Frame)	SAE J2735_201603, Section 6.86
	pivotOffset	Offset-B11	Offset is with respect to the length and tangential to the width of the object in question and is the distance from the edge of the outline measured from the edge of the length of this unit. An 11-bit delta offset in X or Y direction from some known point. a range of +-10.23 meters	INTEGER (-1024..1023)	SAE J2735_201603, Section 7.119
Required	pivotAngle	Angle	The current	INTEGER (0..28800)	SAE

Data (cont.)				angle between the two objects. This is the only dynamic value when the vehicle is underway. Heading and reported positions of the trailers are given with respect to the object in front of them. The current heading of the sending device is expressed in unsigned units of 0.0125 degrees.		J2735_201603, Section 7.7
		pivots	PivotingAllowed	Flag set to true when the described connection point allows pivoting to occur	BOOLEAN	SAE J2735_201603, Section 7.138
		positionOffset	Node-XY-24b	Current Position relative to the hauling Vehicle. A 24-bit node type with offset values from the last point in X and Y.	N/A (Data Frame)	SAE J2735_201603, Section 6.63
		x	Offset-B12	A 12-bit delta offset in X, Y or Z direction from some known point. A range of +-20.47 meters	INTEGER (-2048..2047)	SAE J2735_201603, Section 7.120
Required Data (cont.)		y	Offset-B12	A 12-bit delta offset in X, Y or Z direction from some known point.	INTEGER (-2048..2047)	SAE J2735_201603, Section 7.120

			a range of +-20.47 meters		

Table 13: Signal Phase and Timing

<table>
<tr><td>Message</td><td colspan="5">Signal Phase and Timing (SPaT)</td></tr>
<tr><td>Applicable Interface(s)</td><td colspan="5">Interface 12, Interface 13, Interface 14, Interface 15</td></tr>
<tr><td>Applicable Standards</td><td colspan="5">ITS Application Information Layer: SAE J2735_201603, Section
Presentation Layer: ISO ASN.1 UPER
Transport Layer: IEEE 1609.3 WSMP
Network Layer: IEEE 1609.3 WSMP
Data Link Layer: IEEE 1609.4, IEEE 802.11
Physical Layer: IEEE 802.11
Security Plane: IEEE 1609.2</td></tr>
<tr><td>Description</td><td colspan="5">The Signal Phase and Timing (SPAT) message is used to convey the current status of one or more signalized intersections. Along with the MSG_MapData message (which describes a full geometric layout of an intersection) the receiver of this message can determine the state of the signal phasing and when the next expected phase will occur.
The SPAT message sends the current movement state of each active phase in the system as needed (such as values of what states are active and values at what time a state has begun/does begin earliest, is expected to begin most likely and will end latest). The state of inactive movements is not normally transmitted. Movements are mapped to specific approaches and connections of ingress to egress lanes and by use of the SignalGroupID in the MapData message
The current signal preemption and priority status values (when present or active) are also sent. A more complete summary of any pending priority or preemption events can be found in the Signal Status message.</td></tr>
<tr><td>Required Data</td><td colspan="5">
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>timeStamp</td><td>MinuteOfTheYear</td><td>Number of elapsed minutes of the current year in the time system being used (typically UTC time)</td><td>INTEGER (0..527040)</td><td>SAE J2735_201603, Section 7.100</td></tr>
<tr><td>intersections</td><td>IntersectionStateList</td><td>The IntersectionStateList data frame consists of a list of IntersectionState entries</td><td>SEQUENCE (SIZE(1..32)) OF IntersectionState</td><td>SAE J2735_201603, Section 6.38</td></tr>
<tr><td></td><td>IntersectionState</td><td>Convey all the SPAT information for a single intersection</td><td>N/A (Data Frame)</td><td>SAE J2735_201603, Section 6.37</td></tr>
<tr><td>id</td><td>IntersectionReferenceID</td><td>globally unique value set, consisting of a regionID and intersection ID assignment provides a unique mapping to the</td><td>N/A (Data Frame)</td><td>SAE J2735_201603, Section 6.36</td></tr>
</table>
</td></tr>
</table>

Required Data (cont.)

		intersection MAP in question which provides complete location and approach/move/lane data		
id	IntersectionID	The IntersectionID is used within a region to uniquely define an intersection within that country or region	INTEGER (0..65535)	SAE J2735_201603, Section 7.56
revision	MsgCount	A sequence number within a stream of messages with the same DSRCmsgID and from the same sender.	INTEGER (0..127)	SAE J2735_201603, Section 7.104
status	IntersectionStatusObject	Contains Advanced Traffic Controller (ATC) status information that may be sent to local OBUs as part of the SPAT process	BIT STRING {manualControlIsEnabled (0), stopTimeIsActivated (1), failureFlash (2), preemptIsActive (3), signalPriorityIsActive (4), fixedTimeOperation (5), trafficDependentOperation (6), standbyOperation (7), failureMode (8), off (9), recentMAPmessageUpdate (10), recentChangeInMAPassignedLanesIDsUsed (11), noValidMAPisAvailableAtThisTime (12), noValidSPATisAvailableAtThisTime (13)	SAE J2735_201603, Section 7.57
timeStamp	Dsecond	The mSec point in the current UTC minute that this message was constructed. Represents the milliseconds within a minute. units of milliseconds	INTEGER (0..65535)	SAE J2735_201603, Section 7.39
states	MovementList	Each Movement is given in turn and contains its signal phase state, mapping to the lanes it applies to, and	SEQUENCE (SIZE(1..255)) OF MovementState	SAE J2735_201603, Section 6.52

Required Data (cont.)			point in time it will end, and it may contain both active and future states. The MovementList data frame consists of a list of MovementState entries.		
		MovementState	convey various information about the current or future movement state of a designated collection of one or more lanes of a common type	N/A (Data Frame)	SAE J2735_201603, Section 6.53
	signalGroup	SignalGroupID	Map to lists of lanes (and their descriptions) which this MovementState data applies to.	INTEGER (0..255)	SAE J2735_201603, Section 7.171
	state-time-speed	MovementEventList	Consists of a list of MovementEvent entries - sets of movement data with: a) SignalPhaseState, b) TimeChangeDetails, and c) AdvisorySpeeds.	SEQUENCE (SIZE(1..16)) OF MovementEvent	SAE J2735_201603, Section 6.5
		MovementEvent	Details about a single movement	N/A (Data Frame)	SAE J2735_201603, Section 6.51
	eventState	MovementPhaseState	Overall current state of the movement (in many cases a signal state), including its core phase state and an indication of whether this state is permissive or protected.	unavailable (0), dark (1), stop-Then-Proceed (2), stop-And-Remain (3), permissive-Movement-Allowed (5), protected-Movement-Allowed (6), permissive-clearance (7), protected-clearance (8), caution-Conflicting-Traffic (9)	SAE J2735_201603, Section 7.103
	timing	TimeChangeDetails	Start and min/max end	N/A (Data Frame)	SAE J2735_2016

Required Data (cont.)

		times of phase confidence and estimated next occurrence		03, Section 6.134
minEndTime	TimeMark	Expected shortest end time. Relates a moment in UTC (Coordinated Universal Time)-based time when a signal phase is predicted to change, with a precision of 1/10 of a second.	INTEGER (0..36001)	SAE J2735_201603, Section 7.194
maxEndTime	TimeMark	Expected longest end time. Relates a moment in UTC (Coordinated Universal Time)-based time when a signal phase is predicted to change, with a precision of 1/10 of a second.	INTEGER (0..36001)	SAE J2735_201603, Section 7.194
likelyTime	TimeMark	Best predicted value based on other data. Relates a moment in UTC (Coordinated Universal Time)-based time when a signal phase is predicted to change, with a precision of 1/10 of a second.	INTEGER (0..36001)	SAE J2735_201603, Section 7.194

Table 14: MapData

<table>
<tr><td>Message</td><td>MapData (MAP)</td></tr>
<tr><td>Applicable Interface(s)</td><td>Interface 12, Interface 13, Interface 14, Interface 15</td></tr>
<tr><td>Applicable Standards</td><td>ITS Application Information Layer: SAE J2735_201603, Section
Presentation Layer: ISO ASN.1 UPER
Transport Layer: IEEE 1609.3 WSMP
Network Layer: IEEE 1609.3 WSMP
Data Link Layer: IEEE 1609.4, IEEE 802.11
Physical Layer: IEEE 802.11
Security Plane: IEEE 1609.2</td></tr>
<tr><td>Description</td><td>The MapData message is used to convey many types of geographic road information. At the current time its primary use is to convey one or more intersection lane geometry maps within a single message. The map message content includes such items as complex intersection descriptions, road segment descriptions, high speed curve outlines (used in curve safety messages), and segments of roadway (used in some safety applications). A given single MapData message may convey descriptions of one or more geographic areas or intersections. The contents of this message involve defining the details of indexing systems that are in turn used by other messages to relate additional information (for example, the signal phase and timing via the SPAT message) to events at specific geographic locations on the roadway.</td></tr>
<tr><td>Required Data</td><td>
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>msgIssueRevision</td><td>MsgCount</td><td>A sequence number within a stream of messages with the same DSRCmsgID and from the same sender.</td><td>INTEGER (0..127)</td><td>SAE J2735_201603, Section 7.104</td></tr>
<tr><td>intersections</td><td>IntersectionGeometryList</td><td>All intersection definitions. Consists of a list of IntersectionGeometry entries</td><td>SEQUENCE (SIZE(1..32)) OF IntersectionGeometry</td><td>SAE J2735_201603, Section 6.35</td></tr>
<tr><td>-</td><td>IntersectionGeometry</td><td>Description of an intersection's roadway geometry and its allowed navigational paths</td><td>N/A (Data Frame)</td><td>SAE J2735_201603, Section 6.34</td></tr>
<tr><td>id</td><td>IntersectionReferenceID</td><td>conveys the combination of an optional RoadRegulatorID and of an IntersectionID that is unique within that region</td><td>N/A (Data Frame)</td><td>SAE J2735_201603, Section 6.36</td></tr>
<tr><td>id</td><td>IntersectionID</td><td>A unique mapping to the intersection in question within</td><td>INTEGER (0..65535)</td><td>SAE J2735_201603, Section</td></tr>
</table>
</td></tr>
</table>

Required Data (cont.)

		the above region of use		7.56
revision	MsgCount	A sequence number within a stream of messages with the same DSRCmsgID and from the same sender.	INTEGER (0..127)	SAE J2735_201603, Section 7.104
refPoint	Position3D	The reference from which subsequent data points are offset until a new point is used	N/A (Data Frame)	SAE J2735_201603, Section 6.87
lat	Latitude	The geographic latitude of an object, expressed in 1/10th integer microdegrees,	INTEGER (-900000000..900000001)	SAE J2735_201603, Section 7.91
long	Longitude	The geographic longitude of an object, expressed in 1/10th integer microdegrees,	INTEGER (-1799999999..1800000001)	SAE J2735_201603, Section 7.95
laneWidth	LaneWidth	Reference width used by all subsequent lanes unless a new width is given. Units of 1 cm	INTEGER (0..32767)	SAE J2735_201603, Section 7.90
laneSet	LaneList	Data about one or more lanes. Consists of a list of GenericLane entries	SEQUENCE (SIZE(1..255)) OF GenericLane	SAE J2735_201603, Section 6.47
-	GenericLane	Describes the basic attribute information of the lane	N/A (Data Frame)	SAE J2735_201603, Section 6.29
laneID	LaneID	The unique ID number assigned to this lane object	INTEGER (0..255)	SAE J2735_201603, Section 7.88
maneuvers	AllowedManeuvers	the permitted maneuvers for this lane	BIT STRING { maneuverStraightAllowed (0), maneuverLeftAllowed (1), maneuverRightAllowed (2), maneuverUTurnAllowed (3), maneuverLeftTurnOnRedAllowed (4), maneuverRightTurnOnRedAllowed (5),	SAE J2735_201603, Section 7.4

Required Data (cont.)				maneuverLaneChangeAllowed (6), maneuverNoStoppingAllowed (7), yieldAllwaysRequired (8), goWithHalt (9), caution (10), reserved1 (11) }	
	xy	NodeListXY	Lane spatial path information as well as various Attribute information along the node path. provides the sequence of signed offset node point values for determining the Xs and Ys, using the then current Position3D object to build a path for the centerline of the subject lane type.	N/A (Data Frame)	SAE J2735_201603, Section 6.72
	nodes	NodeSetXY	a lane made up of two or more XY node points and any attributes defined in those nodes	SEQUENCE (SIZE(2..63)) OF NodeXY	SAE J2735_201603, Section 6.77
	-	NodeXY	data for a single node point in a path	N/A (Data Frame)	SAE J2735_201603, Section 6.78
	Delta	NodeOffsetPointXY	Nodes are described in terms of X and Y offsets in units of 1 centimeter	N/A (Data Frame)	SAE J2735_201603, Section 6.75
	Node-XY1 Node-XY2 Node-XY3 Node-XY4 Node-XY5 Node-XY6 (choice)	Node-XY-20b Node-XY-22b Node-XY-24b Node-XY-26b Node-XY-28b Node-XY-32b	node is within 5.11m of last node node is within 10.23m of last node node is within 20.47m of last node node is within 40.96m of last node node is within	N/A (Data Frame)	SAE J2735_201603, Section 6.61, 6.62, 6.63, 6.64, 6.65, 6.66

Required Data (cont.)

		81.91m of last node node is within 327.67m of last node		
x (corresponding to above choice)	Offset-B10 Offset-B11 Offset-B12 Offset-B13 Offset-B14 Offset-B16	(10,11,12,13,14,16)-bit delta offset in X, Y or Z direction from some known point.	INTEGER (-512..511) INTEGER (-1024..1023) INTEGER (-2048..2047) INTEGER (-4096..4095) INTEGER (-8192..8191) INTEGER (-32768..32767)	SAE J2735_201603, Section 7.118, 7.119, 7.120, 7.121, 7.122, 7.123
y (corresponding to above choice)	Offset-B10 Offset-B11 Offset-B12 Offset-B13 Offset-B14 Offset-B16	(10,11,12,13,14,16)-bit delta offset in X, Y or Z direction from some known point.	INTEGER (-512..511) INTEGER (-1024..1023) INTEGER (-2048..2047) INTEGER (-4096..4095) INTEGER (-8192..8191) INTEGER (-32768..32767)	SAE J2735_201603, Section 7.118, 7.119, 7.120, 7.121, 7.122, 7.123
connectsTo	ConnectsToList	A sequence of other defined lanes to which each lane connects beyond its stop point	SEQUENCE (SIZE(1..16)) OF Connection	SAE J2735_201603, Section 6.16
-	Connection	Data about how the stop line at the end of a single lane connects to another lane beyond its stop point	N/A (Data Frame)	SAE J2735_201603, Section 6.14
connectingLane	ConnectingLane	The index of the connecting lane and also the maneuver from the current lane to it	N/A (Data Frame)	SAE J2735_201603, Section 6.13
lane	LaneID	Index of the connecting lane. The unique ID number assigned to this lane object	INTEGER (0..255)	SAE J2735_201603, Section 7.88
maneuver	AllowedManeuvers	The Maneuver between the enclosing lane and this lane at the stop line to connect them	BIT STRING { maneuverStraightAllowed (0), maneuverLeftAllowed (1), maneuverRightAllowed (2), maneuverUTurnAllowed (3), maneuverLeftTurnOnRedAllo	SAE J2735_201603, Section 7.4

Required Data (cont.)				wed (4), maneuverRightTurnOnRedAllowed (5), maneuverLaneChangeAllowed (6), maneuverNoStoppingAllowed (7), yieldAllwaysRequired (8), goWithHalt (9), caution (10), reserved1 (11) }	
	signalGroup	SignalGroupID	The matching signal group send by the SPAT message for this lane/maneuver.	INTEGER (0..255)	SAE J2735_201603, Section 7.171

Table 15: Roadside Safety Message

<table>
<tr><td>Message</td><td>Roadside Safety Message (RSM)</td></tr>
<tr><td>Applicable Interface(s)</td><td>Interface 12, Interface 13</td></tr>
<tr><td>Applicable Standards</td><td>ITS Application Information Layer: SAE J2945/9 (not yet published)
Presentation Layer: ISO ASN.1 UPER
Transport Layer: IEEE 1609.3 WSMP
Network Layer: IEEE 1609.3 WSMP
Data Link Layer: IEEE 1609.4, IEEE 802.11
Physical Layer: IEEE 802.11
Security Plane: IEEE 1609.2</td></tr>
<tr><td>Description</td><td></td></tr>
<tr><td>Required Data</td><td>
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>School Zone Speed Limit</td><td></td><td>The RSM shall contain the speed limit for the reduced speed (school) zone</td><td></td><td>SAE J2945/4, Section 2.5.2.2.2.3</td></tr>
<tr><td>Speed Zone Geometry</td><td></td><td>The RSM shall contain the reduced speed zone geometry.</td><td></td><td>SAE J2945/4, Section 2.5.2.2.2.4</td></tr>
<tr><td>Event Identification Number</td><td></td><td>The RSM shall contain the event identification number</td><td></td><td>SAE J2945/4, Section 2.5.2.1.1</td></tr>
<tr><td>Event Type</td><td></td><td>The RSM shall contain the event type</td><td></td><td>SAE J2945/4, Section 2.5.2.1.2</td></tr>
<tr><td>Event Start Time</td><td></td><td>The RSM shall contain the event start time</td><td></td><td>SAE J2945/4, Section 2.5.2.1.3.1</td></tr>
<tr><td>Event Duration</td><td></td><td>The RSM shall contain the event duration</td><td></td><td>SAE J2945/4, Section 2.5.2.1.3.1</td></tr>
<tr><td>Geographic Information</td><td></td><td>The RSM shall contain all data elements in the Geographic Information data frame</td><td></td><td>SAE J2945/4, Section 2.5.2.1.5</td></tr>
</table>
</td></tr>
</table>

Table 16: Signal Request Message

<table>
<tr><td>Message</td><td>Signal Request Message (SRM)</td></tr>
<tr><td>Applicable Interface(s)</td><td>Interface 12, Interface 14, Interface 15</td></tr>
<tr><td>Applicable Standards</td><td>ITS Application Information Layer: SAE J2735_201603
Presentation Layer: ISO ASN.1 UPER
Transport Layer: IEEE 1609.3 WSMP
Network Layer: IEEE 1609.3 WSMP
Data Link Layer: IEEE 1609.4, IEEE 802.11
Physical Layer: IEEE 802.11
Security Plane: IEEE 1609.2</td></tr>
<tr><td>Description</td><td>The Signal Request Message is a message sent by a DSRC equipped entity (such as a vehicle) to the RSU in a signalized intersection. It is used for either a priority signal request or a preemption signal request depending on the way each request is set. Each request defines a path through the intersection which is desired in terms of lanes and approaches to be used. Each request can also contain the time of arrival and the expected duration of the service. Multiple requests to multiple intersections are supported. The requestor identifies itself in various ways (using methods supported by the RequestorDescription data frame), and its current speed, heading and location can be placed in this structure as well. The specific request for service is typically based on previously decoding and examining the list of lanes and approaches for that intersection (sent in MAP messages). The outcome of all of the pending requests to a signal can be found in the Signal Status Message (SSM), and may be reflected in the SPAT message contents if successful.</td></tr>
<tr><td>Required Data

Required</td><td>
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>-</td><td>SignalReqScheme</td><td>Used in a priority or preempt request frame to select which preempt or priority controller sequence is to be activated. The data element has either a priority value or a preemption value, depending on the setting of the most significant bit and what data frame it is used in.</td><td>OCTET STRING (SIZE(1)) upper nibble: Preempt #: -- Bit 7 (MSB) 1 = Preempt and 0 = Priority</td><td>SAE J2735_201603, Section 7.172</td></tr>
<tr><td>second</td><td>DSecond</td><td>The mSec point in the current UTC minute that this message was constructed. Represents the milliseconds within a minute. units of milliseconds</td><td>INTEGER (0..65535)</td><td>SAE J2735_201603, Section 7.39</td></tr>
<tr><td>requests</td><td>SignalRequestList</td><td>Request Data for one or more signalized intersections that support SRM</td><td>SEQUENCE (SIZE(1..32)) OF SignalRequestPackage</td><td>SAE J2735_201603, Section 6.118</td></tr>
</table>
</td></tr>
</table>

Data (cont.)				dialogs. Consists of a list of SignalRequest entries		
			SignalRequestPackage	Contains both the service request itself (the preemption and priority details and the inbound-outbound path details for an intersection) and the time period (start and end time) over which this service is sought from one single intersection.	N/A (Data Frame)	SAE J2735_201603, Section 6.123
		request	SignalRequest	Used (as part of a request message) to request either a priority or a preemption service from a signalized intersection.	N/A (Data Frame)	SAE J2735_201603, Section 6.120
		id	IntersectionReferenceID	globally unique value set, consisting of a regionID and intersection ID assignment provides a unique mapping to the intersection MAP in question which provides complete location and approach/move/lane data	N/A (Data Frame)	SAE J2735_201603, Section 6.36
		id	IntersectionID	A unique mapping to the intersection in question within the above region of use	INTEGER (0..65535)	SAE J2735_201603, Section 7.56
		requestID	RequestID	The unique requestID used by the requestor. The RequestID data element is used to provide a unique ID between two parties for various dialog exchanges	INTEGER (0..255)	SAE J2735_201603, Section 7.153
Required		requestType	PriorityRequestType	Provides a means to indicate if a	ENUMERATED { priorityRequestTypeReserv	SAE J2735_20160

Data (cont.)				request (found in the Signal Request Message) represents a new service request, a request update, or a request cancellation	ed (0), priorityRequest (1), priorityRequestUpdate (2), priorityCancellation (3), }	3, Section 7.142
	inBoundLane	IntersectionAccessPoint	Desired entry approach or lane	N/A (Data Frame)	SAE J2735_201603, Section 6.33	
	lane	LaneID	The unique ID number assigned to this lane object	INTEGER (0..255)	SAE J2735_201603, Section 7.88	
	approach	ApproachID	Used to relate the index of an approach, either ingress or egress within the subject lane	INTEGER (0..15)	SAE J2735_201603, Section 7.11	
	connection	LaneConnectionID	A connection index for a lane to lane connection	INTEGER (0..255)	SAE J2735_201603, Section 7.86	
	requestor	RequestorDescription	contains vehicle ID (if from a vehicle) as well as type data and current position and may contain additional transit data.	N/A (Data Frame)	SAE J2735_201603, Section 6.98	
	id	VehicleID	The ID used in the BSM or CAM of the requestor. This ID is presumed not to change during the exchange	N/A (Data Frame)	SAE J2735_201603, Section 6.147	
	entityID	TemporaryID	Used as a means to identify the local vehicles that are interacting during an encounter	OCTET STRING (SIZE(4))	SAE J2735_201603, Section 7.187	

Table 17: Basic Status Message

<table>
<tr><td>Message</td><td colspan="5">Signal Status Message (SSM)</td></tr>
<tr><td>Applicable Interface(s)</td><td colspan="5">Interface 12, Interface 14, Interface 15</td></tr>
<tr><td>Applicable Standards</td><td colspan="5">ITS Application Information Layer: SAE J2735_201603
Presentation Layer: ISO ASN.1 UPER
Transport Layer: IEEE 1609.3 WSMP
Network Layer: IEEE 1609.3 WSMP
Data Link Layer: IEEE 1609.4, IEEE 802.11
Physical Layer: IEEE 802.11
Security Plane: IEEE 1609.2</td></tr>
<tr><td>Description</td><td colspan="5">The Signal Status Message is a message sent by an RSU in a signalized intersection. It is used to relate the current status of the signal and the collection of pending or active preemption or priority requests acknowledged by the controller. It is also used to send information about preemption or priority requests which were denied. This in turn allows a dialog acknowledgment mechanism between any requester and the signal controller. The data contained in this message allows other users to determine their "ranking" for any request they have made as well as to see the currently active events. When there have been no recently received requests for service messages, this message may not be sent. While the outcome of all pending requests to a signal can be found in the Signal Status Message, the current active event (if any) will be reflected in the SPAT message contents.</td></tr>
<tr><td>Required Data</td><td colspan="5">
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>second</td><td>DSecond</td><td>The mSec point in the current UTC minute that this message was constructed. Represents the milliseconds within a minute. units of milliseconds</td><td>INTEGER (0..65535)</td><td>SAE J2735_201603, Section 7.39</td></tr>
<tr><td>status</td><td>SignalStatusList</td><td>consists of a list of SignalStatus entries</td><td>SEQUENCE (SIZE(1..32)) OF SignalStatus</td><td>SAE J2735_201603, Section 6.121</td></tr>
<tr><td>-</td><td>SignalStatus</td><td>Provide the status of a single intersection to others, including any active preemption or priority state in effect.</td><td>N/A (Data Frame)</td><td>SAE J2735_201603, Section 6.124</td></tr>
<tr><td>sequenceNumber</td><td>MsgCount</td><td>A sequence number within a stream of messages with the same DSRCmsgID and from the same sender.</td><td>INTEGER (0..127)</td><td>SAE J2735_201603, Section 7.104</td></tr>
<tr><td>id</td><td>IntersectionReferenceID</td><td>globally unique value set, consisting of a regionID and</td><td>N/A (Data Frame)</td><td>SAE J2735_201603, Section 6.36</td></tr>
</table>
</td></tr>
</table>

Required Data (cont.)				intersection ID assignment provides a unique mapping to the intersection MAP in question which provides complete location and approach/move/lane data		
	sigStatus	SignalStatusPackageList	list of detailed status containing all priority or preemption state data, both active and pending, and who requested it requests which are denied are also listed here for a short period of time. Consists of a list of SignalStatusPackage entries	SEQUENCE (SIZE(1..32)) OF SignalStatusPackage	SAE J2735_201603, Section 6.122
	-	SignalStatusPackage	Contains all the data needed to describe the preemption or priority state of the signal controller with respect to a given request and to uniquely identify the party who requested that state to occur.	N/A (Data Frame)	SAE J2735_201603, Section 6.119
	requestor	SignalRequestorInfo	information regarding the entity that requested a given signal behavior	N/A (Data Frame)	SAE J2735_201603, Section 6.117
	id	VehicleID	The ID used in the BSM or CAM of the requestor. This ID is presumed not to change during the exchange	N/A (Data Frame)	SAE J2735_201603, Section 6.147
	entityID	TemporaryID	Used as a means to identify the local vehicles that are interacting during an encounter	OCTET STRING (SIZE(4))	SAE J2735_201603, Section 7.187
	request	RequestID	The unique requestID used by the requestor. The	INTEGER (0..255)	SAE J2735_201603, Section

Required Data (cont.)

			RequestID data element is used to provide a unique ID between two parties for various dialog exchanges		7.153
	sequenceNumber	MsgCount	A sequence number within a stream of messages with the same DSRCmsgID and from the same sender.	INTEGER (0..127)	SAE J2735_201603, Section 7.104
	inboundOn	IntersectionAccessPoint	Estimated lane / approach of vehicle. Specifies the index of either a single approach or a single lane at which a service is needed.	N/A (Data Frame)	SAE J2735_201603, Section 6.33
	lane	LaneID	The unique ID number assigned to this lane object	INTEGER (0..255)	SAE J2735_201603, Section 7.88
	approach	ApproachID	Used to relate the index of an approach, either ingress or egress within the subject lane	INTEGER (0..15)	SAE J2735_201603, Section 7.11
	connection	LaneConnectionID	A connection index for a lane to lane connection	INTEGER (0..255)	SAE J2735_201603, Section 7.86
	status	PrioritizationResponseStatus	Status of request, this may include rejection	ENUMERATED { unknown (0), requested (1), processing (2), watchOtherTraffic (3), granted (4), rejected (5), maxPresence (6), reserviceLocked (7)}	SAE J2735_201603, Section 7.140

Table 18: Radio Technical Commission for Maritime Services Corrections Message

<table>
<tr><td>Message</td><td>Radio Technical Commission for Maritime Services Corrections (RTCM) Message</td></tr>
<tr><td>Applicable Interface(s)</td><td>Interface 12, Interface 13, Interface 14, Interface 15</td></tr>
<tr><td>Applicable Standards</td><td>ITS Application Information Layer: SAE J2735_201603, Section 5.12
Presentation Layer: ISO ASN.1 UPER
Transport Layer: IEEE 1609.3 WSMP
Network Layer: IEEE 1609.3 WSMP
Data Link Layer: IEEE 1609.4, IEEE 802.11
Physical Layer: IEEE 802.11
Security Plane: IEEE 1609.2</td></tr>
<tr><td>Description</td><td>Encapsulates RTCM differential corrections for GPS and other radio navigation signals as defined by the RTCM (Radio Technical Commission For Maritime Services) special committee. RTCM messages are "wrapped" for transport on the DSRC media, and then can be re-constructed back into the final expected formats defined by the RTCM standard and used directly by various positioning systems to increase the absolute and relative accuracy estimates produced.</td></tr>
<tr><td>Required Data</td><td>
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>msgCnt</td><td>MsgCount</td><td>A sequence number within a stream of messages with the same DSRCmsgID and from the same sender.</td><td>INTEGER (0..127)</td><td>SAE J2735_201603, Section 7.104</td></tr>
<tr><td>rev</td><td>RTCM-Revision</td><td>Specific revision of the RTCM standard which is being used</td><td>unknown (0), rtcmRev2 (1), rtcmRev3 (2), reserved (3),</td><td>SAE J2735_201603, Section 7.162</td></tr>
<tr><td>msgs</td><td>RTCMmessageList</td><td>A list of RTCMmessage entries</td><td>SEQUENCE (SIZE(1..5)) OF RTCMmessage</td><td>SAE J2735_201603, Section 6.111</td></tr>
<tr><td></td><td>RTCMmessage</td><td>Stream of octets of the actual RTCM message: 1001 GPS L1 observations at 5 Hz, 1005 Antenna Reference Point (ARP) coordinates at 2 Hz</td><td>OCTET STRING (SIZE(1..1023))</td><td>SAE J2735_201603, Section 7.163</td></tr>
</table>
</td></tr>
</table>

Table 19: SPaT Data

Message	SPaT Data
Applicable Interface(s)	Interface 11a
Applicable Standards	ITS Application Information Layer: NTCIP 1202-ASC Presentation Layer: ISO ASN.1 UPER Transport Layer: IETF UDP, IETF TCP Network Layer: IETF IPv6 Data Link Layer: LLC and MAC compatible with Physical and Network Physical Layer: IEEE 802.3 (local Ethernet) Security Plane: IEEE 1609.2
Description	SPaT Data is the data sent from the Traffic Signal Controller to the RSU that is used to populate the SPaT Message defined by SAE J2735 and subsequently broadcast from the RSU via DSRC.
Required Data	*See SPaT*

Table 20: Logged Data

Message	Logged Data				
Applicable Interface(s)	Interface 7				
Applicable Standards	ITS Application Information Layer: Undefined Application Layer: HTTPS Session Layer: IETF TLS, IETF DTLS Transport Layer: IETF UDP, IETF TCP Network Layer: IETF IPv6 Data Link Layer: LLC and MAC compatible with Physical and Network Physical Layer: IEEE 802.3 (fiber-optic backhaul) Security Plane: IEEE 1609.2, IETF TLS, IETF, DTLS				
Description	Data that is received and Logged by the RSU that is sent to the Traffic CV Management System				
Required Data	Name	Type	Description	Values	Reference
	BSM		*See BSM*		
	SPaT		*See SPaT*		
	SRM		*See SRM*		
	SSM		*See SSM*		

Table 21: Controller Area Network Bus Data

Message	CAN Bus Data
Applicable Interface(s)	Interface 21, Interface 22, Interface 23, Interface 24
Applicable Standards	Controller Area Network (CAN) – ISO 11898 SAE J1939
Description	Data that is available from the Vehicle System via the CAN Bus (e.g. speed, RPMs, etc.)
Required Data	*All data from the CAN Bus is optional. Data regarding vehicle motion/state can be derived through alternative means.*

Table 22: MAP Data

Message	MAP Data
Applicable Interface(s)	Interface 2
Applicable Standards	N/A (User Interface)
Description	MAP Data is the data input by Traffic CV Management Center Staff that is used to populate the MAP Message defined by SAE J2735 and subsequently broadcast from the RSU via DSRC.
Required Data	*See MAP*

Table 23: RSM Data

Message	RSM Data
Applicable Interface(s)	Interface 2
Applicable Standards	N/A (User Interface)
Description	RSM Data is the data input by Traffic CV Management Center Staff that is used to populate the RSM defined by SAE J2735 and subsequently broadcast from the RSU via DSRC.
Required Data	*See RSM*

Table 24: Signal Priority Authorization List

<table>
<tr><td>Message</td><td>Signal Priority Authorization List</td></tr>
<tr><td>Applicable Interface(s)</td><td>Interface 2</td></tr>
<tr><td>Applicable Standards</td><td>N/A (User Interface)</td></tr>
<tr><td>Description</td><td>A list of priority authorizations which indicate which vehicles are authorized to receive priority, at which intersection, for which movements, at which times.</td></tr>
<tr><td>Required Data</td><td>
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>Priority Authorization</td><td>List</td><td>An entry in the Signal Priority Authorization List that contains a vehicle identifier, priority type identifier, intersection identifier, approach identifier, connection identifier, and time of day.</td><td></td><td>N/A</td></tr>
<tr><td>Vehicle Identifier</td><td>Not defined</td><td>A unique identifier associated with a vehicle that is authorized to receive priority. This identifier must correspond to a unique identifying vehicle characteristic (found in the SRM or in SRM metadata, such as the security information) sent by an OBU in the SRM.</td><td>INTEGER/ STRING</td><td>N/A</td></tr>
<tr><td>Priority Type Identifier</td><td>Not defined</td><td>Indicates the type of priority (e.g. priority, preemption) that the identified vehicle is eligible to receive. This identifier must correspond to the SignalReqScheme sent by an OBU in the SRM.</td><td>Priority, Preemption …</td><td>N/A</td></tr>
<tr><td>Intersection Identifier</td><td>Not defined</td><td>Indicates the intersection for which the identified vehicle is eligible to receive priority. This identifier must correspond to the (id) IntersectionID sent by an OBU in the SRM.</td><td>INTEGER</td><td>N/A</td></tr>
<tr><td>Approach Identifier</td><td>Not defined</td><td>Indicates the approach for which the identified vehicle is eligible to receive priority. This identifier must correspond to the (approach) ApproachID sent by an OBU in the SRM.</td><td>INTEGER</td><td>N/A</td></tr>
<tr><td>Connection Identifier</td><td>Not defined</td><td>Indicates the connection for which the identified vehicle is eligible to receive priority. This identifier must correspond to the (connection) LaneConnectionID sent by an OBU in the SRM.</td><td>INTEGER</td><td>N/A</td></tr>
<tr><td>Time of Day Identifier</td><td>Not defined</td><td>Indicates the time of day the identified vehicle is authorized to receive priority.</td><td>Undefined</td><td>N/A</td></tr>
</table>
</td></tr>
</table>

Table 25: Priority Authorization Query

<table>
<tr><td>Message</td><td>Priority Authorization Query</td></tr>
<tr><td>Applicable Interface(s)</td><td>Interface 7</td></tr>
<tr><td>Applicable Standards</td><td>ITS Application Information Layer: Undefined
Application Layer: HTTPS
Session Layer: IETF TLS, IETF DTLS
Transport Layer: IETF UDP, IETF TCP
Network Layer: IETF IPv6
Data Link Layer: LLC and MAC compatible with Physical and Network
Physical Layer: IEEE 802.3 (fiber-optic backhaul)
Security Plane: IEEE 1609.2, IETF TLS, IETF, DTLS</td></tr>
<tr><td>Description</td><td>A query sent from an RSU to the Traffic CV Management System to determine if a vehicle with a given ID is authorized to receive priority at a given intersection, for a given movement, at a given time of day.</td></tr>
<tr><td>Required Data</td><td>
<table>
<tr><th>Name</th><th>Type</th><th>Description</th><th>Values</th><th>Reference</th></tr>
<tr><td>Vehicle Identifier</td><td>Not defined</td><td>A unique identifier associated with a vehicle that is authorized to receive priority. This identifier must correspond to a unique identifying vehicle characteristic (found in the SRM or in SRM metadata, such as the security information) sent by an OBU in the SRM.</td><td>INTEGER/ STRING</td><td>N/A</td></tr>
<tr><td>Priority Type Identifier</td><td>Not defined</td><td>Indicates the type of priority (e.g. priority, preemption) that the identified vehicle is eligible to receive. This identifier must correspond to the SignalReqScheme sent by an OBU in the SRM.</td><td>Priority, Preemption …</td><td>N/A</td></tr>
<tr><td>Intersection Identifier</td><td>Not defined</td><td>Indicates the intersection for which the identified vehicle is eligible to receive priority. This identifier must correspond to the (id) IntersectionID sent by an OBU in the SRM.</td><td>INTEGER</td><td>N/A</td></tr>
<tr><td>Approach Identifier</td><td>Not defined</td><td>Indicates the approach for which the identified vehicle is eligible to receive priority. This identifier must correspond to the (approach) ApproachID sent by an OBU in the SRM.</td><td>INTEGER</td><td>N/A</td></tr>
<tr><td>Connection Identifier</td><td>Not defined</td><td>Indicates the connection for which the identified vehicle is eligible to receive priority. This identifier must correspond to the (connection) LaneConnectionID sent by an OBU in the SRM.</td><td>INTEGER</td><td>N/A</td></tr>
<tr><td>Time of Day Identifier</td><td>Not defined</td><td>Indicates the time of day the identified vehicle is authorized to receive priority.</td><td>Undefined</td><td>N/A</td></tr>
</table>
</td></tr>
</table>

Table 26: Priority Authorization Result

Message	Priority Authorization Result				
Applicable Interface(s)	Interface 7				
Applicable Standards	ITS Application Information Layer: Undefined Application Layer: HTTPS Session Layer: IETF TLS, IETF DTLS Transport Layer: IETF UDP, IETF TCP Network Layer: IETF IPv6 Data Link Layer: LLC and MAC compatible with Physical and Network Physical Layer: IEEE 802.3 (fiber-optic backhaul) Security Plane: IEEE 1609.2, IETF TLS, IETF, DTLS				
Description	Information that describes if a vehicle with a given ID is authorized to receive priority at a given intersection, for a given movement, at a given time of day.				
Required Data	Name	Type	Description	Values	Reference
	Vehicle Identifier	Not defined	A unique identifier associated with a vehicle that is authorized to receive priority. This identifier must correspond to a unique identifying vehicle characteristic (found in the SRM or in SRM metadata, such as the security information) sent by an OBU in the SRM.	INTEGER/ STRING	N/A
	Priority Authorization Result	Not Defined	A True/False value which indicates if a vehicle is authorized to receive priority at an intersection/approach/connection that it requested at the time it is requested (as indicated in the Priority Authorization Query)	BOOLEAN	N/A

Table 27: RTCM Data

Message	RTCM Data				
Applicable Interface(s)	Interface 9				
Applicable Standards	ITS Application Information Layer: RTCM 10410.1 Application Layer: HTTPS Session Layer: IETF TLS, IETF DTLS Transport Layer: IETF UDP, IETF TCP Network Layer: IETF IPv6 Data Link Layer: LLC and MAC compatible with Physical and Network Physical Layer: IEEE 802.3 (fiber-optic backhaul, Internet) Security Plane: IEEE 1609.2, IETF TLS, IETF, DTLS				
Description	RTCM Data is the data sent from the Ohio CORS to the RSU that is used to populate the RTCM defined by SAE J2735 and subsequently broadcast from the RSU via DSRC.				
Required Data	Name	Type	Description	Values	Reference
	1001		GPS L1 observations		RTCM 10410.1
	1005		Antenna Reference Point (ARP) coordinates		RTCM 10410.1

Table 28: SRM Data

Message	SRM Data
Applicable Interface(s)	Interface 11a
Applicable Standards	ITS Application Information Layer: NTCIP 1202-ASC Presentation Layer: ISO ASN.1 UPER Transport Layer: IETF UDP, IETF TCP Network Layer: IETF IPv6 Data Link Layer: LLC and MAC compatible with Physical and Network Physical Layer: IEEE 802.3 (local Ethernet) Security Plane: IEEE 1609.2
Description	SRM Data is the data required to place a priority or preemption request sent from the RSU to the Traffic Signal Controller that is extracted from the SRM defined by SAE J2735 received from the RSU via DSRC.
Required Data	*See SRM.*

Table 29: SSM Data

Message	SSM Data
Applicable Interface(s)	Interface 11a
Applicable Standards	ITS Application Information Layer: NTCIP 1202-ASC Presentation Layer: ISO ASN.1 UPER Transport Layer: IETF UDP, IETF TCP Network Layer: IETF IPv6 Data Link Layer: LLC and MAC compatible with Physical and Network Physical Layer: IEEE 802.3 (local Ethernet) Security Plane: IEEE 1609.2
Description	SSM Data is the data sent from the Traffic Signal Controller to the RSU that is used to populate the SSM defined by SAE J2735 and subsequently broadcast from the RSU via DSRC.
Required Data	*See SSM.*

Table 30: School Zone Indicator

Message	School Zone Indicator				
Applicable Interface(s)	Interface 11b				
Applicable Standards	N/A				
Description	Low-Voltage signal that provides an indication regarding the state of a school zone flashing signal				
Required Data	Name	Type	Description	Values	Reference
	School Zone Indicator	Low-Voltage Signal	A low-voltage signal that indicates if the school zone flashing signal is active or not active.	0V – Flashing Lights not Active 24V – Flashing Lights Active	N/A

Table 31: Platoon Query

Message	Platoon Query				
Applicable Interface(s)	Interface 16				
Applicable Standards	Session Layer: IETF TLS Transport Layer: IETF TCP Network Layer: IETF IPv6 Data Link Layer: Wide Area Wireless WAN Physical Layer: Wide Area Wireless WAN Security Plane: HTTP Auth, IETF TLS				
Description	Data that is sent to the Platooning Provider Central Management System to request information regarding whether the requesting vehicle is part of an intended platoon				
Required Data	Name	Type	Description	Values	Reference
	Vehicle Identifier	Not defined	A unique identifier associated with a heavy-duty vehicle that is involved in platooning operations. The Platooning Provider Central Management System uses this identifier to determine if the associated vehicle intends to platoon.	Not defined	N/A

Table 32: Platoon Data

Message	Platoon Data
Applicable Interface(s)	Interface 16
Applicable Standards	Session Layer: IETF TLS Transport Layer: IETF TCP Network Layer: IETF IPv6 Data Link Layer: Wide Area Wireless WAN Physical Layer: Wide Area Wireless WAN Security Plane: HTTP Auth, IETF TLS
Description	Data that is sent to the HDV OBU to indicate if it intends to form a platoon with other

nearby HDVs. The data in this message is used to determine the parameters that are used to request signal priority that will accommodate priority for all vehicles in the intended platoon.

Required Data

Name	Type	Description	Values	Reference
Vehicle Identifier	Not defined	A unique identifier associated with a heavy-duty vehicle that is involved in platooning operations.	Not defined	N/A
Intent to Platoon Indication	Not defined	A True/False value that indicates if the identified vehicle is in an intended platoon	BOOLEAN	N/A
Platoon Leader Indicator	Not Defined	A True/False value that indicates if the identified vehicle is the intended platoon leader	BOOLEAN	N/A
Number of vehicles in Intended Platoon	Not Defined	Indicates the number of vehicles in the intended platoon (including the identified vehicle)	INTEGER	N/A

Table 33: Emergency Vehicle Operator Notification

<table>
<tr><td>Message</td><td colspan="5">Notification</td></tr>
<tr><td>Applicable Interface(s)</td><td colspan="5">Interface 18</td></tr>
<tr><td>Applicable Standards</td><td colspan="5">N/A (Human-Machine Interface)</td></tr>
<tr><td>Description</td><td colspan="5">A visual notification provided to the Emergency Vehicle Operator that supports the Emergency Vehicle Preemption Application.</td></tr>
<tr><td>Required Data</td><td>Name</td><td>Type</td><td>Description</td><td>Values</td><td>Reference</td></tr>
<tr><td></td><td>Signal Priority Granted Notification</td><td>Visual</td><td>A notification issued to an Emergency Vehicle Operator when preemption has been granted at an intersection that priority has been requested for. Based on receipt of the SSM.</td><td>Not defined</td><td>N/A</td></tr>
</table>

Table 34: LDV Operator Alert

Message	Alert				
Applicable Interface(s)	Interface 17				
Applicable Standards	N/A (Human-Machine Interface)				
Description	An audio/visual alert provided to the LDV Operator that supports V2V Safety and V2I Safety Applications.				
Required Data	Name	Type	Description	Values	Reference
	Emergency Electronic Brake Light Alert	Audio/Visual	The type of alert that is issued to an LDV Operator when an Emergency Electronic Brake Light Event has occurred and arbitration on the LDV OBU indicates that it is the highest priority event.	Not defined	N/A
	Forward Collision Warning Alert	Audio/Visual	The type of alert that is issued to an LDV Operator when a Forward Collision Warning Event has occurred and arbitration on the LDV OBU indicates that it is the highest priority event.	Not defined	N/A
	Lane Change Warning Alert	Audio/Visual	The type of alert that is issued to an LDV Operator when a Lane Change Warning Event has occurred and arbitration on the LDV OBU indicates that it is the highest priority event.	Not defined	N/A
	Blind Spot Warning Alert	Audio/Visual	The type of alert that is issued to an LDV Operator when a Blind Spot Warning Event has occurred and arbitration on the LDV OBU indicates that it is the highest priority event.	Not defined	N/A
	Intersection Movement Assist Alert	Audio/Visual	The type of alert that is issued to an LDV Operator when an Intersection Movement Assist has occurred and arbitration on the LDV OBU indicates that it is the highest priority event.	Not defined	N/A
	Red Light Violation Warning Alert	Audio/Visual	The type of alert that is issued to an LDV Operator when a Red Light Violation Warning Event has occurred and arbitration on the LDV OBU indicates that it is the highest priority event.	Not defined	N/A
	Reduced Speed School Zone	Audio/Visual	The type of alert that is issued to an LDV Operator when a Reduced Speed	Not defined	N/A

Required Data (cont.)	Warning Alert		School Zone Event has occurred and arbitration on the LDV OBU indicates that it is the highest priority event.		

Appendix F: Sample Cost Table

Lump Sum Costs	Item	Description			Total Price
	CV Application Development – App 1				$ -
	…				$ -
	CV Application Development – App n				$ -
	Integration with Operating System				$ -
	Installation and Application Testing				$ -
	Communications and Outreach Coordination				$ -
	Integration and Testing				$ -
	Operations and Maintenance				$ -
	Test Tools				$ -
	Inventory/Participant Mgmt. Tool				
	Shipping and Returns				$ -
	Item	Description	One Time	Monthly	Total
	Licensing		$ -	$ -	$ -
Per OBU Costs	Item	Description	Unit Cost	Units	Total
	Onboard Equipment – Light Duty		$ -		$ -
	Onboard Equipment – Transit		$ -		$ -
	Onboard Equipment – Fire/Police		$ -		$ -
	Onboard Equipment – Freight		$ -		$ -
	Installation - Light Duty		$ -		$ -
	Installation – Fire / Police		$ -		$ -
	Installation - Other		$ -		$ -
	Workforce Training Premium		$ -		$ -
Total					**$ -**

Appendix G: Exhibit B Estimate of Labor Hours by Task Activity

PROJECT:

PRIME CONSULTANT

FIRM:

		CLASSIFICATION & LABOR HOURS									
											TOTAL
TASK	SCOPE OF SERVICE SECTION	PM	SE	CL	*	*	*	*	*	*	HOURS
											0
											0
											0
											0
	Total Hours	0	0	0	0	0	0	0	0	0	

SUBCONSULTANT No.: 1

FIRM:

		CLASSIFICATION & LABOR HOURS									
											TOTAL
TASK	STAFF	PM	SE	CL	*	*	*	*	*	*	HOURS
											0
											0
											0
											0
	Total Hours	0	0	0	0	0	0	0	0	0	

SUBCONSULTANT No.: 2

FIRM:

		CLASSIFICATION & LABOR HOURS									
											TOTAL
TASK	STAFF	PM	SE	CL	*	*	*	*	*	*	HOURS
											0
											0
											0
											0
	Total Hours	0	0	0	0	0	0	0	0	0	

SUBCONSULTANT No.: 3

FIRM:

		CLASSIFICATION & LABOR HOURS									
											TOTAL
TASK	STAFF	PM	SE	CL	*	*	*	*	*	*	HOURS
											0
											0
											0
											0
	Total Hours	0	0	0	0	0	0	0	0	0	

TEAM

		CLASSIFICATION & LABOR HOURS									
											TOTAL
TASK	STAFF										HOURS
											0
											0
											0
											0
	Total Hours	0	0	0	0	0	0	0	0	0	

Appendix H: Exhibit C Cost Summary

1.	CITY:		2. CIP NO.:		3. DATE:
	Department of Public Service				
4.	NAME OF CONSULTANT:	5. CONTRACT TITLE:			
6.	ADDRESS:	7. TYPE OF CONTRACT:			
		Cost Plus Fixed Fee/Hourly			
8.	DIRECT LABOR (Specify labor categories):	EST. HRS.	HOURLY RATE	EST. COST	TOTALS
	(if hourly employee add (H) after category)				
				$0.00	
				$0.00	
				$0.00	
				$0.00	
				$0.00	
				$0.00	
				$0.00	
				$0.00	
				$0.00	
				$0.00	
				$0.00	
	DIRECT LABOR TOTAL:	0			**$0.00**
9.	OTHER DIRECT COSTS	RATE	X BASE =	EST. COST	
	ODOT OVERHEAD RATE	**141.44%**	$0.00	$0.00	**$0.00**
10.	OTHER DIRECT COSTS			EST. COST	
	a. TRAVEL				
	Federal mileage rate	est. miles			
	Parking				
	SUBTOTAL:			$0.00	
	b. EQUIPMENT, MATERIALS, SUPPLIES			EST. COST	
	SUBTOTAL:			$0.00	
	c. SUBCONTRACTS			EST. COST	
	SUBCONTRACTS SUBTOTAL:			$0.00	
	d. OTHER (Specify categories)			EST. COST	
	OTHER SUBTOTAL:			$0.00	
	e. COST OF MONEY			EST. COST	
	ODOT Rate (expressed as a percent)		$0.00	$0.00	
	f. OTHER DIRECT COSTS TOTAL:				**$0.00**
11.	TOTAL COST				**$0.00**
12.	FIXED FEE PERCENTAGE AMOUNT		FIXED FEE %:	**10.00%**	**$0.00**
	Current Average ODOT Overhead Rate (%)	**152.83%**			
13.	IF AUTHORIZED AMOUNT, if applicable				
14.	CONTINGENCY SERVICES CONTRACT AMOUNT (IF AUTHORIZED)				**$0.00**
15.	CONTRACT TOTAL				