

Connected Vehicle Pilot Deployment Program Phase 4

System Requirements Specification (SyRS) – WYDOT for C-V2X Conversion

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1	09/07/2016	ICF-Wyoming	First version of the SyRS document technically accepted by USDOT
2	10/31/2016	ICF-Wyoming	Updated version based on latest architecture and system design.
3	09/01/2017	WYDOT	Updated version based on latest architecture and system design.
4	10/31/2017	WYDOT	Updated version to include new performance requirements.
5	12/21/2017	WYDOT	Updated version based on latest architecture and system design.
7	02/16/2018	WYDOT	Updated version based on latest architecture and system design.
8	03/16/2018	WYDOT	Updated version with added requirements for testing.
9	05/11/2018	WYDOT	Updated version base on latest architecture and system design, which now includes the Hardware Security Module (HSM) and Secure Data Commons (SDC).
10	07/27/2020	WYDOT	Updated version to reflect the "As Built"
11	10/10/2022	WYDOT	Updated to support conversion from DSRC to C-V2X Phase 4

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16. Abstract The Wyoming Department of Transportation's (WYDOT) Connected Vehicle (CV) Pilot Deployment Program is intended to develop a suite of applications that utilize vehicle to infrastructure (V2I) and vehicle to vehicle (V2V) communication technology to reduce the impact of adverse weather on truck travel in the I-80 corridor. These applications support a flexible range of services from advisories, roadside alerts, parking notifications and dynamic travel guidance. Information from these applications are made available directly to the equipped fleets or through data connections to fleet management centers (who will then communicate it to their trucks using their own systems). The pilot will be conducted in three Phases. Phase I includes the planning for the CV pilot including the concept of operations development. Phase II is the design, development, and testing phase. Phase III includes a real-world demonstration of the applications developed as part of this pilot. This document presents the high-level Systems Requirement Specifications (SyRS) for the physical objects and applications identified in the Concept of Operations document. The SyRS provides testable requirements based on the user needs identified by the pilot site and will be used as the basis for system design activities. The SyRS also supports the pilot site's partnership and vendor selection process by setting clear expectations of various physical objects and applications that will be procured, integrated and demonstrated as part of the pilot. The 2020 revised version reflects the as built system at the end of CV Pilots Phase 3. This update reflects updating from DSRC to C-V2X and these requirements are updated to support this system.					
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1 Introduction

1.1 Purpose of the Document

This document is the System Requirements Specification (SyRS) of The Wyoming Connected Vehicle Pilot project for the United States Department of Transportation's (USDOT) connected vehicle program. This is document number: FHWA-JPO-16-291.

The SyRS is being updated in October 2022 to reflect converting the existing Wyoming Connected Vehicle project from DSRC to C-V2X technology. The conversion impacts requirements for the Wyoming CV system and its subsystems, namely the roadside units (RSUs), onboard units (OBUs), external interfaces, performance; and requirements traceability. Information reflecting as built changes that are no longer applicable will be marked with a "strikethrough", those requirements and features that will not be part of this Phase 4 effort will be marked with bolded text indicating that they are not part of Phase 4. In addition, components no longer part of the Wyoming CV Pilot Phase 4 are marked with  (see Figures 2-1 and 2-2).

1.2 Project Scope

Wyoming Department of Transportation (WYDOT) is one of the first wave of Connected Vehicle (CV) Pilot sites selected to showcase the value of and spur the adoption of Connected Vehicle Technology in the United States. Connected Vehicle Technology is a broad term to describe the applications and the systems that take advantage of dedicated short-range communications (DSRC) between vehicle to vehicle (V2V), vehicle to infrastructure (V2I) and infrastructure to vehicle (I2V) to improve safety, mobility and productivity of the users of the nation's transportation system. With Phase 4 the system is being updated to replace all the DSRC RSUs with C-V2X units. Approximately ten C-V2X OBUs are being added for testing.

As one of the three selected pilots, WYDOT is focusing on improving safety and mobility by creating new ways to communicate road and travel information to commercial truck drivers and fleet managers along the 402 miles of Interstate 80 (I-80 henceforth) in the State. For the pilot project, WYDOT worked in a planning phase through September 2016. The deployment process will happen in the second phase (ending in August 2020) followed by a 12-month demonstration period in the third phase. Phase 4 is a modification in cooperative agreement for 24-months (9/30/2022 till 9/30/2024) in support of replacing the DSRC RSUs with C-V2X and incorporating approximately ten C-V2X OBUs for testing. At a very high level, the pilot scope includes the following implementation elements:

- **Deployment of about 75 roadside units (RSU)** that can receive and broadcast messages using DSRC along various sections on I-80. With Phase 4 these all DSRC RSUs will be removed and replaced with C-V2X.
- **Equip around 400 vehicles, a combination of fleet vehicles and commercial trucks, with on-board units (OBU).** Of the 400 vehicles, at least 75 would be heavy trucks. All

vehicles are expected to be regular users of I-80. Several types of OBU are being procured as part of the pilot and differ based on their communication capabilities, ability to integrate with the in-vehicle network, and connectivity to ancillary devices and sensors. All OBUs will have the functionality to broadcast Basic Safety Messages (BSM) and will include a human-machine interface (HMI) to share alerts and advisories to drivers of these vehicles. With Phase 4 approximately ten C-V2X OBUs will be used in test vehicles. These OBUs will broadcast BSMs, enroll in the SCMS, include an HMI for driver alerts and advisories, and support logging of driver alerts. OBU support for Wi-Fi networking and satellite Traveler Information Message reception will be tested.

- **Develop several V2V and V2I (and I2V) applications** that will enable communication with drivers for alerts and advisories regarding various road conditions. These applications include support for in-vehicle dissemination of advisories for collision avoidance, speed management, detours, parking, and presence of work zones and maintenance and emergency vehicles downstream of their current location.
- **Enable overall improvements in WYDOT's traffic management and traveler information practices** by using data collected from connected vehicles. Targeted improvements include better activation of variable speed limits (VSL) and improved road condition dissemination via 511, Dynamic Message Signs (DMS) and other WYDOT sources.

Systems and applications developed in the pilot will enable drivers of connected vehicles to have awareness of hazards and situations they cannot even see. The CV Pilot is considered a System of Systems, with two systems of interest: The *Vehicle System* and the *Wyoming CV System*, see Figure 1-1. The *Vehicle System* includes four Sub-Systems that represent the various vehicle and equipment types to be used in the pilot. These Sub-Systems vary in their data collection and sharing capabilities. The *Wyoming CV System* includes the infrastructure used in the pilot and back-office systems capable of various processes that lead to the generation and distribution of advisories and alerts. Together, the *Vehicle* and *Wyoming CV Systems* support a variety of V2V and V2I applications. Both systems interface with external systems, including WYDOT, USDOT and the National Weather Service (NWS). Phase 4 will drop support for the USDOT (Research Data Exchange, Secure Data Commons) and NWS (to include Pikalert) connections.

The CV Pilot Project will, at its core, provide key information to the drivers through five on-board applications: i) Forward Collision Warning (FCW); ii) I2V Situational Awareness (SA); iii) Distress Notification (DN); iv) Work Zone Warning (WZW); and v) Spot Weather Impact Warning (SWIW). In addition, the CV Pilot project will support overall traffic management and traveler information services offered by WYDOT. Phase 4 will drop support for Distress Notification.

Through these applications and functions, WYDOT hopes to improve operations on the corridor especially during periods of adverse weather and when work zones are present. By means of the anticipated outcomes of the pilot, fleet managers will be able to make better decisions regarding their freight operations on I-80, truckers will be made aware of downstream conditions and provided guidance on parking options as they travel the corridor, and automobile travelers will receive improved road condition and incident information through various existing, improved and new information outlets.

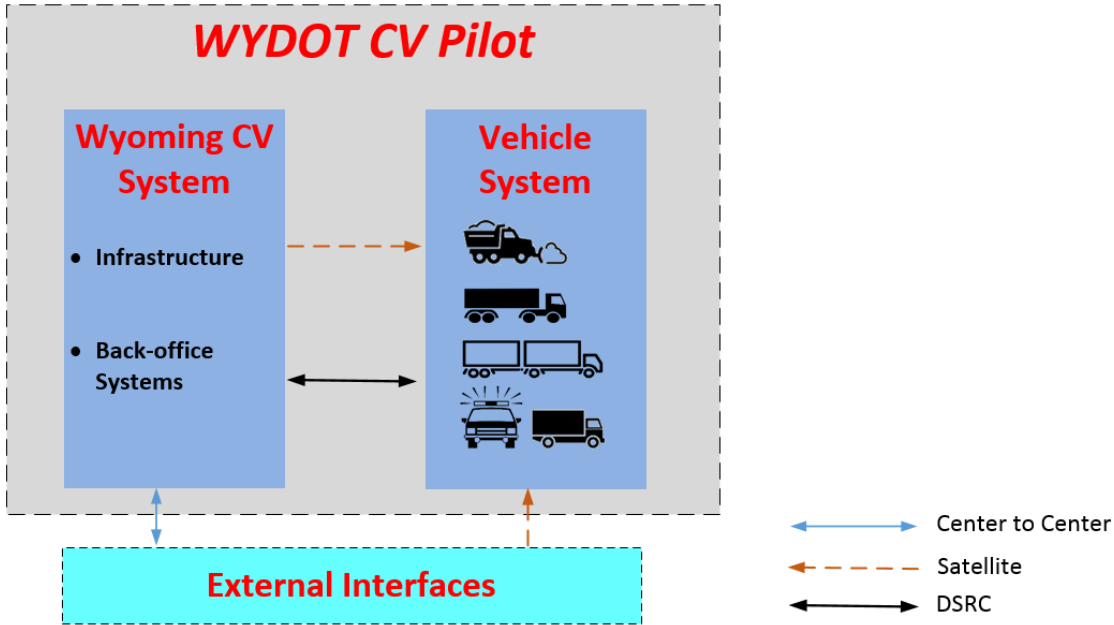


Figure 1-1 Wyoming CV Pilot System of Systems.
Source: WYDOT

1.3 Definition, Acronyms, and Abbreviations

Table 1-1 Glossary of Terms.

Term	Definition
Advanced Automatic Crash Notification Relay	An application that provides the capability for a vehicle to automatically transmit an emergency message when the vehicle has been involved in a crash or other distress situation.
Basic Safety Message	<p>Connected V2V safety applications are built around the SAE J2735 BSM, which has two parts.</p> <p>BSM Part I:</p> <ul style="list-style-type: none"> Contains the core data elements (vehicle size, position, speed, heading, acceleration). Transmitted approximately 10x per second. <p>BSM Part II:</p> <ul style="list-style-type: none"> Added to Part I depending upon events (e.g., ABS activated). Contains a variable set of data elements drawn from many optional data elements (availability by vehicle model varies). Transmitted less frequently <p>The BSM is transmitted over DSRC (range of between at least 2 and 300 meters). The BSM is tailored for low latency, localized broadcast required by V2V safety applications, Phase 4 will drop support for DSRC and add support for C-V2X</p>
Broadcast	Sharing data with no specific destination. All broadcasted data is sent unencrypted but is signed with a certificate (based on 1609.2).

1. Introduction

Term	Definition
Commercial Vehicle Operator Portal	Provides forecasted road condition information on common commercial vehicle routes.
Freight-Specific Dynamic Travel Planning	An application that provides both pre-trip and enroute travel planning, routing, and commercial vehicle related traveler information, which includes information such as truck parking locations and current status.
Host Vehicle	A connected vehicle that receives messages from a remote vehicle. In this document, the host vehicle is also used to describe the originator of a vehicular transmission of information to the RSU.
Data Ingest	Obtaining and importing data for use or storage.
Mandatory Requirements	Minimum set of information necessary to accomplish one action/requirement.
Receive Data	A connected device accepts a data package broadcasted or transmitted by another connected device.
Remote Vehicle	A connected vehicle that periodically and dynamically broadcasts a message about its general situation to a host vehicle.
Road Weather Information for Freight Carriers	An application that is a special case of the Road Weather Advisories and Warnings for Motorists application focuses on Freight Carrier users.
WYDOT Road Segment	A road segment is defined as a link in TMDD v3.03c as Link: A link is defined as a roadway or transit right-of-way between two nodes. WYDOT has implemented road segments to fully cover I-80 in each direction.
Segment Alert	TIMs that provide information related to Weather, Road Condition, Construction, Incident and Truck Parking, or a combination of, that is linked to a specific spatial area that is describe following Section 6.30 Data Frame: DF_GeographicalPath of J2735.
Situational Awareness	An application that determines if the road conditions measured by other vehicles represent a potential safety hazard for the vehicle containing the application.
Spot Weather Impact Warning	An application that will alert drivers to unsafe conditions or road closure at specific points on the downstream roadway as a result of weather-related impacts.
Transmit	Sharing data directed to a specific receiver. In the case of transmission between Systems, all transmitted data is signed and encrypted where required based on 2945/1.
Transportation Management Center	Center that collects information and informs the public about changing travel conditions.
Warnings about Upcoming Work Zone	An application that provides information about the conditions that exist in a work zone to vehicles that are approaching the work zone.
WGS-84	Latest revision of the standard for use in cartography, geodesy, and navigation including by GPS.
Yaw rate	Angular velocity of rotation or rate of change of heading angle when horizontal.

Table 1-2. Acronym List.

Acronym/Abbreviation	Definition
ABS	Anti-lock Braking System
BSM	Basic Safety Message
DB	Data Broker
DNM	Distress Notification Message
DW	Data Warehouse
CA and ConAdmin	Construction Administration
CAN bus	Controller Area Network bus
ConOps	Concept of Operations
CV	Connected Vehicle
CVOP	Commercial vehicle operator portal
DMS	Dynamic Message Signs
DSRC	Dedicated Short Range Communications
FHWA	Federal Highway Administration
HAR	Highway Advisory Radio
HMI	Human Machine Interface
HSM	Hardware Security Module
I-80	Interstate 80
IC	Incident Console
IEEE	Institute of Electrical and Electronics Engineers
ISP	Information Service Provider
ITS	Intelligent Transportation System
LTS	Location and Time Service
NWS	National Weather Service
OBU	On-board Unit. This represents the package of DSRC radios, computing, sensors and human-machine interface that will be installed on a vehicle. This is similar to the Retrofit Safety Devices (RSD) used in the Safety Pilot Program.
ODE	Operational Data Environment
OTA	Over the Air
PA	Pikalert System
PSID	Provider Service Identifier
RCRS	Road Condition Reporting System
RF	Radio Frequency
RDE	Research Data Exchange
RSU	Roadside Unit. This represents the package of DSRC radios, computing, communications that will be installed on the roadside on I-80
RWIS	Road Weather Information System
SCMS	Security Credential Management System
SCP	Secure Copy
SDC	Secure Data Commons
SDX	Situation Data Exchange
SHH	Secure Shell
TIM	Traveler Information Message

Acronym/Abbreviation	Definition
TMC	Transportation Management Center
TPI	Third-Party Information Service Providers
TRAC	Transportation Reports and Action Console
V2I	Vehicle to infrastructure
V2V	Vehicle to vehicle
VSL	Variable Speed Limit
WHP	Wyoming Highway Patrol
WYDOT	Wyoming Department of Transportation
WTI	Wyoming Traveler Information system

1.4 References

The following table lists the documents, sources and tools used to develop the concepts in this document.

Table 1-3. References.

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31	Campbell, J. L., L., B. J., Graving, J. S., Richard, C. M., Lichty, M. G., Sanquist, T., . . . Morgan, J. L. (2016). <i>Human Factors Design Guidance for Driver-Vehicle Interfaces (Report No. DOT HS 812 360)</i> . Washington, DC: National Highway Traffic Safety Administration.

#	Documents, Sources Referenced
32	Kusano, K., & Gabler, H. (2011). <i>Method for Estimating Time to Collision at Braking in Real-World, Lead Vehicle Stopped Rear-End Crashes for Use in Pre-Crash System Design</i> . SAE International.
33	Fred Kitchener, et al. (2017). <i>Connected Vehicle Pilot Deployment Program Phase 2, Data Management Plan – Wyoming</i> . U.S Department of Transportation

1.5 Document Overview

This document follows the sequential logic illustrated in Figure 1-2. An example is also provided to illustrate how identified User Needs drove the development of the requirements at the System, Interface and Sub-System level—in other words, how a detailed Sub-System Requirement can be traced back to a particular User Need.

The remainder of this document is organized as follows:

- Section 2 provides a general description of the system, explaining the different systems of interest, their capabilities and applications that will be developed through this pilot project.
- Section 3 details the requirements with external interfaces to the systems of interest.
- Section 4 details the System level requirements for the CV Pilot Systems.
- Section 5 details the Sub-System level requirements for the CV Pilot Sub-Systems.
- Section 6 details the performance requirements for the different Sub-systems.
- Section 7 provides the traceability of the different components of the system of systems to the user needs.
- Appendices A and B lists the requirements for the OBU and RSU, respectively.

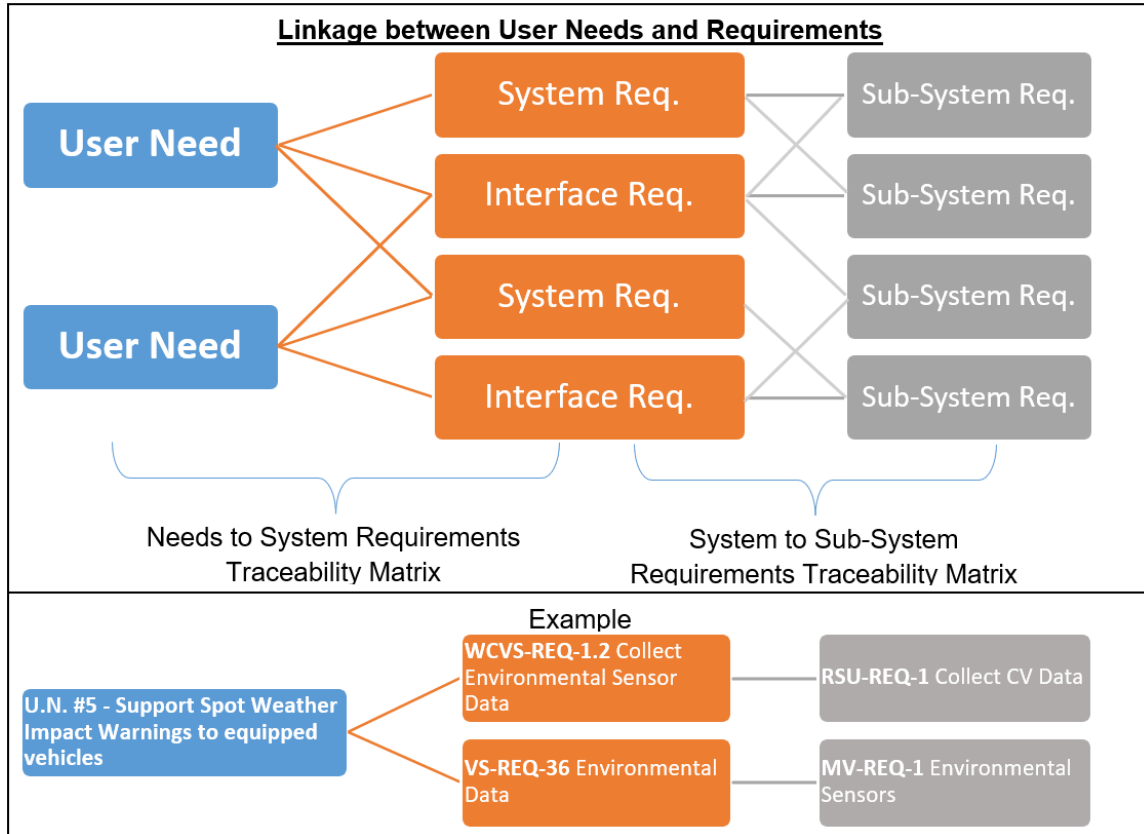


Figure 1-2. Illustration of the Sequential Logic of the System Requirements.

Source: WYDOT

2 General System Description

2.1 System Context

This project will develop systems that make relevant information directly available to, and shared among, equipped fleets. Information is also shared through linkages with fleet management centers (who will then communicate it to their trucks using their own communication systems) and other external agencies and partners.

Supporting the applications and the CV environment of roadside, vehicle and back-office infrastructure are core services that allow safe, secure, reliable operations of the system. The main project objectives of the pilot to be accomplished and demonstrated are as follows:

- Deploy and operate a set of vehicles that are equipped with on-board units (OBU) with DSRC connectivity. These vehicles will be a combination of snowplows, fleet vehicles, emergency vehicles and private trucks that will broadcast a basic safety message, collect vehicle, weather and road condition data, and provide it remotely to the WYDOT Transportation Management Center. These vehicles will also receive in-vehicle alerts through the infrastructure and wirelessly from various applications developed as part of the pilot through a human-machine interface (HMI). **Phase 4 will migrate connectivity from DSRC to C-V2X and leverage approximately ten test vehicles. Phase 4 will not include the collection of weather data from vehicles.**
- Deploy roadside units (RSUs) with DSRC connectivity that are able to transmit advisories and alerts to equipped vehicles along I-80. **Phase 4 will migrate all DSRC RSUs to C-V2X RSUs.**
- Leverage the data provided from the equipped vehicles to develop and demonstrate a suite of V2V and V2I applications. As part of the pilot, several applications will be developed to support wide-area travel advisories, variable speed limit postings, forecast road condition information, spot-specific warnings, work zones, distress notifications, and parking notifications. **Phase 4 will drop support for forecast road condition information and distress notification.**

A detailed explanation of the Wyoming CV Pilot project can be found in *Connected Vehicle Pilot Deployment Program Phase I, Concept of Operations (ConOps)* (Gopalakrishna, et al., 2015). The context diagram shown in Figure 1-1 highlights the different communication types between the systems of interest, which will be through WYDOT-owned telecom (such as WYDOT's communication backhaul or WYOLINK radio system) or other remote telecommunications (cellular or satellite) shown in the figure.

2.2 System Capabilities

This section describes functions to be performed by the *Vehicle System* and the *Wyoming CV System*. The *Vehicle System* will perform eight functions:

2. General System Description

1. Collect CV Data – Connected vehicles wirelessly receive BSMs from other connected vehicles.
2. Collect TIMs – Wirelessly receives packets containing traveler information from the *Wyoming CV System* and distress information from other connected vehicles. Phase 4 will drop support for distress information.
3. Manage and Process Information for Applications – Manages and processes information for the five on-board applications.
4. Provide In-Vehicle Application Alerts – Provides prioritized alerts and advisories for the Vehicle Operator.
5. Broadcast Vehicle Data – Broadcasts, at a predefined rate, vehicle information (BSMs and DNs) to other connected devices and to the *Wyoming CV System*. Phase 4 will drop support for DNs.
6. Transmit Environmental and Log Data – Transmits environmental data and management logs to the *Wyoming CV System*. Phase 4 will drop support for environmental log transmissions.
7. Store Data – Locally stores selected data collected and generated (both from the field and the applications) until they are transferred to the *Wyoming CV System*.
8. OBU Management – Logs availability and operational capability, including validating and obtaining certificates, time and location accuracy, logging system information, and routine wellness check.

The *Wyoming CV System* performs six functions:

1. Collect CV Information – Collects data from the *Vehicle System*. Data collected includes BSMs, event logs, weather sensor data, and distress messages. Phase 4 drops support for weather sensor and distress message collection.
2. Generate Road Weather Alerts and Advisories – Generates segment-level advisories and alerts of both current and forecast road and weather conditions based on customizable thresholds. Phase 4 drop segment-level advisories and alerts for current and forecast road and weather conditions.
3. Support Information Brokerage – Distributes Road Weather Alerts and Advisories to the WYDOT's interfaces.
4. Distribute TIMs – Distributes the TIM to the *Vehicle System* and the Situation Data Exchange (SDX).
5. Store Data – Data generated are stored by the system.
6. Manage and Maintain System – The WYDOT Maintenance team monitors the system for availability and operational capabilities.

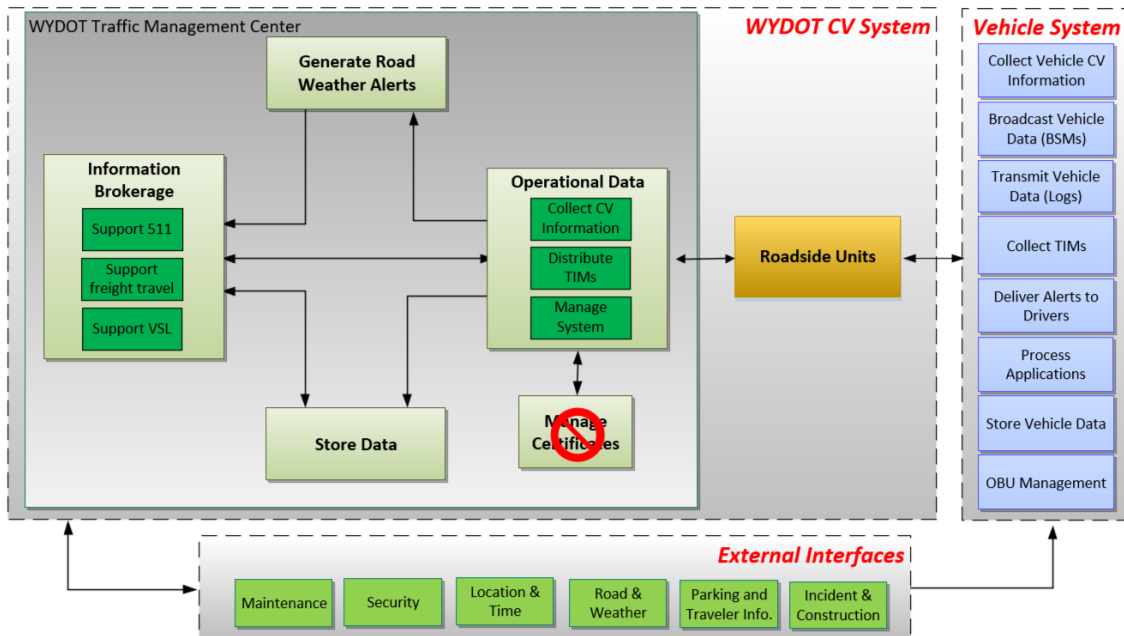
In addition to on-board vehicle applications, information generated by the *Wyoming CV System* is expected to be used to support WYDOT traffic management and traveler information. WYDOT expects to use the information from the pilot for the following purposes:

- **Setting and removing VSL along the I-80 corridor** – VSLs will be managed through the Wyoming Traveler Information (WTI) interface. When segment-level alerts and advisories are received from the *Wyoming CV System* in WTI, the TMC operator will have the option to reduce speed according to the normal operation protocols. Similarly, when speed limits are reduced due to information available from the TMC, this information will be communicated with the *Wyoming CV System* and shared as part of

the TIM. The VSL zones utilize changeable yet enforceable speed limits in 143 miles along four (4) segments – 23 miles around Evanston, 25 miles around Green River, 57 miles along Elk Mountain and 47 miles between Cheyenne and Laramie.

- **Supporting 511 and other traveler information** – Road weather collected by the Wyoming CV System will be ingested into and processed by the Pikalert system for dissemination to the public. In addition, incident information collected by the CV system will be used to directly update the WTI. The WTI system, upon database saves, has the integrated logic to automatically update the 511 systems (web, phone, email/text messages, app) in near real time. Phase 4 will drop support for road weather collection by the Wyoming CV System and Pikalert.
- **Supporting road weather advisories and freight-specific travel guidance through CVOP** – Information from the *Wyoming CV System* will update the CVOP system to provide freight-specific information to subscribed fleet partners. Currently, more than 800 firms subscribe to CVOP.

The functional architecture view describes the abstract functional elements or processes and their logical interactions via data flows that satisfy the system requirements. Figure 2-1 depicts the functional diagram of the Systems of Interest along with the external interfaces that interact with the CV Systems. Section 2.4 describes in more detail the internal and external interactions of each system.



NOTE ⓧ shows items not part of Phase 4.

Figure 2-1. Functions of the Wyoming CV System and the Vehicle System.

Source: WYDOT

2.3 Wyoming System

The *Wyoming CV System* includes the infrastructure used in the pilot and the back-office systems in charge of the various processes that lead to the generation and distribution of advisories and alerts for CV Pilot vehicles. The *Wyoming CV System* is located at the WYDOT TMC. Additionally, this system provides external interfaces to share the advisories and alerts with the public and commercial vehicle operators.

The *Wyoming CV System* is composed of six Sub-Systems:

- Roadside Units (RSU)
- Operational Data Environment (ODE)
- Hardware Security Module (HSM) – with Phase 4 this is dropped from the Wyoming CV System and picked up with the cloud Integrated Security Services SCMS offering and called the TMC Authority (TMCA).
- Pikalert System – no longer used with Phase 4
- Data Broker (DB)
- Data Warehouse (DW)

2.3.1 Roadside Units

This Sub-System describes the physical units for deployment as part of the system along I-80. RSUs include DSRC connectivity, application support, data storage, and other support services to enable CV applications, such as necessary certificates. WYDOT RSUs can be either fixed or portable equipment depending on the use. In general, RSUs serve as a two-way communication portal between connected vehicles that provide information through DSRC and the ODE. About 75 RSUs are planned to be deployed in the pilot. **With Phase 4 DSRC will be migrated to C-V2X.**

2.3.2 Operational Data Environment

The WYDOT ODE Sub-System receives information collected with connected devices, checks its quality, and then shares it with other Sub-Systems in charge of analyzing and distributing the information. The ODE also exports data to the SDX for USDOT-related activities. The ODE will be hosted at WYDOT TMC and uses the same codebase as the USDOT ODE. High-level requirements for the ODE are contained within the *ODE ConOps from the Southeast Michigan Test Bed Advanced Data Capture Field Testing*. These include requirements for Validation, Integration, Sanitization, and Aggregation (VISA), which are combined in this document with the description of ODE processed data.

2.3.3 Hardware Security Module

The Wyoming CV Pilot uses the IIS/GHS¹ rented, black box hardware security module (HSM) in the Cheyenne TMC. In essence, the HSM will manage the Wyoming CV System's certifications. It has a Representational State Transfer (RESTful)² endpoint that receives an unsigned TIM and outputs a signed TIM. The HSM also has a link to the ISS/GHS Certificate Management System

¹ IIS/GHS is the company hosting the pilot's certificate management system (i.e., INTEGRITY Software Services/Green Hills Software).

² https://en.wikipedia.org/wiki/Representational_state_transfer

(CMS) to get updated certifications. It should be noted that its internal workings are a black box that is proprietary code, and therefore WYDOT will not have access to it. WYDOT will physically have two 1U rack³ units that each have dual power supplies and are fail over in capability. The units also have a gig Ethernet connection with IPv4 and IPv6. **With Phase 4 the onsite HSMS will be returned and the cloud hosted Transportation Management Center Authority (TMCA) from ISS will be used.**

2.3.4 Pikalert System

The Pikalert System supports the integration and fusion of CV and non-CV weather data to develop alerts and advisories regarding adverse weather conditions along I-80. CV data are received from the ODE, while non-CV data derive from weather sources and the WYDOT DB. To generate the alerts and advisories, the Pikalert System assigns CV and non-CV data to 1-mile segments on I80 every 5 minutes. The CV data is quality checked, then passed to the Road Weather Hazard module (RWH). The RWH uses these data to produce the alerts and advisories for adverse weather and for a 72-hour forecast of road weather conditions and hazards. The generated information is then shared with the DB for further distribution. **With Phase 4 Pikalert will not be used.**

2.3.5 WYDOT Data Broker

WYDOT DB receives information from the ODE, Pikalert and some external systems, analyzes them, and shares them with the corresponding system or service including other sources. The DB supports the information brokerage of road weather alerts and advisories to WYDOT's Third-Party Interface (TPI) through the data warehouse, TRAC, WTI, Road Condition Reporting System (RCRS), and CVOP. Additionally, this system takes in incident information from the Incident Console (IC), work zone data from the Construction Administrator and parking availability information from the 511 Application. The DB also sends the information back to the ODE to support the dissemination of TIM to the RSUs and can also access historical data stored at the DW if needed. **With Phase 4 Pikalert and the WYDOT Third-Party Interface (TPI) will no longer be used.**

2.3.6 WYDOT Data Warehouse

The WYDOT DW stores various TMC and CV related data. The DW includes timestamped and geotagged logs of CV and non-CV data—information collected, generated and shared within the *Wyoming CV System*—that will be used for performance measurement. **Phase 4 will not include performance measures.**

2.4 Wyoming CV System External Interfaces

Figure 2-2 shows the physical architecture with interfaces numbered for reference and discussion here and in following sections. The Wyoming CV System includes the following external interfaces for exchanging data and information with external WYDOT and USDOT systems.

- **I2V DSRC Communications Interface** (Interface WE1 and VE1) Wireless DSRC interface provides communication between Wyoming CV System and Vehicle System

³ Rack height unit 1.75" (https://en.wikipedia.org/wiki/Rack_unit)

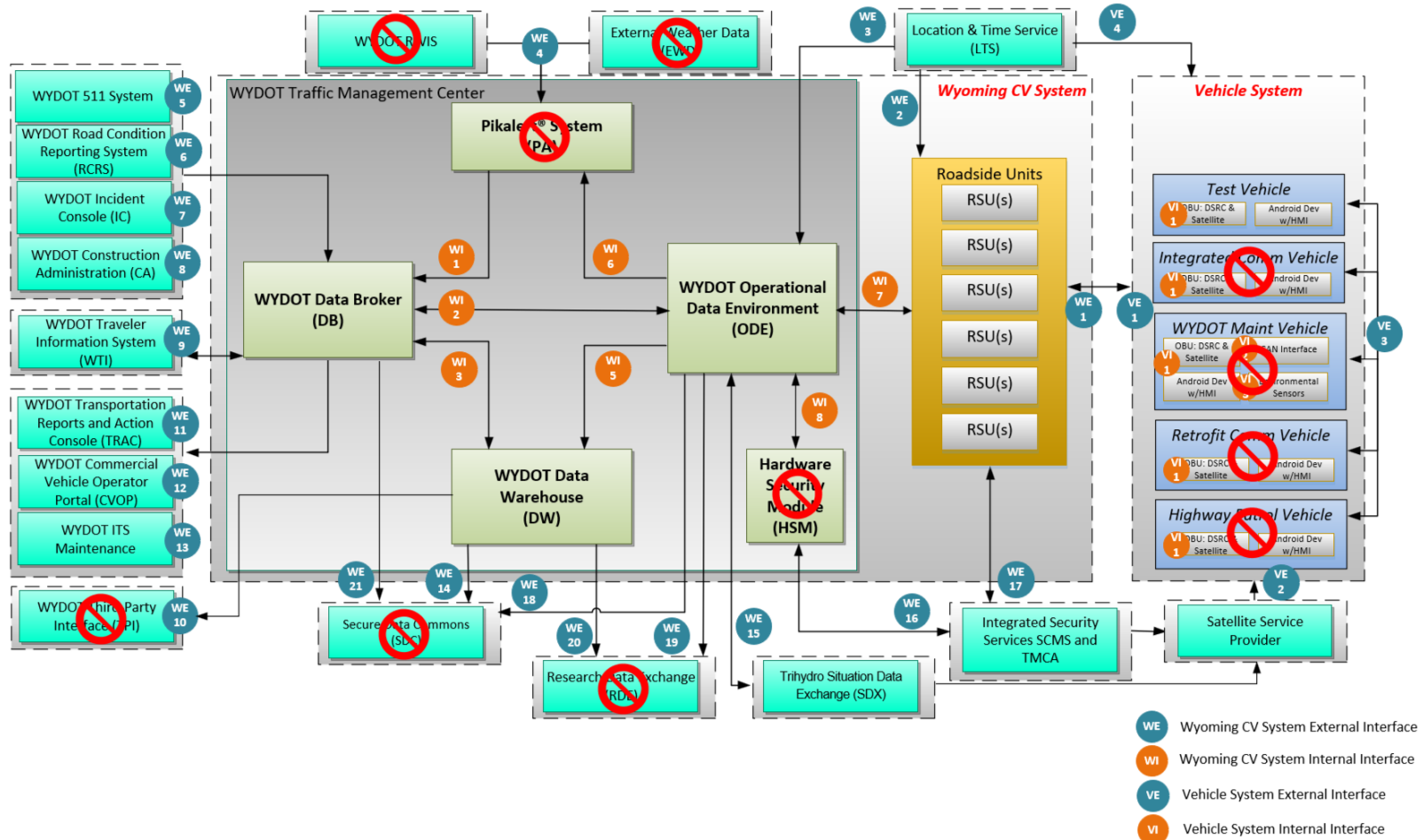
through exchange of messages conforming to SAE J2735 and SAE J2945/1. **With Phase 4 DSRC will be replaced with C-V2X.**

- **Location and Time Service (LTS)** (Interfaces WE2 and WE 3) – Provides location and time information, which is later used to geotag and timestamp all information produced by the systems of interest.⁴
- **EWD and RWIS** (Interface WE4) – EWD provides regional weather data shared through data sources outside of WYDOT, such as the National Oceanic and Atmospheric Administration’s Meteorological Assimilation Data Ingest System and USDOT. RWIS provides atmospheric and pavement condition information collected through Environmental Sensor Stations (ESS) deployed as part of the WYDOT RWIS network in the field. **Phase 4 will remove EWD and RWIS support.**
- **WYDOT 511 Application** (Interface WE5) – Provides information to the public regarding I-80’s road weather and traffic conditions (e.g., road closure). The application is currently being updated to also share crowdsourced truck parking information with the CV Pilot.
- **WYDOT RCRS** (Interface WE6) – An Android tablet-based application that resides in WYDOT snowplows which enables field personnel (e.g., snowplow operators) to report weather and roadway pavement conditions following WYDOT’s 8 Code (roadway condition), 9 Code (atmospheric) and 10 Code (other road condition) system.
- **WYDOT IC** (Interface WE7) – Provides timestamped and geotagged incident information on incidents along I-80 obtained from the WHP and other sources (e.g., maintenance).
- **WYDOT Construction Administration (CA)** (Interface WE8) – Provides timestamped and geotagged information of WYDOT’s scheduled and unscheduled work-zone activities along I-80.
- **WTI** (Interface WE9) – Supports traveler information services to the public and to fleet management centers via various means (website, 511, 511 App, text, email, and alerts).
- **WYDOT TPI** (Interface WE10) – A standardized interface based on the TMDD standard that can be used to support delivery of traveler information to external centers and information service providers.
- **WYDOT TRAC** (Interface WE11) – An operator console used in the TMC to monitor and manage planned, ongoing, and forecast events and actions on facilities monitored by the TMC. The TRAC provides a tabular list of currently ongoing events that require operator attention. These events may be entered manually and can be reported based on other systems like RCRS, radio communications with field personnel and citizen reports.
- **WYDOT CVOP** (Interface WE12) – A subscription-based website created by WYDOT for providing advanced notification of forecasted conditions to commercial travelers and fleet managers. Currently there are over 800 companies subscribed to the CVOP. As part of the CV Pilot System, the CVOP will be enhanced to include current weather information for segments on I-80.
- **WYDOT ITS Maintenance** (Interface WE13) – Provides a mechanism to report service outages and resumption of services of WYDOT’s ITS equipment.
- **Secure Data Commons (SDC) / Research Data Exchange (RDE)** (Interfaces WE14, WE18, WE19, WE20, and WE21) – Provides WYDOT CV Pilot data to the independent

⁴ The location is obtained from a GPS using WGS-84 coordinates system, and time is provided using UTC from GPS time.

- evaluators and the RDE for use in independent analysis and impact evaluation across multiple CV pilots. **Phase 4 will drop support for the SDC and RDE.**
- **Trihydro Situation Data Exchange (SDX)** (Interface WE15) – A service based on the original USDOT Situation Data Warehouse (SDW), operated by Trihydro that stores near real-time data and shares them with the remote users and developers for further distribution. As shown, this interface also supports communication of messages through **Satellite Service Provider (SSP)** satellites, allowing the system to transmit traveler-related information.
 - **USDOT SCMS** (Interfaces WE16 and WE17) – Generates security certificates to manage messages securely from connected devices. As shown, this interface also supports communication of messages through **SSP** satellites, allowing the system to SCMS-related information. **Phase 4 will use the ISS SCMS.**

2. General System Description




NOTE: The Wyoming CV System Interface WI4 (PA→DW) and VI2 (OBU-CAN Bus) were not implemented in the final system design.  shows items not part of Phase 4

Figure 2-2. Physical View of WYDOT CV Pilot System Architecture with Numbered Interfaces.

Source: WYDOT

2.5 Vehicle System

The *Vehicle System* represents the deployment of on-board equipment, sensors, and an HMI that will support CV applications. All vehicles that are part of the *Vehicle System* will have the following core capabilities:

- Ability to share and receive information via DSRC communication from other connected devices (vehicles and RSUs). With Phase 4 DSRC will be migrated to C-V2X.
- Ability to broadcast BSM.
- An HMI that allows alerts and advisories to be communicated with the driver.

Additionally, several vehicles that are part of the *Vehicle System* have further capability. Based on this, the *Vehicle System* is divided into four Sub-Systems, which define the various vehicle types for this pilot based on their data collection, communication capabilities and fleet/vehicle type. Each Sub-System and its rationale are described below.

2.5.1 WYDOT Maintenance Vehicles

This Sub-System represents the maintenance fleets operated by WYDOT. This includes, but is not limited to, snowplow vehicles assigned to the I-80 corridor. These vehicles represent a set of vehicles over which WYDOT has full control as part of their operations. As such, some of the vehicles will be equipped with the full package of environmental sensors and equipment necessary to support the CV Pilot applications.

Around 60 vehicles are expected to be part of this sub-system, but not all with the same capabilities. All vehicles will have the ability to:

- Receive TIMs via DSRC and Satellite.
- Broadcast BSM Parts I and II.

Whereas 50 of them are expected to be able to:

- Collect weather sensor data.

While vehicles within this subsystem will have the capability to integrate its network via a Controller Area Network (CAN bus) connection, no vehicle within this subsystem will provide Can Bus integration in this pilot.

WYDOT Maintenance Vehicles will not be part of Phase 4.

2.5.2 WYDOT Highway Patrol Vehicles

This Sub-system represents the highway patrol fleet assigned to the I-80 corridor. While also operated by WYDOT, these vehicles represent a set over which WYDOT has less flexibility given the nature of their operations. Around 50 highway patrol vehicles are expected to be part of this sub-system, which will have the ability to:

- Receive TIMs via DSRC and Satellite.
- Broadcast BSM Parts I and II.

WYDOT Highway Patrol Vehicles will not be part of Phase 4.

2.5.3 Integrated Commercial Vehicles

This connected trucks Sub-System represents a subset of commercial trucks owned and operated by fleet partners involved in the pilot. Similar to Highway Patrol Vehicles, no external weather sensor data will be collected from these systems (i.e., only data from the vehicle) and there is no CAN Bus integration. To summarize, this Sub-system will include the abilities to:

- Receive TIMs via DSRC and Satellite (or other remote communication methods).
- Broadcast BSM Parts I and II.

In essence, these vehicles represent the capability to use vehicle data collected from trucks in the pilot. WYDOT anticipates that about 200 trucks will have these functionalities.

Integrated Commercial Vehicles will not be part of Phase 4.

2.5.4 Retrofit Commercial Vehicle

This Sub-system is intended to simulate a commercial-off-the-shelf system—which is different from the one installed on the integrated commercial vehicles—that enables a vehicle to communicate data through DSRC to other connected devices and receive TIMs through DSRC or satellite. About 50 vehicles are expected in this category and their abilities include:

- Receive TIMs via DSRC and Satellite (or other remote communication methods).
- Broadcast BSM Parts I and II.

Retrofit Commercial Vehicles will not be part of Phase 4.

Test Vehicles

This Sub-system is intended to test the C-V2X system with Phase 4. It will communicate with C-V2X to other vehicles and RSUs. They will also be used to test satellite reception of TIMs. About 10 vehicles are expected in this category and their abilities include:

- Receive TIMs via C-V2X and test satellite (or other remote communication methods).
- Broadcast BSM Parts I and II.

2.6 Pilot On-Board Applications

The WYDOT CV Pilot will develop five on-board applications that will provide key information to the drivers of equipped vehicles. In addition to on-board applications, information generated by the *Wyoming CV System* is planned to support ongoing WYDOT traffic management and traveler information services. WYDOT expects to use the information from the pilot for:

- Setting and removing VSLs along the I-80 corridor.
- Supporting 511 and other traveler information.
- Supporting road weather advisories and freight-specific travel guidance through WYDOT's CVOP.

The following subsections provide a view of the applications to be developed as for this Pilot.

2.6.1 Forward Collision Warning (FCW)

FCW is a V2V communication-based safety feature that issues a warning to the driver of the connected host vehicle in case of an impending front-end collision with a connected vehicle ahead in traffic in the same lane and direction of travel on both straight and curved geometry roadways as illustrated in Figure 2-3. FCW will help drivers avoid or mitigate front-to-rear vehicle collisions in the forward path of travel. This application is critically important for safety along I-80 in conditions when snowplows are moving slower than following traffic and/or when visibility may be limited due to adverse weather. The application does not attempt to control the host vehicle to avoid an impending collision. This application will follow the description from standard SAE J2945/1 March 2016 Section 4.2.4.

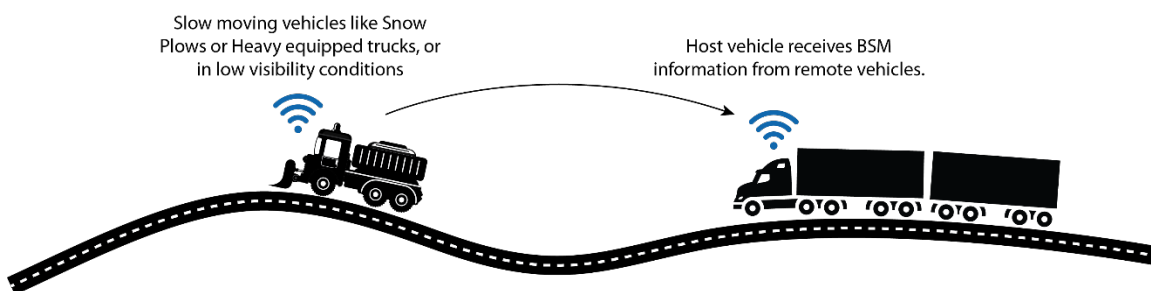


Figure 2-3. Forward Collision Warning Concept Diagram.

Source: WYDOT

2.6.2 Infrastructure-to-Vehicle (I2V) Situational Awareness

One of the important promises of Connected Vehicle technology is the delivery of up-to-date travel information to drivers that impact their safety and mobility. The WYDOT CV Pilot will implement an I2V Situational Awareness application that assembles important travel information from back-office systems and communications that directly to drivers through both DSRC and satellite communications. This application enables delivery of relevant downstream road condition information to drivers along I-80 in Wyoming, including: Weather alerts, Speed restrictions, Vehicle restrictions, Road conditions, Incidents ahead, Truck parking⁵, and Road closures.

This information is expected to enhance both safety and traveler mobility along the corridor. The generic application is illustrated in Figure 2-4. It should be noted that the 402 miles of Wyoming I-80 is too long to provide cost effective DSRC communications coverage. Accordingly, the WYDOT CV Pilot will implement satellite-based communications to send situational awareness road condition information directly to satellite enabled connected vehicles along the entire length of Wyoming I-80, when out of range of DSRC communications. This application will follow the description from SAE J3067 August 2014 Section 2.9.3.6.

Phase 4 will migrate DSRC to C-V2X and will test satellite-based communications.

⁵ As part of this project, the WYDOT CV Pilot team will update the WYDOT 511 Application for personal information devices (e.g., smartphones) to capture crowdsourced truck parking information and to share that with commercial vehicle drivers, particularly during inclement road weather conditions

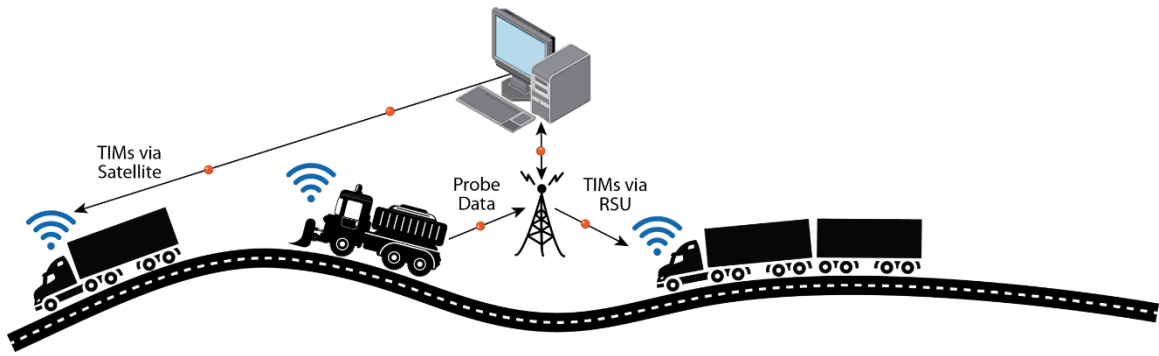


Figure 2-4. I2V Situational Awareness Concept Diagram.
 Source: WYDOT

2.6.3 Distress Notification (DN)

This application enables connected vehicles to communicate a distress status back to Wyoming CV System when the vehicle’s sensors detect an event that might require assistance from others (e.g., air bag deployed, vehicle disabled) or the vehicle’s operator manually initiates a distress status. The vehicle generates and broadcasts a DN (e.g., Mayday) to the nearest RSU. The DN will include the location, time of message, distress message explanation, and vehicle category. The RSU forwards it on to the *Wyoming CV System* for notification of system operators and first responders.

Recognizing that this CV Pilot cannot provide continuous coverage of I-80 by RSUs, this application includes a V2V relay of DNs, illustrated in Figure 2-5. When a distressed vehicle (#1) is not within communication range of an RSU, the message is received by nearby connected vehicles (#2) traveling in the same and/or in opposite directions. These vehicles relay the Notification to the nearest RSU, whether upstream or downstream, which forwards it on to the *Wyoming CV System*. The relay function also enables vehicles traveling the opposite direction (#2), to inform vehicles upstream (#3), traveling in the same direction as the distressed vehicle, of the need for caution ahead.

Although this application is loosely based on the Mayday application description from SAE J3067 Section 3.5.9.2.1, it is built on a higher priority TIM communication using SAE J2735 March 2016, Section 5.16, Part 3, Integrated Transport Information System (ITIS) advisory elements.

Phase 4 drops supports for Distress Notification.

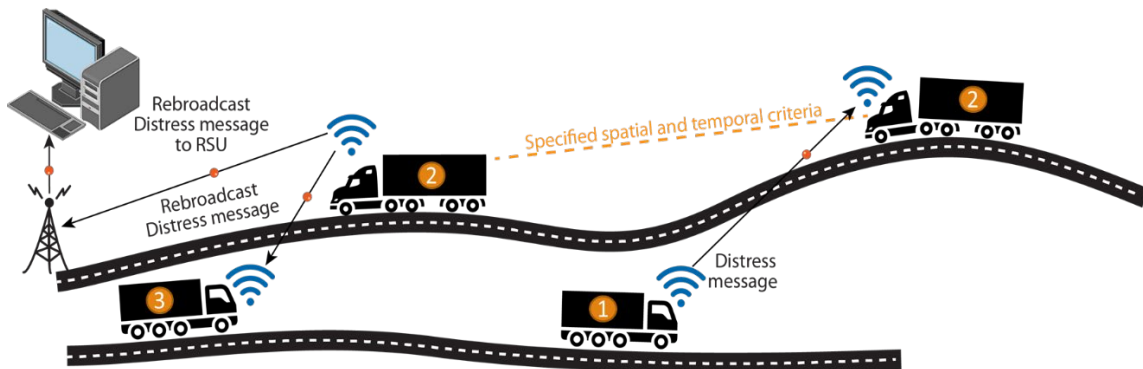


Figure 2-5. Distress Notification concept diagram.
 Source: WYDOT

2.6.4 Work Zone Warning (WZW)

The WZW Application provides information about the conditions that exist in a work zone which the host vehicle is approaching (illustrated in Figure 26). This capability provides approaching vehicles with information about work zone activities that could present unsafe conditions for the workers or the host vehicle, such as obstructions in the vehicle’s travel lane, lane closures, lane shifts, speed reductions or vehicles entering/exiting the work zone. This application will follow the TIM WZW described in SAE J2735 March 2020 Part 3 in Section 6.142.

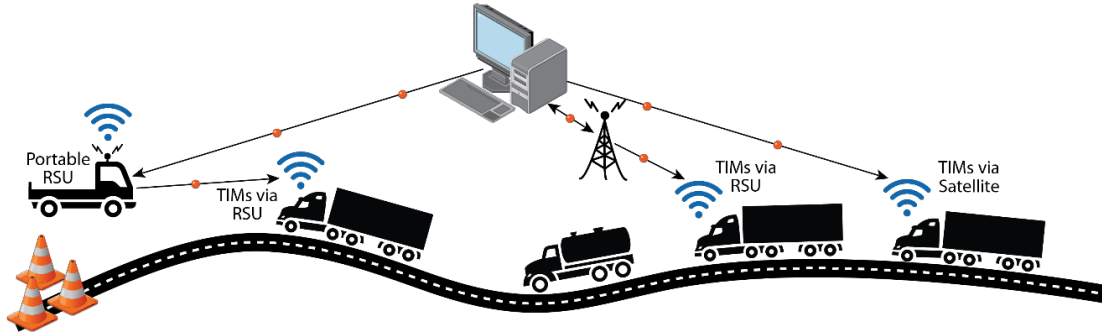


Figure 2-6. Work Zone Warning Concept Diagram.
Source: WYDOT

2.6.5 Spot Weather Impact Warning (SWIW)

SWIW is a special case of I2V Situational Awareness that enables hazardous road condition information due to weather, such as fog or icy roads, to be broadcast from a RSU and received by the connected host vehicles (see Figure 2-7). This application, however, is distinct from other I2V Situational Awareness applications in that it provides more localized information (i.e., at the segment level instead of area wide or region wide). This application will follow the TIM advisory content from part 3 defined in SAE J2735 Section 6.142 for ITIS data elements 6.54 for weather conditions and 6.55 for winds defined in SAE J2540_2.

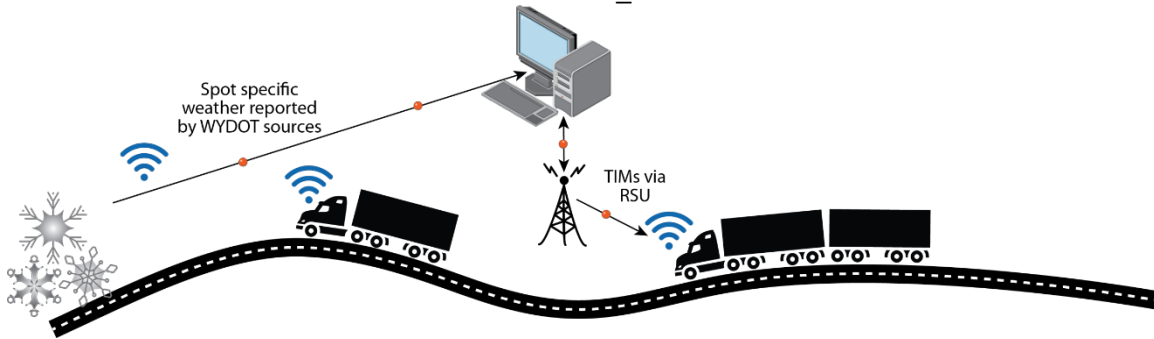


Figure 2-7. Spot Weather Impact Warning concept diagram.
Source: WYDOT

2.7 System Modes and States

This section describes the following modes of operation for the proposed system.

2.7.1.1 Normal Operations

During normal operations, the full suite of CV applications, described in Section 2.6 and 2.7, are available. Objects in the CV environment are being monitored by the WYDOT TMC and are functioning normally.

2.7.1.2 Degraded Mode

In a degraded mode, some of the vehicle or infrastructure objects in the CV environment are not functioning as intended. Depending on the nature of the degradation, different functions and processes are available. For example, *Vehicle System* malfunctions would limit the availability of on-board applications. Operations are limited to wide area advisories via 511 and the use of traditional ITS (DMS and HAR) for roadside communications through existing WYDOT interfaces. On the other hand, failure of specific RSUs in the proposed system can be managed with redundancy in RSU deployment and wide area communications (such as satellite).

2.7.1.3 Back-up Mode

In a back-up mode, some of the *Wyoming CV System* Sub-systems like the ODE, Pikalert, DB are not functioning as intended. Due to the risk associated with malfunctioning center system, all CV-related use-cases would be suspended and the proposed system would revert back to pre-CV state of operations. **Phase 4 will not include Pikalert.**

2.8 Major System Constraints

The following constraints were identified during the conceptualization of the system and are considered as part of the system design:

- Vehicle to vehicle interactions are limited by the presence of connected vehicles in vicinity of each other during conditions of interest.
- Minimizing distraction to truck drivers is critical to any advisories and alerts issued by the system. Any in-vehicle advisory needs to be balanced with the demands of the driving tasks required of the truck driver during stressful conditions.
- Many important highway locations lack reliable, cost effective commercial power and communications services.
- The use of LTE-V2X technology in the pilot will be guided by the IEEE 1609.2, 2a and 2b, IEEE 1609.2.1, 1609.3, and 1609.4 standards for Security, Network Services and Multi-Channel Operation (IEEE, 2016, 2017, 2019, IEEE, 2022, IEEE, 2020; IEEE, 2016c), the SAE J2735 Message Set Dictionary (SAE, 2020), the SAE J2945/1 Communication Minimum Performance Requirements standard (SAE, 2020), the SAE J3161 LTE Vehicle-to-Everything (LTE-V2X) Deployment Profiles and Radio Parameters for Single Radio Channel Multi-Service Coexistence and the Connected Transportation Interoperability (CTI) 4001 v01.01 Roadside Unit Standard (RSU) As standards change and evolve, system requirements will continue to evolve. **Phase 4 will migrate from DSRC to C-V2X.**

2.9 User Characteristics

The following sections represent the user classes and other involved personnel in the proposed system.

2.9.1 Stakeholders

The following are the stakeholders, in no particular order, for the proposed system:

- U.S. Department of Transportation
- WYDOT – Traffic, Construction, Maintenance, GIS/ITS, IT, Telecom Programs
- Wyoming Highway Patrol (WHP)
- Fleet Managers
- Wyoming Trucking Association
- Adjacent State DOTs
- Third party application developers
- System integrators and vendors

2.9.2 User Profiles

The following user profiles are directly impacted by the system.

Table 2-1. User Profiles in the Proposed System

User Group	Owner	Short Description	Changes to responsibilities and interaction with the system
1. Traffic Management Center - Operators	WYDOT	Traffic Management Operators responsible for managing advisory, control strategies from the TMC in Cheyenne. Responsible for VSL, DMS, Traffic Incident Management etc.	Personnel will have to factor new sources of data and information into their decision making. Their primary interface will be through the TRAC system which will include information from the CV environment.
2. Highway Patrol - Dispatch	WYDOT	Personnel providing the dispatch and center capability for highway patrol on I-80. Includes port of entry operations. For the purpose of user needs, this group also includes State homeland security systems and personnel who are involved in emergency response when event-scale warrants emergency operations protocol. This group also manages the port-of entries and are responsible for commercial vehicle safety enforcement.	Will see increased communication about road conditions and incident notifications from the TMC as a result of the notifications from CV Pilot. No direct engagement with <i>Wyoming CV System</i> .
3. ITS Maintenance	WYDOT	WYDOT maintenance staff specifically for Intelligent Transportation System (ITS) devices.	ITS maintenance will be responsible for a new set of devices that need to be maintained as per the performance requirements.

2. General System Description

User Group	Owner	Short Description	Changes to responsibilities and interaction with the system
4. Fleet Management Centers	Various	Personnel and systems at participating fleet management centers who will receive information only from the CVOP.	These management centers will see new capabilities realized through improvements in the CVOP.
5. Snowplow Operators	WYDOT	Operators of snowplow vehicles who are on the frontlines of weather event response. Personnel are also responsible for providing road condition updates and situational awareness of travel conditions on I-80.	Snowplow operators will see additional in-vehicle advisories and alerts on their human-machine interface. They will also continue their road condition updates.
6. Highway Patrol – Field	WYDOT	Operators of highway patrol cars on I-80 who are on the frontlines for incident response, traffic control and enforcement on I-80. From a user needs perspective, this group also includes local police, fire and medical crews that provide first responder capability along the I-80 corridor. This group also manages the port-of entries and are responsible for commercial vehicle safety enforcement.	Field patrol officers will see additional in-vehicle advisories and alerts. They will also be responsible for setting up portable RSUs around incidents and work zones.
7. Commercial Truck Drivers	Various	Commercial truck drivers who travel the I-80 corridor as part of their freight movement with OBUs installed in their vehicles.	Drivers of Connected trucks will see a significant change to their driving environment including in-vehicle alerts and advisories through a new interface. Drivers may also see an increased amount of communication with their fleet managers and more location-specific information communicated to them.

2.9.3 Interactions among user classes

A greater degree of interaction between the WYDOT TMC user groups and fleet management centers is expected to occur in the proposed system. Similarly, a greater degree of communication is required between WYDOT field personnel (snowplow and highway patrol) and the TMC to support truck advisories and warnings.

2.9.4 Other involved personnel

The following personnel are also involved in the operations of the proposed system:

- USDOT SCMS Operators – Personnel responsible for operating the SCMS.
- USDOT Impact Evaluation Contractor – Personnel involved in USDOT-sponsored impact evaluation.
- Third party application developers – Application developers with interest in using data products created by the proposed system.

- System vendors and integrators – Private sector system vendors and integrators involved in the development and operation of the proposed system.
- WYDOT 511 App Users – WYDOT 511 App users provide valuable information on road conditions and parking availability that will be used by the system to notify truckers.

2.9.5 User Needs

Through the process of identifying user needs, the team has identified what the project stakeholders want from the intended system. Three main groups of stakeholder needs include:

- Centers' Needs, such as TMC, highway patrol (dispatch), and fleet management centers, truck facility operators, amongst others.
- Field Needs, related to commercial truck drivers, personal auto travelers, maintenance supervisors, snowplow operators, and highway patrol (in the field).
- Wide Area Needs, namely 511 phone, application and website consumers and media.

A detailed description of the stakeholder needs is provided in the *Connected Vehicle Pilot Deployment Program Phase I, Concept of Operations (ConOps)* Document (Gopalakrishna et al., 2015).

These stakeholder needs, which overlap with each other, were combined and analyzed to develop the needs for the system. The following list of needs were identified for the system (Table 2-2). A traceability matrix that highlights the mapping between our system requirements and the needs provided in Section 6.

Table 2-2. User Needs for CV Pilot System

UN #	List of User Needs
1	Support warnings of impending forward collision in a host vehicle based on information received from a remote vehicle.
2	Support ability to provide situational awareness of road conditions on the corridor to an equipped vehicle.
3	Support notification of distress conditions to and from equipped vehicles (not supported in Phase 4).
4	Support notification of warnings about work zones to equipped vehicles.
5	Support Spot Weather Impact Warnings to equipped vehicles.
6	Support WYDOT Corridor Management & Traditional Traveler Information Program Services.
7	Need capability to monitor and update CV Pilot field devices system health (up-time, communication strength, device status) remotely during normal and adverse weather conditions.
8	Need to develop human machine interface that minimizes the distraction and does not pose a burden on the work load of the driver.
9	Need capability through the pilot of logging time-stamped data for various pilot elements.
10	Need a capability to collect, manage, store data collected from equipped fleets as part of the pilot.
11	Need to be able to share data to/from vehicles to field, and back-office systems in both real-time and non-real time for various CV applications.
12	Need to ensure that data transfer is secure. Non-reputable, signed, and secured data sent and received by vehicles in this pilot.
13	Need to be able to share mobile data at required latency for various pilot applications.

2.10 Dependencies and Assumptions

Some key assumptions and constraints are made in defining the features for the proposed system. The V2I requirements were built with SAE J3067 August 2014. The user needs were used with the operation scenarios from the Concept of Operations (Gopalakrishna et al., 2015) to identify and define the functional requirements from Section 3 onwards.

While some of the V2V requirements were used from J3067, in all cases where SAE J2945™/1 March 2016 had related V2V applications, the newer J2945/1 was used.

The current standard for basic safety messages within J2945/1 is for light vehicles and does not address heavy trucks or tractor-trailers. The CV pilot developers plan to extend the current specification to include trailer-related standards. For this, the CV pilot team will watch for an outcome in the form of a standard based on the NHTSA research project “V2V Basic Safety Message for Truck/CV Trailers.”

Additionally, SAE J2735™ July 2020 is used to update the outdated parts of the J3067 based on the new message set dictionary for DSRC. This document retains the original J3067’s system requirements numbers and descriptions in order to ensure compatibility with other CV projects and to provide clarity for future standards.

In cases where conflicting information is defined between the J2945/1, J2735, and J3067, J2945/1 will take initial precedence, followed by J2735 and finally J3067. The reason for this is J2945/1 is most specific and up to date for V2V safety communications and is there for most relevant to our pilot. J2735 is the second order of precedence because it has many updates to the message set that were not available when J3067 was written. J3067, while somewhat outdated is still relevant because it covers V2I communications and additional applications that are relevant to the Wyoming Pilot.

As J2945/2 and J2945/x become available the Wyoming Pilot will implement the standard interfaces and messages for Situation Awareness – Weather Condition Application, Situational Awareness Suboptimal Road Segment Conditions Applications and RWINFO for Freight Use Case if applicable and the pilot is not too far into implementation.

As for the assumptions, these include the following:

- During the pilot design and demonstration, the number of connected vehicles is expected to be a fraction of the I-80 truck traffic. However, as the rate of connectivity grows, the system needs to be able to work with new on-board units on vehicles as they come on board. This necessitates a strong adherence to standards so that vehicles equipped with DSRC and on-board units are able to receive information from the infrastructure. **Phase 4 will conduct light testing with C-V2X, with no expectation of other vehicle interactions.**
- Road weather forecasts by segment still will likely rely on a human meteorologist who is able to assimilate disparate datasets to generate a travel advisory. This does not apply for current observations or short-term alerts of impending conditions which may be based on reported conditions by connected vehicles directly.
- Cost-effective real-time monitoring of truck parking availability across the state of Wyoming can be accomplished through crowdsourcing interface in the WYDOT 511 App to support CV Pilot objectives. Due to budget constraints and project scope, equipping parking facilities with availability monitoring systems was not considered.

- USDOT-developed Security Certificate Management System (SCMS) can support secure communications as part of a larger security management framework developed for the proposed system. Evaluation is ongoing to select the PoC SCMS from CAMP or a commercial SCMS that will provide continued availability after the end of Phase 3. **For Phase 4 the ISS SCMS will be used.**
- The USDOT developed ODE software is compatible with the 2016 version of J2735 and J2945/1 as well as the current version of the SCMS and the current version of the RSU specification. Additionally, the ODE is adequately scalable to support a 400-vehicle pilot.
- The USDOT developed Situational Data Clearinghouse is compatible with the 2016 version of J2735 and J2945/1 as well as the current version of the SCMS and the current version of the RSU specification. Additionally, the clearinghouse is adequately scalable to support the Wyoming pilot of about 400 additional vehicles.
- CAN Bus information is notoriously difficult to acquire due vehicle manufactures using different and proprietary codes sets. As such, this pilot will not attempt to use the standard CAN bus information (e.g., steering wheel angle, brake status, air bag deployment, traction control, antilock brake status and transmission status). While this information is helpful, it is not required.
- **Phase 4 assumes the FCC will grant a license or waiver for C-V2X to WYDOT.**

An important constraint to note is the dependency on external standards and WYDOT documents that are currently being developed or have not been published yet.

3 External Interface Requirements

The CV Pilot System relies heavily on interfaces between various ongoing USDOT systems as well as existing WYDOT systems within the TMC. An additional interface is also defined to the weather enterprise which collects weather data from various external sources like NWS, NOAA, and Weather Data Environment (WDE) to support weather forecasting. The following interfaces are identified in this section:

- USDOT Interfaces
 - Security Credential Management System (**via ISS in Phase 4**)
 - Situation Data Exchange
 - Secure Data Commons. **Removed in Phase 4**
 - Research Data Exchange. **Removed in Phase 4**
- Location and Time Source Interface
- WYDOT Interfaces
 - 511 App
 - Third Party Interface. **Removed in Phase 4**
 - Transportation Reports and Action Console
 - Road Condition Reporting System
 - Wyoming Traveler Information
 - Commercial Vehicle Operator Portal
 - Incident Console
 - Construction Admin
 - WYDOT ITS Maintenance
- Weather Interface – **Removed in Phase 4**
 - External Data – NWS, NOAA Radar, WDE, others.
 - Fixed Data – RWIS

3.1 USDOT Interfaces

The following requirements apply to USDOT systems that will play a role in the CV Pilot. Several of these systems are undergoing modifications and updates to support future pilot activities. As their requirements change, the following requirements might be modified as well.

3.1.1 Security Credential Management System (SCMS)

SCMS-REQ-1 Wyoming CV System (WCVS) SCMS Use – The Wyoming CV System shall interface with the ISS SCMS based on the requirements in the current version of the End Entity Requirements document found at the SCMS Managers forum (<https://www.scmsmanager.org/wp-content/uploads/2022/06/SCMS-Manager-End-Entity-Requirements-Design-Guidance-and-Validation-Approach-v1.00.pdf>) **Phase 4 will use the ISS SCMS.**

SCMS-REQ-1.1 SCMS Wyoming CV System Certificates – The Wyoming CV System shall download certificates from the ISS SCMS. **Phase 4 will use the ISS SCMS.**

SCMS-REQ-1.2 SCMS Wyoming CV System Misbehavior Reporting – The *Wyoming CV System* shall send misbehavior reports after they are published to the ISS SCMS within 24 hours. **This is outside the scope of Phase 4.**

SCMS-REQ-1.3 SCMS Wyoming CV System Certificates Revocation List (CRL) – The *Wyoming CV System* shall download the CRL from the ISS SCMS. **This is outside the scope of Phase 4.**

SCMS-REQ-1.4 SCMS Wyoming CV System Rejection – The *Wyoming CV System* shall reject messages received from any vehicles on the current CRL. **This is outside the scope of Phase 4.**

SCMS-REQ-2 Vehicle System SCMS Use – The *Vehicle System* used in the Wyoming Pilot shall be certified from a USDOT authorized testing facility based on the current version of the Security Credential Management System Proof-of-Concept Implementation EE Requirements and Specifications Supporting SCMS Software (available at <https://wiki.campllc.org/display/SCP/SCMS+CV+Pilots+Documentation>). Phase 4 will use the ISS SCMS. The FCC has not delivered final rules regarding LTE-V2X usage, and it is unclear when those rules will be published, vendors shall describe current OmniAir certifications and plans for C-V2X certification. Vendors should complete certification within 6 months of OmniAir/FCC rules agreement with respect to C-V2X and channel 183.

SCMS-REQ-2.1 SCMS Vehicle System Certificates – The *Vehicle System* shall download certificates from the ISS SCMS. **Phase 4 will use the ISS SCMS.**

SCMS-REQ-2.2 SCMS Vehicle System Misbehavior Reporting – The *Vehicle System* shall send misbehavior reports after they are defined to the ISS SCMS. **This is outside the scope of Phase 4.**

SCMS-REQ-2.3 SCMS Vehicle System Certificates Revocation List (CRL) – The *Vehicle System* shall download and utilize the CRL from the ISS SCMS. **This is outside the scope of Phase 4.**

SCMS-REQ-2.4 SCMS Vehicle System Rejection – The *Vehicle System* shall reject messages received from any vehicles on the current CRL. **This is outside the scope of Phase 4.**

3.1.2 Situation Data Exchange (SDX)

The SDX is a warehouse maintained currently by Trihydro. **Trihydro has committed to continuing support for WYDOT by maintaining and supporting the SDX for Phase 4.** This requirement is for general compliance with the national communication of TIMs and is one way that the Wyoming pilot can get TIMs to third parties for broader distribution.

SDX-REQ-1 Data Provided to the SDX – The *Wyoming CV System* shall transmit traveler information messages (TIMs) generated by the system to the SDX within five minutes of generation. TIMs are formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM).

SDX-REQ-2 Distribute TIM to VS – The Situation Data Exchange shall distribute TIMs to the *Vehicle System* through satellite, as defined in WCVS-REQ-10.2 Distribute TIM to SDX.

3.1.3 Secure Data Commons (SDC)

SDC-REQ-1 Data Provided to the SDC – The *Wyoming CV System* shall transmit information to the Secure Data Commons. **The SDC will not be supported in Phase 4.**

3.1.4 Research Data Exchange (RDE)

RDE-REQ-1 Data Provided to the RDE – The *Wyoming CV System* shall transmit information to the Research Data Exchange. **The RDE will not be supported in Phase 4.**

3.2 Location and Time Source (LTS)

Location and time are obtained in accordance with J2945/1 and J2735.

LTS-REQ-1 WCVS Time – The *Wyoming CV System* shall acquire time as specified below.

LTS-REQ-1.1 WCVS LTS Time – The *Wyoming CV System* shall acquire time from the LTS interface in accordance with Section 5.10.1 of the ICD.

LTS-REQ-1.2 WCVS Time Synchronization – The *Wyoming CV System* shall receive time synchronization information from a Stratum 2 NTP source, as described in Section 5.12.1 of the ICD.

LTS-REQ-2 WCVS LTS Time Standard – The *Wyoming CV System* shall use Coordinated Universal Time (UTC) time for logged data (e.g., events logs and environmental data) based on the format defined in J2735 section 6.19 and epoch of January 1st, 1970.

LTS-REQ-3 WCVS LTS Location – The *Wyoming CV System* shall acquire location from the LTS interface in accordance with J2945/1 section 6.2.1.

LTS-REQ-4 VS LTS Time – The *Vehicle System* shall acquire time from the LTS interface in accordance with Section 5.3.1 of the ICD.

LTS-REQ-5 VS LTS Time Standard – The *Vehicle System* shall use Coordinated Universal Time (UTC) time for logged data (e.g., events logs and environmental data) based on the format defined in J2735 section 6.19 and epoch of January 1st, 1970.

LTS-REQ-6 VS LTS Location – The *Vehicle System* shall acquire location from the LTS interface in accordance with J2945/1 section 6.2.1.

3.3 WYDOT Interfaces

The following requirements are identified for existing WYDOT systems as they interact with the *Wyoming CV System*.

3.3.1 WYDOT 511 Application (511App)

The 511App will be used for collecting parking information from users of the App along I-80. Users will have the opportunity to enter parking availability for facilities along the corridor as part of the 511App interface, which will share the information with the *Wyoming CV System*.

511-REQ-1 511App Parking Data Collection – The *Wyoming CV System* shall receive parking status data from Wyoming 511 App.

511-REQ-1.1 Availability – The *Wyoming CV System* shall categorize parking availability for the facility of interest as follows: i) Full – No parking availability, ii) Spaces available, or iii) Only a few spaces available.

511-REQ-1.2 Default – The *Wyoming CV System* shall set parking availability default to available if not provided.

511-REQ-1.3 Time – The *Wyoming CV System* shall timestamp parking availability reports.

511-REQ-1.4 Location – The *Wyoming CV System* shall associate parking availability with a parking facility on I-80.

511-REQ-1.5 Protocol – The *Wyoming CV System* shall receive information, based on HTTP protocol, from the 511App.

511-REQ-1.6 Schema – The *Wyoming CV System* shall receive information based on the parking schema defined by WYDOT (WYDOT Truck Parking Map – as of 07/2016⁶).

511-REQ-2 Timeframe – The *Wyoming CV System* shall receive Parking availability data from the WYDOT 511 application within thirty minutes of generation.

3.3.2 WYDOT Third Party Interface (TPI) – Not part of Phase 4

As part of ongoing approaches to improve traveler information, WYDOT is creating a standardized interface that is based on the Traffic Management Data Dictionary (TMDD) standard that can be used to support delivery of traveler information to external centers and information service providers. The current approved TMDD standard (v3.03c) is being used to develop the interface. From the pilot perspective, the interface includes the following relevant TMDD user needs that will drive a specification based on the Needs to Requirements Traceability Matrix (NRTM) in the standard:

- 2.3.1 Need for Connection Management
- 2.3.2 Need to Provide Information on Organizations, Centers, and Contacts
- 2.3.3 Need to Share Event Information
- 2.3.4 Need to Provide Roadway Network Data
- 2.3.5.5 Need to Share Environment Sensor Data
- 2.3.5.6 Need to Share Lane Closure Gate Control

TPI-REQ-1 TPI Data – The *Wyoming CV System* shall transmit traffic condition information to the WYDOT TPI, as described in Section 5.36.1 of the ICD. **This is outside the scope of Phase 4.**

3.3.3 WYDOT Transportation Reports and Action Console (TRAC)

The TRAC is an operator console used in the TMC to monitor and manage planned, ongoing, and forecast events and actions on facilities monitored by the TMC. The TRAC provides a tabular list of actions that require operator attention. As events progress, operators mark actions as complete. The TRAC receives information from various sources available to the TMC (e.g., citizen reports, 511 App, RCRS, field reports) but can also include operator inputs. The TRAC interface is the primary interface for communicating information to the operators in the TMC.

⁶<http://www.dot.state.wy.us/files/live/sites/wydot/files/shared/Public%20Affairs/Maps/Truck%20parking%20map.pdf>

TRAC-REQ-1 TRAC Updates – The *Wyoming CV System* shall transmit CV pilot events to the TRAC. CV-Pilot events are those generated by the *Wyoming CV System* that require operator attention as defined in the following requirements. **Not part of Phase 4.**

TRAC-REQ-1.1 Distress Notification – The *Wyoming CV System* shall transmit received distress notifications to TRAC. Distress notifications are defined in WCVS-REQ-1.3. **Not part of Phase 4.**

TRAC -REQ-1.1.1 Transmission Time – The *Wyoming CV System* shall transmit distress notifications to TRAC within five minutes of its generation in the system. **Not part of Phase 4.**

TRAC-REQ-1.2 Segment Alerts – The *Wyoming CV System* shall transmit segment-level alerts, defined in WCVS-REQ-4, to TRAC. **Not part of Phase 4**

TRAC-REQ-1.2.1 Transmission Time – The *Wyoming CV System* shall transmit alerts to TRAC within five minutes of its generation in the system. **Not part of Phase 4**

TRAC-REQ-1.2.2 Segment Alerts-Pikalert – The *Wyoming CV System* shall transmit Pikalert segment-level alerts, defined in WCVS-REQ-4, to TRAC. **Pikalert will not be supported in Phase 4.**

3.3.4 WYDOT Road Condition Reporting (RCRS)

The RCRS is an Android-based app that is installed on snowplows. Snowplow operators input road and atmospheric condition based on their observations while on the road. This information is transmitted wirelessly back to the TMC. This information is used by the pilot system to improve road weather condition reporting and forecasting. The information is also used to adjust speed limits and determine a maintenance response.

RCRS-REQ-1 RCRS Data Sharing – The *Wyoming CV System* shall receive road condition information from the RCRS.

RCRS-REQ-1.1 Road Condition – The *Wyoming CV System* shall receive road condition information from the RCRS following the 8 Code System. The 8 Code includes:

- 8-1 Dry Road
- 8-2 Wet Road
- 8-3 Slick
- 8-4 Slick Spots
- 8-5 Drifted Snow
- Black Ice
- Freezing Temps

RCRS-REQ-1.2 Weather – The *Wyoming CV System* shall receive atmospheric information from the RCRS following the 9 Code System. The 9 Code includes:

- 9-1 Favorable
- 9-2 Snowing
- 9-3 Raining
- 9-4 Strong Winds
- 9-5 Fog
- 9-6 Blowing Snow
- 9-7 Reduced Visibility

RCRS-REQ-1.3 Other Road Condition – The *Wyoming CV System* shall receive other road information from RCRS following the 10 Code System. The 10 Code includes:

- 10-7 Out of Service
- 10-45 Animal Carcass
- 10-46 Citizen Assist
- 10-50 Crash
- 10-54 Livestock
- Total Blockage
- Partial Blockage
- Slide Off
- Detour Available

RCRS-REQ-1.4 Report Time – The *Wyoming CV System* shall receive reports from RCRS containing a timestamp of when the operator entered the information into the app.

RCRS-REQ-1.5 Location – The *Wyoming CV System* shall receive reports from RCRS containing a location reference of when the operator entered the information into the app.

RCRS-REQ-1.6 Transmit Time – The *Wyoming CV System* shall receive reports from RCRS containing a timestamp of when the report was transmitted to the TMC. The transmitting timestamp may be different from the reporting time.

3.3.5 WYDOT Wyoming Traveler Information (WTI)

The WTI is a system that assembles information for various WYDOT traveler information resources. These resources include the 511App, 511 Phone System, website and text/email alert services.

WTI-REQ-1 WTI Inputs – The *Wyoming CV System* shall transmit CV Pilot event information to the WTI. CV-Pilot events are those generated by the *Wyoming CV System* as defined in the following requirements. **Not part of Phase 4.**

WTI-REQ-1.1 Current Segment Alerts – The *Wyoming CV System* shall transmit current segment-specific alerts, defined in WCVS-REQ-4, to the WTI. **Not part of Phase 4.**

WTI-REQ-1.1.1 Transmission Time – The *Wyoming CV System* shall transmit alerts within five minutes of its generation in the system to the WTI. **Not part of Phase 4.**

WTI-REQ-1.2 Forecast Segment Alerts – The *Wyoming CV System* shall transmit forecast segment-specific alerts, defined in WCVS-REQ-5, to the WTI. **Not part of Phase 4.**

WTI-REQ-1.2.1 Forecast Time – The *Wyoming CV System* shall transmit forecast reports to WTI for pre-specified forecast windows determined by WYDOT (6, 12, 24, 48, 72 hours). **Not part of Phase 4**

WTI-REQ-1.2.2 Forecast Update – The *Wyoming CV System* shall update its forecast reports in WTI at WYDOT-determined intervals (every 12 hours for example). **Not part of Phase 4.**

WTI-REQ-2 WTI Outputs – The *Wyoming CV System* shall receive the current information for corridor roadway segments available from the WTI within five minutes of generation. Roadway segments are defined by WYDOT as sections of roadway between variable mileposts. Corridor information is defined by the following requirements.

WTI-REQ-2.1 Posted Speed – The *Wyoming CV System* shall receive notification that current posted speed for a segment is changed. This is applicable for only those segments on I-80 where variable speed limits are in operation. The notification includes the new posted speed.

WTI-REQ-2.2 Vehicle Restrictions – The *Wyoming CV System* shall receive the notification of vehicle restrictions that have been set for a roadway segment.

WTI-REQ-2.2.1 Restriction Information – The *Wyoming CV System* shall receive details on the restriction in effect for affected segments. Restrictions can consist of one or more of the following:

- Width restriction
- Height restriction
- Weight restrictions
- High-Profile restrictions
- Chain Law Level 1
- Chain Law Level 2

WTI-REQ-2.2.2 Restriction Start Time – The *Wyoming CV System* shall receive the start time of restrictions in effect for segments.

WTI-REQ-2.3 Posted Messages – The *Wyoming CV System* shall receive the notification of DMS messages that have been set in the corridor.

WTI-REQ-2.3.1 Message Information - The *Wyoming CV System* shall receive the content of the posted DMS message.

WTI-REQ-2.4 Posted Closures - The *Wyoming CV System* shall receive the notification of closures that have been set for a roadway segment.

WTI-REQ-2.4.1 Closure Beginning – The *Wyoming CV System* shall receive notification of the beginning point of the closure. Beginning point of the closure will be identified by the exit number on I-80.

WTI-REQ-2.4.2 Closure End – The *Wyoming CV System* shall receive notification of the ending point of the closure. Ending point of the closure will be identified by the exit number on I-80.

WTI-REQ-2.4.3 Closure Start Time – The *Wyoming CV System* shall receive notification of the starting time of the closure.

3.3.6 WYDOT Commercial Vehicle Operator Portal (CVOP)

The CVOP is a subscription-based website created by WYDOT for providing advanced notification for commercial travelers and fleet managers. Currently there are over 800 companies subscribed to the CVOP. The CVOP today is restricted to providing forecasted weather information for segments on I-80. Planned enhancements to the CVOP include providing current information from the CV Pilot system.

CVOP-REQ-1 CVOP Inputs – The *Wyoming CV System* shall transmit CV Pilot event information to the CVOP. CV-Pilot events are those generated by the *Wyoming CV System* as defined in the following requirements.

CVOP-REQ-1.1 Current Segment Alerts – The *Wyoming CV System* shall transmit current segment-specific alerts, defined in WCVS-REQ-4, to the CVOP.

CVOP-REQ-1.1.1 Transmission Time – The *Wyoming CV System* shall transmit alerts within five minutes of its generation in the system to the CVOP.

CVOP-REQ-1.2 Forecast Segment Alerts – The *Wyoming CV System* shall transmit forecast segment-specific alerts, defined in WCVS-REQ-5, to the CVOP. **Not part of Phase 4.**

CVOP-REQ-1.2.1 Forecast Time – The *Wyoming CV System* shall transmit forecast reports to the CVOP for pre-specified forecast windows determined by WYDOT (6, 12, 24, 48, 72 hours). **Not part of Phase 4.**

CVOP-REQ-1.2.2 Forecast Update – The *Wyoming CV System* shall update its forecast reports in CVOP at WYDOT-determined intervals (every 12 hours for example). **Not part of Phase 4.**

3.3.7 WYDOT Incident Console (IC)

WYDOT Incident Console is an operator system that is used to record incidents on the corridor. Incidents can be reported by various methods including field reports from highway patrols, visual inspection, and maintenance field personnel. This information needs to be communicated with the CV Pilot system.

IC-REQ-1 IC Data Sharing – The *Wyoming CV System* shall receive timestamped incident information from the IC.

IC-REQ-2 Protocol – The *Wyoming CV System* shall receive incident information, based on HTTP protocol, from the IC. The HTTP protocol used will be based on the six part specifications RFC 7230-RFC 7235.

IC-REQ-3 Schema – The *Wyoming CV System* shall receive incident information from WYDOT IC, as described in Section 5.31.1 of the ICD.

IC-REQ-4 Transmission – The *Wyoming CV System* shall receive Road Incident data from WYDOT Incident Console within five minutes of generation.

3.3.8 WYDOT Construction Administration (CA)

WYDOT Construction Administration (CA), also known as ConAdmin, is an operator-based system that logs various planned work zone related activities on the I-80 corridor.

CA-REQ-1 CA Data Sharing – The *Wyoming CV System* shall receive timestamped work zone information from the CA.

CA-REQ-2 Protocol – The *Wyoming CV System* shall receive work zone information, based on HTTP protocol, from the CA.

CA-REQ-3 Schema – The *Wyoming CV System* shall receive work zone information from WYDOT CA, as described in Section 5.32.1 of the ICD.

CA-REQ-4 Transmission – The *Wyoming CV System* shall receive work zone data from WYDOT Construction Administrator within thirty minutes of generation.

3.3.9 WYDOT ITS Maintenance

WYDOT ITS Maintenance is an interface to the team deployed to repair ITS gear in the field and the TMC based on alerts from monitoring systems defined in Section 4.1.6 of the SyRS.

ITSM-REQ-1 WYDOT ITS Alerts – The *Wyoming CV System* shall send alerts, defined in *WCVS-REQ-16*, to the WYDOT ITS Maintenance team within five minutes of a system becoming unavailable.

3.4 Weather Interface (WI)

WI-REQ-1 External Data Acquisition – The *Wyoming CV System* shall collect weather information from external sources, as defined in the Section 4.1 - Data Ingest Module Requirements of the *Motorist Alert and Warning Application* (NCAR, 2014). The external weather information may consist of one or more of the following sources:

- NWS watches and warnings, including county-based and polygon-based data.
- NWS storm reports, including hail, wind, and tornado data.
- NWS radar data.
- Weather model data
 - Global Forecast System (GFS),
 - North American Mesoscale Forecast System (NAM)
 - High-Resolution Rapid Refresh (HRRR).
- NOAA remote sensing data.
- NOAA single polarization radar data.
- NOAA satellite data.
- USDOT Weather Data Environment

The External Data Acquisition will not be part of Phase 4.

WI-REQ-2 Fixed Data Acquisition – The *Wyoming CV System* shall receive road weather information system (RWIS) data from the WYDOT RWIS Server as defined in Section 4.1 – Data Ingest Module Requirements of the *Motorist Alert and Warning Application* (NCAR, 2014). **Fixed Data Acquisition will not be part of Phase 4.**

4 System Requirements

The following sections provide the system and Sub-system requirements for the CV pilot.

4.1 Wyoming CV System (WCVS) Requirements

The *Wyoming CV System* includes the infrastructure used in the pilot and back-office systems in charge of the various processes that lead to the generation and distribution of advisories and alerts to the *Vehicle System*. The *Wyoming CV System* will be located at the WYDOT TMC.

4.1.1 Collect CV Information

The following set of requirements pertain to the ability to collect data from the *Vehicle System*.

WCVS-REQ-1 Collect CV Data – The *Wyoming CV System* shall collect data from the *Vehicle System*.

WCVS-REQ-1.1 Collect BSM Data – The *Wyoming CV System* shall collect Basic Safety Message Parts I and II (as defined in J2945/1) from the *Vehicle System* consistent with Section 6.3.8 (BSM Scheduling and Congestion Control) of J2945/1.

WCVS-REQ-1.2 Collect Environmental Sensor Data – The *Wyoming CV System* shall collect environment sensor data using secure copy (SCP) from the *Vehicle System* consistent with secure shell (SSH). **Not part of Phase 4.**

WCVS-REQ-1.3 Collect Distress Messages – The *Wyoming CV System* shall collect distress messages using the Traveler Information Message (as defined in section 5.16 of J2735) from the *Vehicle System* consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. **Distress Messages will not be part of Phase 4.**

WCVS-REQ-2 Validate Data – The *Wyoming CV System* shall provide validation- and sanitization-related functions of CV Data as defined in Section 3.1.4.1 of the SDD.

4.1.2 Generate Alerts and Advisories

The following set of requirements pertain to the ability of the system to generate current and forecast road condition information based on the inputs received. Segment-level alerts are contained within TIMs and provide information related to Weather, Road Condition, Construction, Incident and Truck Parking, or a combination of, that is linked to a specific spatial area that is described following Section 6.30 Data Frame: DF_GeographicalPath of J2735.

WCVS-REQ-3 Ingest Data for Road Weather information – The *Wyoming CV System* shall use one or more of the following sources of data to generate road weather information:

- Collected CV Information defined in WCVS-REQ-1. Not part of Phase 4.
- Segment road and weather conditions from the WYDOT RCRS in RCRS-REQ-1.

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- Weather conditions from weather interfaces defined in WI-REQ-1 and WI-REQ-2. **WI-REQ-1 and WI-REQ-2 is not part of Phase 4.**

WCVS-REQ-4 Contents of Alerts and Advisories – The *Wyoming CV System* shall generate alerts and advisories of roadway hazard conditions as defined in the following requirements:

WCVS-REQ-4.1 Precipitation Hazard – The *Wyoming CV System* shall generate a precipitation type and intensity report every 5 minutes, as specified in Section 3.1.4.2 of the SDD. **Not part of Phase 4.**

WCVS-REQ-4.2 Road Condition Hazard – The *Wyoming CV System* shall generate a pavement state and slickness flag report every 5 minutes, depending on input data, as specified in Section 3.1.4.2 of the SDD. **Not part of Phase 4.**

WCVS-REQ-4.3 Visibility Hazard – The *Wyoming CV System* shall generate a visibility report, along with the condition causing it, every 5 minutes, as specified in Section 3.1.4.2 of the SDD. **Not part of Phase 4.**

WCVS-REQ-4.4 Work Zone Hazard – The *Wyoming CV System* shall generate a work zone report within 5 minutes of receiving work zone information from the Construction Administration (defined in CA-REQ-1), as specified in Section 3.1.5.4 of the SDD.

WCVS-REQ-4.5 Incident Hazard – The *Wyoming CV System* shall generate an incident report within 5 minutes of receiving incident notifications from the Incident Console (defined in IC-REQ-1), as specified in Section 3.1.4.3 of the SDD.

WCVS-REQ-4.6 Parking – The *Wyoming CV System* shall generate a parking report within 5 minutes of receiving parking availability notification, as specified in Section 3.1.4.3 of the SDD.

WCVS-REQ-5 Forecast Conditions – The *Wyoming CV System* shall generate forecasts of conditions as defined in the following requirements: **Not part of Phase 4.**

WCVS-REQ-5.1 Atmospheric Forecasts – The *Wyoming CV System* shall produce atmospheric weather forecasts, at a minimum, for (a) atmospheric temperature, (b) probability of precipitation, (c) wind speed, and (d) wind direction. **Not part of Phase 4.**

WCVS-REQ-5.2 Road Weather Forecasts – The *Wyoming CV System* shall produce road weather forecasts, at a minimum, for (a) pavement temperature, and (b) subsurface temperature. **Not part of Phase 4.**

WCVS-REQ-5.3 Forecast Time – The *Wyoming CV System* shall generate forecast reports for customizable forecast windows. The windows of interest will be determined by WYDOT (6, 12, 24, 48 hours for example). **Not part of Phase 4.**

WCVS-REQ-5.4 Forecast Update – The *Wyoming CV System* shall generate forecast updates for customizable intervals. The update frequency will be determined by WYDOT and may vary based on time of year (every 3 hours for example in winter to 12 hours during summer). **Not part of Phase 4.**

WCVS-REQ-6 Associate Alerts and Forecast to Segments – The *Wyoming CV System* shall associate each alert and forecast to one or more road segments on I-80. Roadway segments are defined by WYDOT as sections of roadway between variable mileposts. **Not part of Phase 4.**

4.1.3 Support Information Brokerage

The following set of requirements pertain to how the information in the Wyoming CV system will be brokered between various external interfaces.

WCVS-REQ-7 External Brokerage with WYDOT Interfaces – The *Wyoming CV System* shall transfer data with WYDOT systems as defined in WCVS-REQ-7.1 and WCVS-REQ-7.2.

WCVS-REQ-7.1 Receive from WYDOT External Interfaces – The *Wyoming CV System* shall receive data from WYDOT systems as defined in 511-REQ-1, RCRS-REQ-1, WTI-REQ-2, IC-REQ-1, and CA-REQ-1.

WCVS-REQ-7.2 Distribute to WYDOT External Interfaces – The *Wyoming CV System* shall distribute information to WYDOT systems as defined in TPI-REQ-1, TRAC-REQ-1, WTI-REQ-1, CVOP-REQ-1, and ITSM-REQ-1. **TPI-REQ-1 is not supported with Phase 4.**

WCVS-REQ-8 Internal Brokerage – The *Wyoming CV System* shall support internal brokerage of data as defined in RSU-REQ-1, RSU-REQ-2, ODE-REQ-1, ODE-REQ-3, PA-REQ-2, PA-REQ-4, DB-REQ-4, DB-REQ-5, DB-REQ-6, DB-REQ-7, DW-REQ-1, DW-REQ-2, DW-REQ-4, HSM-REQ-1, HSM-REQ-2, HSM-REQ-3, and HSM-REQ-4. **PA-REQ-2 and PA-REQ-4 are not supported with Phase 4.**

4.1.4 Distribute TIMs

The following set of requirements pertain to the development and distribution of the TIM from the *Wyoming CV System* to the *Vehicle System* and the Situation Data Exchange (SDX)

WCVS-REQ-9 Create TIM – The *Wyoming CV System* shall create a Traveler Information Message (TIM) formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM). The TIM is used to send various types of information (advisory and road sign types) to equipped devices. It makes heavy use of the ITIS encoding system to send well known phrases but allows limited text for local place names. The supported message types specify several sub-dialects of ITIS phrase patterns to further reduce the number of octets to be sent. The expressed messages are active at a precise start and duration period, which can be specified to a resolution of a minute. The affected local area can be expressed using either a radius system or one of the systems of short defined regions, similar to the way roadway geometry is defined in the MAP messages.

WCVS-REQ-10 Distribute TIM – The *Wyoming CV System* shall distribute signed TIMs to the *Vehicle System* and the Situation Data Exchange (SDX).

WCVS-REQ-10.1 Distribute TIM to VS – The *Wyoming CV System* shall distribute signed TIM to the *Vehicle System* consistent with Section 3.5.8 (Traveler Information Requirements) of J3067.

WCVS-REQ-10.2 Distribute TIM to SDX – The *Wyoming CV System* shall distribute signed TIM to the SDX consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. This requirement is for general compliance with the national communication of TIMs and is one way that the Wyoming pilot can get TIMs to third parties for broader distribution.

4.1.5 Store Data

The following requirements pertain to the storage of data in the *Wyoming CV System*.

WCVS-REQ-11 Store VS Data – The *Wyoming CV System* shall store processed data collected by the *Vehicle Systems* and retain it for the duration of the CV Pilot. Data Processing is defined in ODE-REQ-2.

WCVS-REQ-11.1 Store BSM – The *Wyoming CV System* shall store processed BSM Parts I and II data received from the *Vehicle System*. As the BSM will be previously validated, only core data elements will be stored (defined in sections 6.8, 6.147, 6.128, and 6.133 of J2735).

WCVS-REQ-11.2 Store Environment Sensor Data – The *Wyoming CV System* shall store processed environment sensor data consistent with Section 5.19.2 of the ICD.

Environmental Sensor Data is not part of Phase 4.

WCVS-REQ-11.3 Store Distress Messages – The *Wyoming CV System* shall store processed distress messages using the Traveler Information Message (as defined in section 5.16 of J2735) received from the *Vehicle System* consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. As the distress message will be previously validated, only core data will be stored (defined in sections 5.16, and 6.142 of J2735). **Distress Messages will not be part of Phase 4.**

WCVS-REQ-12 Store Generated Alerts/Advisories – The *Wyoming CV System* shall store generated road weather alerts and advisories (defined WCVS-REQ-4) and retained for the duration CV Pilot. **Not part of Phase 4.**

WCVS-REQ-13 Store TIM – The *Wyoming CV System* shall store TIMs distributed to the *Vehicle System* and the Situation Data Exchange (SDX) and retain it for the duration of the CV Pilot.

WCVS-REQ-14 Store System Monitoring Data – The *Wyoming CV System* shall store system monitoring data, as defined by WCVS-REQ-16 Monitored Functions and retain it for the duration of the CV Pilot.

4.1.6 Manage and Maintain System

WCVS-REQ-15 Notifications – The *Wyoming CV System* shall notify designated personnel within five minutes of a monitored function becoming unavailable.

WCVS-REQ-16 Monitored Functions – The *Wyoming CV System* shall monitor the functions described in WCVS-REQ-16.1 through WCVS-REQ-16.4.

WCVS-REQ-16.1 Sub-System Availability – The *Wyoming CV System* shall monitor the Sub-systems for availability of ping services running. The WYDOT maintenance team will be sent a notification after a device, web service or running service is non-responsive for five minutes.

WCVS-REQ-16.2 Sub-System Performance – The *Wyoming CV System* shall monitor the system's ability to transmit information in a timely manner. This will be done by monitoring message input queues age of oldest entry not processed. If the messages are not processed within five minutes the WYDOT maintenance team will be notified.

WCVS-REQ-16.3 Availability for Interfaces – The *Wyoming CV System* shall monitor the external interfaces for availability of ping services running. The WYDOT maintenance team will be sent a notification after a device, web service or running service is non-responsive for five minutes.

WCVS-REQ-16.4 Availability for Data Storage – The *Wyoming CV System* shall monitor available data storage of ping services running. The WYDOT maintenance team will be sent

a notification after a device, web service or running service is non-responsive for five minutes. Notification will also be sent for disk space under 10% availability.

WCVS-REQ-17 Archive Data – The *Wyoming CV System* shall provide the TMC administrator the ability to archive data used by the CV pilot by writing CV data to the WYDOT Data Warehouse, data written to the Data Warehouse is automatically archived per existing TMC best practices.

WCVS-REQ-18 Management and Performance Policy – The *Wyoming CV System's* infrastructure-related elements shall manage the policy for data collection and performance data following requirements defined in *Appendix B.4 RSU Performance Data* of the SyRS.

Performance measures and performance data will not be part of Phase 4.

~~**WCVS-REQ-19 Manage Architecture** – The *Wyoming CV System's* infrastructure-related elements shall conform to the core architecture requirements defined in *Appendix A* of the SyRS. This requirement no longer applies to this system.~~

WCVS-REQ-20 Manage Safe Communications – The *Wyoming CV System's* infrastructure-related elements shall conform to the core safety communications requirements defined in *Appendix B.2 V2I Core Safety Communication Requirements* of the SyRS.

WCVS-REQ-21 Manage CV Equipment – The *Wyoming CV System* shall provide the TMC administrator the ability to add/edit/delete equipment from the internal inventory list.

WCVS-REQ-22 Test WCVS Equipment – The *Wyoming CV System* shall provide the TMC administrator the ability to test the RSUs by allowing a series of Python testing scripts to be run on an RSU and results of the test returned to the user.

WCVS-REQ-23 Track WCVS Equipment – The *Wyoming CV System* shall provide the TMC administrator the geolocation of RSUs.

WCVS-REQ-24 Update WCVS Equipment – The *Wyoming CV System* shall provide the TMC administrator the ability to push out updates to the RSU firmware.

WCVS-REQ-25 Update VS Equipment – The *Wyoming CV System* shall provide the TMC administrator the ability to push out OTA updates to the OBU firmware.

4.2 Vehicle System (VS) Requirements

The *Vehicle System* represents the deployment of on-board units, sensors, and a human-machine interface that will support CV applications. The following set of requirements provide the system-level requirements for the vehicle systems.

4.2.1 Receive CV Information

VS-REQ-1 Receive BSM – The *Vehicle System* shall receive Basic Safety Message (as defined in SAE J2945/1) over DSRC from other connected vehicles consistent with Section 6.3.8 of SAE J2945/1 (BSM Scheduling and Congestion Control). **In Phase 4 this will be done with C-V2X rather than DSRC.**

4.2.2 Receive TIMs

VS-REQ-2 Receive TIM – The *Vehicle System* shall wirelessly receive a packet containing traveler information from the *Wyoming CV System*. Each packet may contain one or more individual traveler information message as defined in Section 5.16 of SAE J2735.

VS-REQ-2.1 Receive TIM through DSRC – The *Vehicle System* shall wirelessly receive a packet containing traveler information from the *Wyoming CV System* through DSRC. **In Phase 4 this will be done with C-V2X rather than DSRC.**

VS-REQ-2.2 Receive TIM through Satellite – The *Vehicle System* shall wirelessly receive a packet containing traveler information from the *Wyoming CV System* (via the Situation Data Exchange) through satellite.

VS-REQ-2.3 Process Received TIM's from Satellite only within Geofenced Area – The *Vehicle System* should discard wirelessly received packets containing traveler information from the *Wyoming CV System* (via the Situation Data Exchange) through satellite outside of a configurable geofenced area around the vehicle position.

VS-REQ-2.4 Duplicate Received TIM's through Satellite and RSUs Discarded – The *Vehicle System* shall discard duplicate wirelessly received packets containing traveler information from the *Wyoming CV System* (via the Situation Data Exchange) from satellite and RSUs. Only the first one shall be retained. This is to ensure that duplicate TIMs are not sent to the HMI.

VS-REQ-3 Receive Distress Information – The *Vehicle System* shall wirelessly receive a packet containing distress information from other connected vehicles over DSRC. Distress information is a high priority messages based on the received distress broadcast (defined in J3067 3.5.9.2.1) but has the content of the TIM (defined in J2735 5.16 Part III advisory ITIS data elements 6.1 from J2540-2 Accidents and Incidents). **Distress information will not be part of Phase 4.**

4.2.3 Collect Vehicle and Environmental Data. Phase 4 will not include collecting vehicle and environmental data

VS-REQ-4 Collect Vehicle Data – The *Vehicle System* shall have the capability to collect vehicle information from the host vehicle and the driver as stated below. **Not part of Phase 4.**

VS-REQ-4.1 Collect Vehicle Status Data – The *Vehicle System* shall have the capability to collect vehicle status information from the host vehicle, as stated in Section 5.4.2 of the ICD. **Not part of Phase 4.**

VS-REQ-4.2 Collect Dimension Data – The *Vehicle System* shall have the capability to collect information from the host vehicle driver. The VS will maintain these values across power cycles and OTA updates. The data will be included in BSMs broadcasted by the Vehicle System. The list of fields are shown in Table 7-1 of the ICD, where column #1 contains the value "yes/driver". **Not part of Phase 4.**

VS-REQ-4.2.1 Vehicle Dimension Data – The *Vehicle System* shall have the capability to collect vehicle dimension from the host vehicle driver through the Human Machine Interface. **Not part of Phase 4.**

VS-REQ-4.2.2 Vehicle Trailer Data – The *Vehicle System* shall have the capability to collect information from the host vehicle driver regarding the dimensions of attached

trailers, including capability to indicate that no trailer is present, through the Human Machine Interface. **Not part of Phase 4.**

VS-REQ-5 External Environment Sensor Data – The *Vehicle System* shall collect additional environmental sensor data from host vehicles equipped with external environmental sensors. Additional data collected from external environmental sensors is shown in Table 7-4 of the Interface Control Document. **Not part of Phase 4.**

VS-REQ-5.1 External Environment Sensor Data Configuration – The collection of sensor data by the *Vehicle System* shall be configurable as specified in Section 3.2.5.1 of the SDD. **Not part of Phase 4.**

VS-REQ-5.2 External Environment Sensor Data Management– The application shall support a data management mechanism, specified in Section 3.2.5.1 of the SDD. **Not part of Phase 4.**

4.2.4 Manage and Process Information for On-Board Applications

The following five applications are included in the *Vehicle System*.

4.2.4.1 Forward Collision Warning (FCW)

Forward Collision Warning is a vehicle-to-vehicle (V2V) communication-based safety feature that issues a warning to the driver of the connected host vehicle in case of an impending front-end collision with a connected vehicle ahead in traffic in the same lane and direction of travel on both straight and curved geometry roadways. This application will follow the description from J2945/1 March 2016 Section 4.2.4.

VS-REQ-6 FCW Stopped Vehicles – The *Vehicle System* shall ingest BSM Parts I and II data received from remote vehicles to identify stopped remote vehicles directly ahead in the same lane and direction of travel (defined in J2945/1 section 4.2.4.2 (a)). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-7 FCW Decelerating/Slow Moving Vehicles – The *Vehicle System* shall ingest BSM Parts I and II data received from remote vehicles to identify decelerating or slower moving remote vehicles directly ahead in the same lane and direction of travel (defined in J2945/1 section 4.2.4.2 (c)). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-8 FCW Stopped and Obstructed Vehicles – The *Vehicle System* shall ingest BSM Parts I and II data received from remote vehicles to identify stopped and obstructed remote vehicles directly ahead in the same lane and direction of travel (defined in J2945/1 section 4.2.4.2 (d)). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-9 FCW Rear-End Crash – The *Vehicle System* shall ingest BSM Parts I and II data received from remote vehicles to identify imminent danger of a rear-end crash with a remote vehicle in its lane of travel (defined in J2945/1 section 4.2.4.3). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-9.1 Rear-End Crash in Straight Road – The *Vehicle System* shall identify imminent danger of a rear-end crash with a remote vehicle in its lane of travel in a straight roadway geometry.

VS-REQ-9.2 Rear-End Crash in Curved Road – The *Vehicle System* shall identify imminent danger of a rear-end crash with a remote vehicle in its lane of travel in a curved roadway geometry.

VS-REQ-10 FCW No Warning – The *Vehicle System* shall ingest BSM Parts I and II data received from remote vehicles to identify when there is no need to display a warning on the HMI of the host vehicle. Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-10.1 Safely Following a Vehicle – The *Vehicle System* shall identify when no imminent danger of a rear-end crash is present with a remote vehicle in its lane of travel in common roadway geometries.

VS-REQ-10.2 Passing a Stopped Vehicle – The *Vehicle System* shall identify when no imminent danger of a rear-end crash is present with a remote vehicle that is stopped and not in its lane of travel in common roadway geometries.

4.2.4.2 I2V Situational Awareness (SA)

This application enables relevant downstream road condition information including weather alerts, speed restrictions, vehicle restrictions, road conditions, incidents, parking, and road closures to be broadcast from a roadside unit and received by the connected host vehicle. Such information is useful to connected host vehicles that are not fully equipped with weather sensors or to connected host vehicles in paths toward or entering areas with hazardous conditions. The Wyoming pilot will extend this application to use full coverage of the I-80 corridor with satellite communications to send road condition information directly to selected connected vehicles. This step is important for mitigating the short range and sparse placement of RSUs along the corridor. This application will follow the description from J3067 August 2014 Section 2.9.3.6.

VS-REQ-11 SA TIM-Advisories – The *Vehicle System* shall ingest received TIMs to identify advisories (Part III content choice ITIS.ITISCodesAndText defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-12 SA TIM-Speed Limit – The *Vehicle System* shall ingest received TIMs to identify speed limits (Part III content choice speedLimit defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-13 SA TIM-Exit Services – The *Vehicle System* shall ingest received TIMs to identify Exit Services (Part III content choice exitService defined in J2735 section 6.142). This is used to provide parking information if necessary. Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-14 SA TIM-Region – The *Vehicle System* shall ingest received TIMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.

4.2.4.3 Distress Notification (DN). Phase 4 does not include DN.

Distress Notification provides the capability for the vehicle system to broadcast and transmit an emergency message when either the host or a remote vehicle has been involved in a crash or other distress situation. Distress notification application will not be available on all Vehicle Systems (see RFV-REQ-5)

VS-REQ-15 Distress Notification ID – The *Vehicle System* shall identify received distress notifications. Distress information is a high priority messages loosely based on the mayday

broadcast (defined in J3067 3.5.9.2.1), but has the content of the TIM (defined in J2735 5.16 Part III advisory ITIS data elements 6.1 from J2540_2 Accidents and Incidents). **Not part of Phase 4.**

VS-REQ-15.1 Log – The *Vehicle System* shall log received distress notifications to include the DNM. **Not part of Phase 4.**

VS-REQ-16 Create Distress Notification – The *Vehicle System* shall have the ability to generate a distress notification. **Not part of Phase 4.**

~~**VS-REQ-16.1 System-Generated Distress Notification** – The *Vehicle System* shall have the ability to self-generate a distress notification when the vehicle Event Status reports airbag deployment or disabled vehicle code. Vehicle Status data is specified in Section 5.4.2 of the IGD. This requirement no longer applies to this Pilot.~~

VS-REQ-16.2 Driver-Generated Distress Notification – The *Vehicle System* shall have the ability to generate a distress notification when the vehicle operator selects the distress notification activation alternative in the HMI. **Not part of Phase 4.**

VS-REQ-17 DNM-Region – The *Vehicle System* shall ingest received DNMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage. **Not part of Phase 4.**

VS-REQ-18 DN PSID – The *Vehicle System* shall use a unique high priority Provider Service Identifier (PSID) for the distress notification application as per IEEE 1609.12. **Not part of Phase 4.**

4.2.4.4 Work Zone Warning (WZW)

Work Zone Warnings provides information about the conditions that exist in a work zone to vehicles that are approaching the work zone.

VS-REQ-19 WZW TIM – The *Vehicle System* shall ingest received TIMs to identify work zone warnings (Part III content choice workZone defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-20 WZW TIM-Region – The *Vehicle System* shall ingest received TIMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.

4.2.4.5 Spot Weather Impact Warning (SWIW)

Spot Weather Impact Warning will alert drivers to unsafe conditions or road closure at specific points on the downstream roadway as a result of weather-related impacts (e.g., high winds, flood conditions, ice, and fog).

VS-REQ-21 SWIW TIM – The *Vehicle System* shall ingest received TIMs to identify advisories for wind and weather conditions (Part III content choice advisories defined in J2735 section 6.142 for ITIS - data elements 6.54 Weather Conditions and 6.55 Winds defined in J2540_2). Data ingest is defined as obtaining and importing data for use or storage.

VS-REQ-22 SWIW TIM-Region – The *Vehicle System* shall ingest received TIMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.

4.2.5 Provide In-Vehicle Application Alerts (IVAA)

The following requirements pertain to providing in-vehicle application alerts.

VS-REQ-23 IVAA Rank – The *Vehicle System* should provide prioritized in-vehicle alerts based on the rank order presented in Table 4-1 of the SyRS, with the highest rank on top. **Distress Message not included in Phase 4.**

Table 4-1. Rank order of in-vehicle alerts.

Message	Details
Forward Collision Warning	Specified in Section 4.2.4 SAE J2945/1
Distress Message	Distressed vehicle ahead within five miles Not part of Phase 4.
TIM	Spot Weather
TIM	Work Zone Warning
TIM	Variable Speed Limit

VS-REQ-24 IVAA Level – The *Vehicle System* should have three levels of alert, as described in Table 4-2 of the SyRS. **For Phase 4 we will use the off the shelf vendor alerting system.**

Table 4-2. Levels of alert of the Vehicle System.

Alert Level	Description
None	No alert to issue
Inform message	Inform vehicle operator about upcoming alerts or advisories (one low volume beep followed by an HMI message)
Warning 1	Early warning for a dangerous situation (medium volume beep followed by an HMI message)
Warning 2	Urgent warning to take immediate action (three loud volume beeps followed by an HMI message)

VS-REQ-25 IVAA Priority Alert – The *Vehicle System* should provide only the highest priority alert to the vehicle operator when more than one alert is currently active.

VS-REQ-26 IVAA FCW – The *Vehicle System* shall alert the vehicle operator for forward collision warning based on the warning distance calculation algorithm in Section 3.1 of the “Connected Commercial Vehicles—Retrofit Safety Device Kit Project, Safety Applications and Development Plan” (FHWA-JPO-14-106) and guidance for FCW Time-to Collision, Advisories and Alerts provided in SyRS Section 6.1.1 This could be an inform message, warning 1 or warning 2 based on the calculated deceleration rate required. During the design phase a deceleration rate will be selected for a warning 1 and for warning 2 based on vehicle type and weight. **During Phase 4 these will be based on the selected vendor standard for alerting, no customization required.**

VS-REQ-27 IVAA DN – The *Vehicle System* shall alert the vehicle operator for a distress message when the direction of travel of the host vehicle moving toward the distressed vehicle and is within five miles of the location of a distressed vehicle using an inform message. Distress Notification functionality is described in Section 2.6.3 of the SyRS. **DN is not part of Phase 4.**

VS-REQ-28 IVAA SA-Advisory – The *Vehicle System* shall alert the vehicle operator for a situational awareness advisory using an inform message when the host vehicle is traveling within the geofence representing the segment where the situational awareness applies.

VS-REQ-29 IVAA SA-VSL – The *Vehicle System* shall inform the vehicle operator of the current speed limit of the variable speed limit zone. The current speed limit and the variable speed limit

zone are provided by the TIM. This message is not required if the current vehicle speed is lower than the current speed limit or variable speed limit provide by the TIM.

VS-REQ-30 IVAA SWIW – The *Vehicle System* shall alert the vehicle operator of a spot weather incident when the host vehicle is traveling within the geofence of the spot weather location using (Spot Weather functionality is described in Section 2.6.5 of the SyRS).

VS-REQ-31 IVAA WZW – The *Vehicle System* shall alert the vehicle operator of a work zone, based on the information defined in requirement CA-REQ-3, when host vehicle is traveling within the geofence of the work zone using an inform message (Work Zone Warning functionality is described in Section 2.6.4 of the SyRS).

4.2.6 Human-Machine Interface

All Vehicle Sub-systems will provide information to and receive information from the driver of the host vehicle through a Human-Machine Interface (HMI). HMIs can be either mounted in the vehicle as new equipment (e.g., tablet or touch panel) or installed in existing ones (e.g., tablets or smartphones).

VS-REQ-32 HMI Characteristics – All Vehicle Sub-systems shall contain an HMI that conforms to the following characteristics.

VS-REQ-32.1 HMI-Location – The location where the devices will be mounted/installed shall be selected so that they do not obstruct the line of sight of the driver nor distract the driver from the primary task of driving.

VS-REQ-32.2 HMI-Distraction –The HMI shall minimize the ‘eyes off the road’ time when presenting information for an application.

VS-REQ-32.3 HMI-Readability – The HMI shall provide messages that can be read from the driver’s normal seating position.

VS-REQ-32.4 Visual and Auditory Interface – The HMI shall include both a visual and auditory interface for sharing traveler information.

VS-REQ-32.4.1 Visual Consistency – The HMI shall maintain a consistent structure across applications with respect to presenting information to drivers and inputs to the system.

VS-REQ-32.4.2 Audio Signals – Auditory signals shall be loud enough to overcome masking sounds from road noise, the cab environment, and other equipment. **In Phase 4 the OBU should support an audio output line to be used if HMI is not configured.**

VS-REQ-32.5 Customizations – HMI characteristics shall be customizable to reflect driver preferences. Preferences that may be customizable are:

- Volume
- Brightness
- Contrast text size
- Display contrast
- Mounting eye position

VS-REQ-32.6 System Status – The HMI shall provide system status information to drivers.

VS-REQ-32.6.1 Power Status – The HMI shall notify the driver of the power status of device with the screen graphics (i.e., off, powering up and online).

VS-REQ-32.6.2 System Settings – The HMI shall allow the driver to see the system settings of the device with screen graphics. (i.e., version, brightness, volume font size).

VS-REQ-32.6.3 Application Availability – The HMI shall allow the driver to see application availability with screen graphics (i.e., failed, operating, disabled).

VS-REQ-32.6.4 Pending Update Status – The HMI shall allow the driver to see pending updates for the device with screen graphics (i.e., applications, firmware, operating system).

VS-REQ-32.7 Distress Notification – The HMI shall include a distress button to allow a driver to notify the Vehicle System that the driver has initiated a distress condition (Distress Notification functionality is described in Section 2.6.3 of the SyRS). **Phase 4 will not include distress notification.**

VS-REQ-32.8 Non-Distress Information – The HMI shall allow the driver to input data, as defined in VS-REQ-4.2. **Phase 4 will not include non-distress information.**

4.2.7 Broadcast Vehicle Information (BCVI)

VS-REQ-33 BCVI Messages – The *Vehicle System* shall wirelessly broadcast over DSRC a basic safety message (BSM) to other connected devices. **Phase 4 will use C-V2X rather than DSRC for wireless broadcasts of BSMs.**

VS-REQ-34 BCVI Distress – The *Vehicle System* shall wirelessly broadcast distress messages to other connected devices. Distress information is a high priority messages based on the mayday broadcast (defined in J3067 3.5.9.2.1) but has the content of the TIM (defined in J2735 5.16 Part III advisory ITIS data elements 6.1 from J2540 2 Accidents and Incidents). **Phase 4 will not include BCVI Distress.**

VS-REQ-34.1 Received Distress – The *Vehicle System* shall broadcast distress notifications (over DSRC), received from remote vehicles, for five miles from the location where the distressed vehicle is located. **Phase 4 will not include received distress messages.**

VS-REQ-34.2 Generated Distress - The *Vehicle System*, in distress (described in Section 2.6 of the SyRS), shall broadcast generated distress notifications over DSRC, until the vehicle event code that triggered the distress notification is reset or power is lost (whichever comes first). **Phase 4 will not include generated distress notifications.**

VS-REQ-35 BCVI General Broadcast Requirements – The *Vehicle System* shall use the general broadcast requirements defined in Appendix A.4 Broadcast Traveler Information of the SyRS. **Phase 4 will not include the broadcast of traveler information.**

4.2.8 Transmit Information (TI)

VS-REQ-36 Transmit Data – The *Vehicle System* shall transmit data over DSRC. **Phase 4 shall not use DSRC and should test Wi-Fi.**

VS-REQ-36.1 Transmit Environmental Data – The *Vehicle System* shall transmit over DSRC environmental data, defined in Table 7-4 of the SDD, to the *Wyoming CV System* when available from a vehicle Sub-system. **Phase 4 will not include transmitting of environmental data.**

VS-REQ-36.2 TVI Data Management-Log – The *Vehicle System* shall transmit log files via secure copy (SCP) to the *Wyoming CV System* over Wi-Fi that contain event logs data defined in VS-REQ-41. **Phase 4 should transmit logs via Wi-Fi.**

4.2.9 Communication Performance

VS-REQ-37 Communication Performance – All *Vehicle Sub-systems* shall follow all core communication requirements defined in Appendix A.6 of the SyRS. *This requirement no longer applies to this system.*

4.2.10 Store Local Data (SLD)

VS-REQ-38 SLD Information – The *Vehicle System* shall store information generated by the host vehicle on local storage. Information to be stored is detailed in Table 4-3 of the SyRS.

Table 4-3. Information to be stored on local storage.

Messages	Details
Vehicle Data	Desired Vehicle Status data is specified in VS-REQ-4 Collect Vehicle Data
Distress Notification	Application message is based on high priority TIM in J2735. Not part of Phase 4.
Environmental data	Defined in VS-REQ-5 External Environment Sensor Data. Not part of Phase 4.

VS-REQ-39 SLD Rolling Log – The *Vehicle System* shall maintain rolling logs for in vehicle generated CV data for 10 seconds. Table 4-4 of the SyRS lists one or more sources of the rolling logs that may be available in a vehicle Sub-system.

Table 4-4. Data types that need a rolling log.

Data type	Description of what is logged
BSM broadcast	Parts I and II (defined in Section 7.1.1 of the ICD)
Vehicle Status Data	Specified in VS-REQ-4.1. Not part of Phase 4.

VS-REQ-40 SLD Log Format – The event log format shall contain UTC time stamped text.

VS-REQ-41 SLD Log Data – The *Vehicle System* shall create event logs for all interactions with the *Wyoming CV System* or *Vehicle System* that is retained until it is sent to the *Wyoming CV System* or is older than seven (7) days. An interaction is defined as a received message from the *Wyoming CV System* or the *Vehicle System*. Each log should contain the information in Table 4-5 of the SyRS.

Table 4-5. Data for event log.

Data type	Description
In vehicle data from rolling log	Data from 10 seconds before interaction, data throughout interaction, data from 10 seconds after interaction.
Time based BSM log	Every 30 seconds log a BSM.
External CV data	Data received from the <i>Wyoming CV System</i> to include core data from TIMs and SCMS. The core data is the message elements listed in J2735.
External CV data	Data received from the <i>Vehicle System</i> outside of the in vehicle generated data to include core data from received BSM parts I and II, TIM, and distress messages. The core

	data is the message elements listed in J2735 as well as the message header. Phase 4 excludes distress messages.
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4.2.11 Vehicle System Management (VSM)

VS-REQ-42 VSM SCMS – The *Vehicle System* shall use the ISS SCMS Certificates in accordance with the security and privacy requirements in Section 6.5 of J2945/1.

VS-REQ-43 VSM SCMS Encryption – The *Vehicle System* shall use the ISS SCMS Certificates to sign and encrypt messages transmitted. The approved encryption algorithms are defined in IEEE 1609.2 and explained in [USDOT SCMS CAMP Wiki Cryptography](#).⁷ **Phase 4 will not include any encryption of messages.**

VS-REQ-44 VSM SCMS Sign – The *Vehicle System* shall use the ISS SCMS Certificates to sign, but not encrypt, all broadcasted messages.

VS-REQ-45 VSM SCMS Encryption-Log – The *Vehicle System* shall use the ISS SCMS Certificates to encrypt log files stored locally using the Public Key Encryption defined in [USDOT SCMS CAMP Wiki Cryptography](#). Password protection is also allowable protection for log files. **Phase 4 will not include any encryption of messages.**

VS-REQ-46 VSM SCMS Sign-Log – The *Vehicle System* shall use the ISS SCMS Certificates to sign log files stored locally. Password protection is also allowable for in place of signing log files. **Phase 4 will not include any signing of log files.**

VS-REQ-47 VSM App Availability Log – The *Vehicle System* shall log local application availability to the local event logs by vehicle type. This will contain application restarts and availability based on application availability testing defined in FHWA-JPO-16-292 Connected Vehicle Pilot Deployment Program Phase 1, Application Deployment Plan. **Phase 4 will not include any app availability logs.**

VS-REQ-48 VSM Updates – The *Vehicle System* should support Over-the-Air (OTA) software updates from the *Wyoming CV System* based on WAVE Service Announcements (WSA).

4.2.12 Vehicle System Core Architecture Requirements

VS-REQ-49 Architectural –Vehicle Sub-systems shall follow all core architectural requirements defined in Appendix A.2 OBU Core Architecture Requirements of the SyRS.

VS-REQ-50 Safety Communication –Vehicle Sub-systems shall follow all core safety communication requirements defined in Appendix A.3 V2V Core Safety Communication Requirements of the SyRS.

VS-REQ-51 VS Equipment –Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.

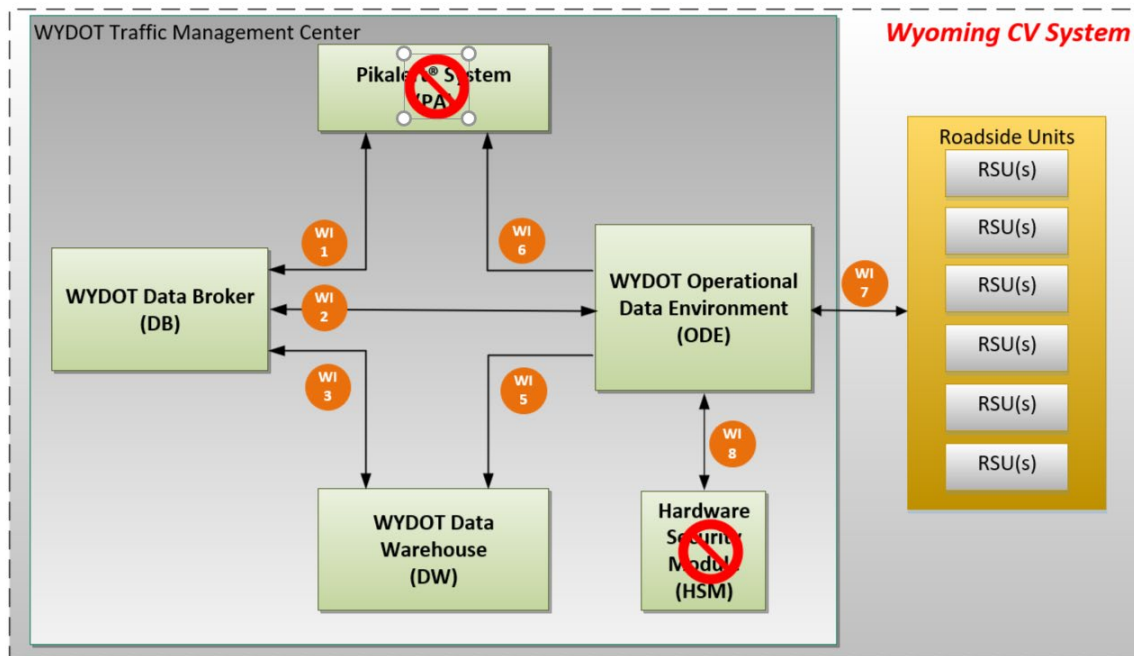
⁷ Available at <https://wiki.campllc.org/display/SCP/Approved+Cryptographic+Algorithms>

5 Sub-System Requirements

This chapter presents the Sub-system requirements that are decomposed from the top-level system requirements.

5.1 Wyoming CV System's Sub-System Requirements

The Wyoming Connected *Vehicle Systems* is composed of five Sub-systems that provide the capabilities of receiving CV and non-CV data, processing it, generating alerts and advisories, distributing the generated information to relevant destinations, and storing all information for further analysis—as explained in Section 2 of this document. The Sub-system figure is reproduced here from Section 2.




NOTE:  shows items not part of Phase 4.

Figure 5-1. Wyoming CV System Sub-System.
Source: WYDOT

Table 5-1 maps out the system requirements identified in Section 4.1 of this document to the Sub-systems. A detail trace of Sub-system requirements to System and Interface requirements is provided in Section 7 (Table 7-2) of the SyRS.

5. Sub-System Requirements

Table 5-1. Mapping of System Requirements to the Wyoming CV Sub-Systems.

System Requirement	RSU	ODE	PA	DB	DW	HSM
USDOT Interfaces						
SCMS-REQ-1 WCVS SCMS Use	X	X				X
SCMS-REQ-1.1 SCMS WCVS Certificates	X	X				X
SCMS-REQ-1.2 SCMS WCVS Misbehavior Reporting	X	X				X
SCMS-REQ-1.3 SCMS WCVS Certificates Revocation List (CRL)	X	X				X
SCMS-REQ-1.4 SCMS WCVS Rejection	X	X				X
SDX-REQ-1 ODE Data Provided to the SDX		X				X
SDX-REQ-2 Distribute TIM to VS		X				
SDC-REQ-1 Data Provided to the SDC, not in Phase 4		X				
RDE-REQ-1 Data Provided to the RDE, not in Phase 4		X				
External Interfaces						
LTS-REQ-1 WCVS Time	X	X				
LTS-REQ-1.1 WCVS LTS Time	X	X				
LTS-REQ-1.2 WCVS Time Synchronization		X				
LTS-REQ-2 WCVS LTS Time Standard	X	X				
LTS-REQ-3 WCVS LTS Location	X	X				
WYDOT Interfaces						
511-REQ-1 511App Parking Data Collection				X		
511-REQ-1.1 Availability				X		
511-REQ-1.2 Default				X		
511-REQ-1.3 Time				X		
511-REQ-1.4 Location				X		
511-REQ-1.5 Protocol				X		
511-REQ-1.6 Schema				X		
511-REQ-2 Timeframe				X		
TPI-REQ-1 TPI Data				X		
TRAC-REQ-1 TRAC Updates				X		
TRAC-REQ-1.1 Distress Notification, not in Phase 4				X		
TRAC-REQ-1.1.1 Transmission Time				X		
TRAC-REQ-1.2 Segment Alerts				X		
TRAC-REQ-1.2.1 Transmission Time				X		
TRAC-REQ-1.2.2 Segment Alerts-Pikalert, not in Phase 4				X		
RCCS-REQ-1 RCCS Data Sharing				X		
RCCS-REQ-1.1 Road Condition				X		
RCCS-REQ-1.2 Weather				X		
RCCS-REQ-1.3 Other Road Condition				X		
RCCS-REQ-1.4 Report Time				X		
RCCS-REQ-1.5 Location				X		

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System Requirement	RSU	ODE	PA	DB	DW	HSM
RCRS-REQ-1.6 Transmit Time				X		
WTI-REQ-1 WTI Inputs				X		
WTI-REQ-1.1 Current Segment Alerts, not in Phase 4				X		
WTI-REQ-1.1.1 Transmission Time				X		
WTI-REQ-1.2 Forecast Segment Alerts, not in Phase 4				X		
WTI-REQ-1.2.1 Forecast Time, not in Phase 4				X		
WTI-REQ-1.2.2 Forecast Update, not in Phase 4				X		
WTI-REQ-2 WTI Outputs				X		
WTI-REQ-2.1 Posted Speed				X		
WTI-REQ-2.2 Vehicle Restrictions				X		
WTI-REQ-2.2.1 Restriction Information				X		
WTI-REQ-2.2.2 Restriction Start Time				X		
WTI-REQ-2.3 Posted Messages				X		
WTI-REQ-2.3.1 Message Information				X		
WTI-REQ-2.4 Posted Closures				X		
WTI-REQ-2.4.1 Closure Beginning				X		
WTI-REQ-2.4.2 Closure End				X		
WTI-REQ-2.4.3 Closure Start Time				X		
CVOP-REQ-1 CVOP Inputs				X		
CVOP-REQ-1.1 Current Segment Alerts				X		
CVOP-REQ-1.1.1 Transmission Time				X		
CVOP-REQ-1.2 Forecast Segment Alerts, not in Phase 4				X		
CVOP-REQ-1.2.1 Forecast Time, not in Phase 4				X		
CVOP-REQ-1.2.2 Forecast Update, not in Phase 4				X		
IC-REQ-1 IC Data Sharing				X		
IC-REQ-2 Protocol				X		
IC-REQ-3 Schema				X		
IC-REQ-4 Transmission				X		
CA-REQ-1 CA Data Sharing				X		
CA-REQ-2 Protocol				X		
CA-REQ-3 Schema				X		
CA-REQ-4 Transmission				X		
ITSM-REQ-1 WYDOT ITS Alerts				X		
Weather Interfaces						
WI-REQ-1 External Data Acquisition, not in Phase 4			X			
WI-REQ-2 Fixed Data Acquisition, not in Phase 4			X			
Wyoming CV System (WCVS)						
WCVS-REQ-1 Collect CV Data	X	X				
WCVS-REQ-1.1 Collect BSM Data	X	X				
WCVS-REQ-1.2 Collect Environmental Sensor Data, not in Phase 4	X	X				

5. Sub-System Requirements

System Requirement	RSU	ODE	PA	DB	DW	HSM
WCVS-REQ-1.3 Collect Distress Messages, not in Phase 4	X	X				
WCVS-REQ-2 Validate Data		X				
WCVS-REQ-3 Ingest Data for Road Weather Information, not in Phase 4		X	X	X		
WCVS-REQ-4 Contents of Alerts and Advisories, not in Phase 4			X			
WCVS-REQ-4.1 Precipitation Hazard, not in Phase 4			X			
WCVS-REQ-4.2 Road Condition Hazard, not in Phase 4			X			
WCVS-REQ-4.3 Visibility Hazard, not in Phase 4			X			
WCVS-REQ-4.4 Work Zone Hazard				X		
WCVS-REQ-4.5 Incident Hazard				X		
WCVS-REQ-4.6 Parking				X		
WCVS-REQ-5 Forecast Conditions, not in Phase 4			X			
WCVS-REQ-5.1 Atmospheric Forecasts, not in Phase 4			X			
WCVS-REQ-5.2 Road Weather Forecasts, not in Phase 4			X			
WCVS-REQ-5.3 Forecast Time, not in Phase 4			X			
WCVS-REQ-5.4 Forecast Update, not in Phase 4			X			
WCVS-REQ-6 Associate Alerts and Forecast to Segments, not in Phase 4			X			
WCVS-REQ-7 External Brokerage with WYDOT Interfaces				X		
WCVS-REQ-7.1 Receive from WYDOT External Interfaces				X		
WCVS-REQ-7.2 Distribute to WYDOT External Interfaces				X		
WCVS-REQ-8 Internal Brokerage	X	X	X	X	X	
WCVS-REQ-9 Create TIM				X		
WCVS-REQ-10 Distribute TIM	X	X				X
WCVS-REQ-10.1 Distribute TIM to VS	X	X				X
WCVS-REQ-10.2 Distribute TIM to SDX		X				X
WCVS-REQ-11 Store VS Data					X	
WCVS-REQ-11.1 Store BSM					X	
WCVS-REQ-11.2 Store Environment Sensor Data, not in Phase 4					X	
WCVS-REQ-11.3 Store Distress Messages, not in Phase 4					X	
WCVS-REQ-12 Store Generated Alerts/Advisories					X	
WCVS-REQ-13 Store TIM					X	
WCVS-REQ-14 Store System Monitoring Data					X	

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System Requirement	RSU	ODE	PA	DB	DW	HSM
WCVS-REQ-15 Notifications	X	X	X	X	X	
WCVS-REQ-16 Monitored Functions	X	X	X	X	X	
WCVS-REQ-16.1 Sub-System Availability	X	X	X	X	X	
WCVS-REQ-16.2 Sub-System Performance, not in Phase 4	X	X	X	X	X	
WCVS-REQ-16.3 Availability for Interfaces	X	X	X	X	X	
WCVS-REQ-16.4 Availability for Data Storage	X	X	X	X	X	
WCVS-REQ-17 Archive Data					X	
WCVS-REQ-18 Management and Performance Policy, not in Phase 4	X					
WCVS-REQ-19 Manage Architecture						
WCVS-REQ-20 Manage Safe Communications	X					
WCVS-REQ-21 Manage CV Equipment	X				X	
WCVS-REQ-22 Test WCVS Equipment	X	X				
WCVS-REQ-23 Track WCVS Equipment	X	X			X	
WCVS-REQ-24 Update WCVS Equipment	X	X				
WCVS-REQ-25 Update VS Equipment	X	X				

5.1.1 Roadside Units (RSU)

RSUs include DSRC connectivity, application support, data storage, and other support services to enable CV applications, such as necessary certificates. In general, RSUs serve as a two-way communication portal between connected vehicles that provide information through DSRC and the Operational Data Environment. **In Phase 4 C-V2X will replace DSRC.**

RSU-REQ-1 Collect CV Data – The Roadside Units shall collect data from the *Vehicle System*, as defined in WCVS-REQ-1.

RSU-REQ-2 Distribute TIM to VS – The Roadside Units shall distribute TIMs received from the ODE to the *Vehicle System*, as defined in WCVS-REQ-10.

RSU-REQ-3 SCMS – The Roadside Units shall interface with the ISS SCMS, as defined in SCMS-REQ-1.

RSU-REQ-4 LTS – The Roadside Units shall interface with the USDOT LTS, as defined in LTS-REQ-1.

~~**RSU-REQ-5 Architectural**~~ – ~~The Roadside Units shall follow all core architectural requirements defined in Appendix B.2 of the SyRS. This requirement no longer applies to this system.~~

RSU-REQ-6 Safety Communication – The Roadside Units shall follow all core safety communication requirements defined in Appendix B.2 V2I Core Safety Communication Requirements of the SyRS. **In Phase 4, RSU should support ethernet connected smart sensors for Vulnerable Road User detection.**

RSU-REQ-7 Broadcast – The Roadside Units shall broadcast information following all requirements defined in Appendix B.3 RSU Broadcast Traveler Information of the SyRS.

~~RSU-REQ-8 Transmit~~—The Roadside Units shall transmit information following all requirements defined in Appendix B5-B.4 of the SyRS. *This requirement no longer applies to this system.*

~~RSU-REQ-9 Receive from VS~~—The Roadside Units shall receive information following all requirements defined in Appendix B6 of the SyRS. *This requirement no longer applies to this system.*

RSU-REQ-10 Management and Performance – The Roadside Units shall manage the policy for data collection and performance data following all requirements defined in Appendix RSU Performance Data of the SyRS. **Phase 4 will not include management and performance data collection.**

RSU-REQ-11 Distribute to ODE – The Roadside Units shall transmit all collected information to the Operational Data Environment, as described in Section 5.18.1 of the ICD.

RSU-REQ-12 Receive Update – The Roadside Units shall receive firmware updates from the TMC administrator. **In Phase 4, updates shall support rollback if update fails.**

RSU-REQ-13 RSU Equipment – Roadside Unit equipment shall conform to the characteristics described in Appendix A of the CAP.

5.1.2 Operational Data Environment (ODE)

The WYDOT ODE is a Sub-system that ingests CV-data from the connected devices field and shares it with various other Sub-systems. The ODE also disseminates data back to connected devices and the Situation Data Exchange, and interfaces with the SCMS. The ODE code has been developed by USDOT and will be used in the pilot. Functional requirements for the ODE are being currently defined by USDOT.

ODE-REQ-1 Collect CV Data – The Operational Data Environment shall collect *Vehicle System* data, defined in WCVS-REQ-1, from the RSU and/or the Vehicle System.

ODE-REQ-2 Data Processing – The Operational Data Environment shall provide the VISA-related functions of CV Data as defined in Section 3.1.4.1 of the SDD.

ODE-REQ-3 Distribute Data – The Operational Data Environment shall distribute processed CV information to other External Interfaces, Systems, and Sub-systems.

ODE-REQ-3.1 Distribute TIM to RSU – The Operational Data Environment shall distribute TIMs to the RSU, to be later transmitted to the *Vehicle System*, as defined WCVS-REQ-10.1.

ODE-REQ-3.2 Distribute TIM to SDX – The Operational Data Environment shall distribute TIMs to the Situation Data Exchange, as defined in WCVS-REQ-10.2.

ODE-REQ-3.3 Distribute to Pikalert – The Operational Data Environment shall distribute Environmental Data to the Pikalert System, as described in Section 5.19 of the ICD. **Pikalert will not be part of Phase 4.**

ODE-REQ-3.4 Distribute to Data Warehouse – The Operational Data Environment shall distribute all collected and processed information to the Data Warehouse, as described in Section 5.20 of the ICD.

ODE-REQ-3.4.1 Distribute to Data Warehouse-BSM – The Operational Data Environment shall distribute all collected and processed BSM information to the Data Warehouse, as described in Section 5.20 of the ICD.

ODE-REQ-3.4.2 Distribute to Data Warehouse-DNM – The Operational Data Environment shall distribute all collected and processed DNM information to the Data Warehouse, as described in Section 5.20 of the ICD. **Phase 4 will not include distress notification messages.**

ODE-REQ-3.4.3 Distribute to Data Warehouse-ES – The Operational Data Environment shall distribute all collected and processed Environmental Sensor information to the Data Warehouse, as described in Section 5.20 of the ICD. **Environmental sensor data will not be collected in Phase 4.**

ODE-REQ-3.5 Distribute to Data Broker – The Operational Data Environment shall distribute distress information to the Data Broker, as described in Section 5.21.1 of the ICD. **Distress information will not be part of Phase 4.**

ODE-REQ-3.6 Distribute to SDC – The Operational Data Environment shall distribute CV data to the Secure Data Commons, as defined in Section 5.37.1 of the ICD. **The SDC will not be part of Phase 4.**

ODE-REQ-3.7 Distribute to RDE – The Operational Data Environment shall distribute CV data to the Research Data Exchange, as defined in Section 5.40.1 of the ICD. **The RDE will not be part of Phase 4.**

ODE-REQ-4 SCMS – The Operational Data Environment shall interface with the USDOT SCMS, as defined in SCMS-REQ-1.

ODE-REQ-5 LTS – The Operational Data Environment shall interface with the USDOT LTS, as defined in LTS-REQ-1.

ODE-REQ-6 OBU Updates – The Operational Data Environment should send OTA firmware updates to the OBU. **The ODE will not be part of OTA firmware updates in Phase 4.**

ODE-REQ-7 Receive Data from DB – The Operational Data Environment shall receive information from the Data Broker, as defined in Section 5.21.2 of the ICD.

ODE-REQ-8 Generate TIM for Connected Vehicles – The ODE shall generate traveler information messages (TIMs), as defined in J2735 (5.16 Message: MSG_Traveler Information Message (TIM)).

5.1.3 Pikalert System (PA). PA will not be part of Phase 4

The Pikalert Sub-system, developed by NCAR, ingests CV-data, fuses it with other weather data sources and generate alerts and advisories for I-80.

PA-REQ-1 External Weather Data – The Pikalert System shall receive weather information, as defined in WI-REQ-1 and WI-REQ-2. **Not in Phase 4**

PA-REQ-2 Wyoming CV Sub-Systems Data – The Pikalert System shall receive information from other Wyoming CV Sub-systems. **Not in Phase 4**

PA-REQ-2.1 ODE Data – The Pikalert System shall receive CV data from the Operational Data Environment as defined in ODE-REQ-3.3. **Not in Phase 4**

PA-REQ-2.2 TMC Data – The Pikalert System shall receive camera imagery from the TMC File Transfer Protocol (FTP) server as described in Section 5.26.1 of the ICD. **Not in Phase 4**

PA-REQ-3 Generate Alerts/Advisories and Forecasts – The Pikalert System shall generate alerts, advisories and forecasts, defined in WCVS-REQ-4. Detailed requirements for how the

Pikalert System generates alerts are in the reference document “Motorist Alert and Warning Application, Detailed System Requirements, Final Report — Feb 28, 2014”, developed by NCAR for FHWA. **Not in Phase 4**

PA-REQ-4 Distribute Alerts/Advisories and Forecasts – The Pikalert System shall distribute alerts, defined in WCVS-REQ-4 to other Sub-systems. **Not in Phase 4**

PA-REQ-4.1 Distribute to DB – The Pikalert System shall transmit generated information to the Data Broker, as described in Section 5.27 of the ICD. **Not in Phase 4**

~~**PA-REQ-4.2 Distribute to DW** – The Pikalert System shall transmit generated information to the Data Warehouse within five minutes of generation of the alert, as described in Sections 5.27.1.3.1 and 5.27.2.3.1 of the ICD. This requirement no longer applies to this system.~~

5.1.4 WYDOT Data Broker (DB)

The WYDOT Data Broker (DB) is a Sub-system that moves data between various Sub-systems and external interfaces.

DB-REQ-1 Receive from External Interfaces – The Data Broker shall receive data from WYDOT system as defined in the external interface requirements as defined in 511-REQ-1, RCRS-REQ-1, WTI-REQ-2, IC-REQ-1, and CA-REQ-1.

DB-REQ-2 Distribute to External Interfaces – The Data Broker shall distribute information to WYDOT systems as defined in TRAC-REQ-1, TPI-REQ-1, WTI-REQ-1, CVOP-REQ-1, and ITSM-REQ-1. **TPI-REQ-1 is not part of Phase 4.**

~~**DB-REQ-3 Generate TIM for Connected Vehicles** – The DB shall generate traveler information messages (TIMs), as defined in J2735 (5.16 Message: MSC_Traveler Information Message (TIM)). This requirement no longer applies to this system.~~

DB-REQ-4 Receive from Pikalert – The DB shall receive all generated segment-level information from Pikalert. **Pikalert will not be part of Phase 4.**

DB-REQ-4.1 Receive Alerts and Advisories – The DB shall receive all generated segment-level alerts and advisories from Pikalert, as described in Section 5.27.1 of the ICD. **Not in Phase 4**

DB-REQ-4.2 Receive Forecast – The DB shall receive all generated segment-level forecast information from Pikalert, as described in Section 5.27.2 of the ICD. **Not in Phase 4**

DB-REQ-5 Distribute to ODE – The DB shall transmit TIM information to the ODE, as defined in Section 5.21.2 of the ICD.

DB-REQ-6 Receive from ODE – The DB shall receive distress information from the ODE, as defined in Section 5.21.1 of the ICD. **Distress information will not be part of Phase 4.**

DB-REQ-7 Distribute to Data Warehouse – The DB shall transmit information to the Data Warehouse as defined in Table 5-2 of the SyRS.

Table 5-2. Information shared with the Data Warehouse.

Data type	Description	Defined in the ICD
TIM	All TIMs generated by the ODE shall be transmitted to the DW	Section 5.35.1.3.1
Distress Notifications	All Distress Notifications received by the DB shall be transmitted to the DW, not part of Phase 4.	Section 5.21.1.3.1 sequence diagram message [30]

Data type	Description	Defined in the ICD
Alerts and Advisories	All Alerts and Advisories received by the DB shall be transmitted to the DW	Section 5.27.1.3.1 sequence diagram message [30]
Forecast	All forecasts received by the DB shall be transmitted to the DW, not part of Phase 4.	Section 5.27.2.3.1 sequence diagram message [30]

DB-REQ-8 Receive Data from DW– The DB shall receive current TIM information from the DW. Current TIM information is defined in DB-REQ-7.

DB-REQ-9 Distribute to SDC – The DB shall manually upload data to the SDC as defined in ICD Section 5.39.1. Phase 4 will not include the SDC.

5.1.5 WYDOT Data Warehouse (DW)

WYDOT Data Warehouse is the central repository of both CV and non-CV data at the TMC. The Data Warehouse also provides incident information and planned work zone information to the WYDOT data broker.

DW-REQ-1 Store Data – The Data Warehouse shall store all data collected and generated by the *Wyoming CV System*, as defined in DW-REQ-1.1, DW-REQ-1.2, DW-REQ-1.3, and DW-REQ-1.4.

DW-REQ-1.1 Store Alerts/Advisories and Forecasts – The Data Warehouse shall store all generated alerts, advisories and forecasts, as defined in WCVS-REQ-12.

DW-REQ-1.1.1 Store Alerts/Advisories-Precipitation Hazard – The Data Warehouse shall store all generated precipitation hazard alerts, advisories and forecasts, as defined in WCVS-REQ-12. **Not in Phase 4**

DW-REQ-1.1.2 Store Alerts/Advisories- Road Condition Hazard – The Data Warehouse shall store all generated road condition hazard alerts, advisories and forecasts, as defined in WCVS-REQ-12. **Not in Phase 4**

DW-REQ-1.1.3 Store Alerts/Advisories-Visibility Hazard – The Data Warehouse shall store all generated visibility hazard alerts, advisories and forecasts, as defined in WCVS-REQ-12. **Not in Phase 4**

DW-REQ-1.1.4 Store Alerts/Advisories-Work Zone Hazard – The Data Warehouse shall store all generated work zone hazard alerts and advisories, as defined in WCVS-REQ-12.

DW-REQ-1.1.5 Store Alerts/Advisories-Incident Hazard – The Data Warehouse shall store all generated incident hazard alerts and advisories, as defined in WCVS-REQ-12.

DW-REQ-1.1.6 Store Alerts/Advisories-Parking – The Data Warehouse shall store all generated parking alerts and advisories, as defined in WCVS-REQ-12.

DW-REQ-1.2 Store Vehicle System Data – The Data Warehouse shall store all data collected by the *Vehicle Systems*, as defined in WCVS-REQ-11.

DW-REQ-1.3 Store TIM – The Data Warehouse shall store all TIMs distributed to the *Vehicle System* and the Situation Data Exchange, as defined in WCVS-REQ-13.

DW-REQ-1.4 Store System Monitoring Data – The Data Warehouse shall store all system monitoring data, as defined in WCVS-REQ-14.

DW-REQ-2 Share Data – The Data Warehouse shall provide access to stored information to Wyoming CV Sub-Systems and External Interfaces defined in DW-REQ-2.1, DW-REQ-2.2, DW-REQ-2.3 and DW-REQ-2.4.

DW-REQ-2.1 Share Data with TPI – The Data Warehouse shall transmit information to the TPI, as defined in Section 5.36.1 of the ICD. **Not in Phase 4**

DW-REQ-2.2 Share Data with SDC – The Data Warehouse shall transmit information to the SDC, as defined in Section 5.38.1 of the ICD. **The SDC will not be part of Phase 4.**

DW-REQ-2.3 Share Data with RDE – The Data Warehouse shall transmit information to the RDE, as defined in Section 5.41.1 of the ICD. **The RDE will not be part of Phase 4.**

DW-REQ-2.4 Share Data with DB – The DW shall share current TIM information, including starting and stopping milepost, TIM ID, active RSU ID, and RSU TIM index, with the DB. The DW receives TIM information from the DB, as defined in DB-REQ-7.

DW-REQ-3 Data Storage Administration – This requirement addresses administration of data storage. The DW shall perform the following administrative functions:

- Maintain System Data Tables
- Manage Data Storage Security
- Manage Data System
- Manage Archive

DW-REQ-3.1 Maintain System Data Tables – The DW shall maintain (i.e., update data columns for additional data fields as necessary, build views for authorized audiences needing to interact with the data) tables of data coming from connected vehicles and other sources used by the connected vehicle pilot. The views built will be based on requests made by the Performance Management and IE team that are not currently defined.

DW-REQ-3.1.1 CVE Data – The DW shall maintain the tables for CVE Data. This includes space for data from BSM related application data, driver/fleet related data, and performance management data.

DW-REQ-3.2 Manage Data Storage Security – The Data Warehouse shall have a designated TMC data storage administrator who will maintain security for data collected by the CV pilot within compliance of Sections 7(D), 7(E), 7(F), 7(G) and Appendix 11 – SMOC (Section 6.2) of the Institutional Review Board (University of Wyoming, 2016).

DW-REQ-3.2.1 User Access – The DW shall be implemented to control granular access to the CV data storage at the column to the table space resolution to people with a need to know and that have been approved by the WYDOT program manager.

DW-REQ-3.2.2 Unauthorized Access – The DW shall be implemented to notify the TMC administrator of attempted access by unauthorized personnel to the CV data storage to all users that have not been specifically approved by the WYDOT program manager.

DW-REQ-3.3 Manage Data System – The Data Warehouse shall have a designated TMC data storage administrator who will manage the data systems for the CV pilot. The following three requirements address data system management at the TMC and the cloud databases used by the CV pilot.

DW-REQ-3.3.1 System Back-ups – The DW shall provide the TMC administrator the ability to back up the data, provided by the WYDOT CV System, using WYDOT best practices for data protection, as stated in Section 2.5 of the Data Management Plan

(FHWA-JPO-17-470) (Kitchener et al., 2017). This will be done for the development, test, quality assurance and production environments.

DW-REQ-3.3.2 Import/Export – The DW shall provide the TMC administrator the ability to perform import/export operation as needed for the CV pilot data.

DW-REQ-3.3.3 Version Control – The DW shall provide the TMC administrator the ability to maintain version control for the data systems in use by the CV pilot.

DW-REQ-3.4 Manage Data Archive – The DW shall provide the TMC administrator the ability to archive data used by the CV pilot data to be retained using WYDOT best practices for data archival, as stated in Section 2.5 of the Data Management Plan (FHWA-JPO-17-470) (Kitchener et al., 2017).

DW-REQ-4 Receive Data – The Data warehouse shall receive information sent from other Sub-systems.

5.1.6 Hardware Secure Module

The hardware security module (HSM) will manage the Wyoming CV System's certifications. **In Phase 4 the HSM will not be part of the Wyoming CV System, it will be an outsourced part of the ISS SCMS cloud called the TMCA.**

HSM-REQ-1 Receive from ODE – The HSM shall receive unsigned TIMs from the ODE as defined in Section 3.1.4.1 of the SDD. **Not in Phase 4**

HSM-REQ-2 Share with ODE – The HSM shall provide signed TIMs to the ODE as defined in Section 3.1.4.1 of the SDD. **Not in Phase 4**

HSM-REQ-3 Receive from SCMS – The HSM shall receive updated certificates from the SCMS as defined in Section 3.1.3 of the SDD. **Not in Phase 4**

HSM-REQ-4 Share with SCMS – The HSM shall shares authentication data with the SCMS as defined in Section 3.1.3 of the SDD. **Not in Phase 4**

5.2 Vehicle Sub-System Requirements

The *Vehicle Systems* is composed of four Sub-systems that provide the capabilities of collecting, receiving and sharing data, processing it, presenting alerts and advisories to drivers, and storing information for a limited time—as described in Section 2.2 of the SyRS. Table 5-3 maps out the system requirements identified in Section 4.2 to the Sub-systems. A detail trace of Sub-system requirements to System and Interface requirements is provided in Section 7 (Table 7-3) of the SyRS.

Table 5-3. Mapping of System Requirements to the Vehicle Sub-Systems.

System Requirement		MV	HPV	IT	RFV
Vehicle System					
VS-REQ-1	Receive BSM	X	X	X	X
VS-REQ-2	Receive TIM	X	X	X	X
VS-REQ-2.1	Receive TIM through DSRC (C-V2X in Phase 4)	X	X	X	X
VS-REQ-2.2	Receive TIM Through Satellite	X	X	X	X
VS-REQ-3	Receive Distress Information, not in Phase 4	X	X	X	
VS-REQ-4	Collect Vehicle Data , not in Phase 4	X	X	X	X
VS-REQ-4.1	Collect Vehicle Status Data, not in Phase 4	X			

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System Requirement		MV	HPV	IT	RFV
VS-REQ-4.2	Collect Dimension Data, not in Phase 4	X	X	X	X
VS-REQ-4.2.1	Vehicle Dimension Data, not in Phase 4	X	X	X	X
VS-REQ-4.2.2	Vehicle Trailer Data, not in Phase 4	X	X	X	X
VS-REQ-5	External Environment Sensor Data, not in Phase 4	X			
VS-REQ-5.1	External Environment Sensor Data Configuration, not in Phase 4	X			
VS-REQ-5.2	External Environment Sensor Data Management, not in Phase 4	X			
VS-REQ-6	FCW Stopped Vehicles	X	X	X	X
VS-REQ-7	FCW Decelerating/Slow Moving Vehicles	X	X	X	X
VS-REQ-8	FCW Stopped and Obstructed Vehicles	X	X	X	X
VS-REQ-9	FCW Rear-End Crash	X	X	X	X
VS-REQ-9.1	Rear-End Crash in Straight Road	X	X	X	X
VS-REQ-9.2	Rear-End Crash in Curved Road	X	X	X	X
VS-REQ-10	FCW No Warning	X	X	X	X
VS-REQ-10.1	Safely Following a Vehicle	X	X	X	X
VS-REQ-10.2	Passing a Stopped Vehicle	X	X	X	X
VS-REQ-11	SA TIM-Advisories	X	X	X	X
VS-REQ-12	SA TIM-Speed Limit	X	X	X	X
VS-REQ-13	SA TIM-Exit Services	X	X	X	X
VS-REQ-14	SA TIM-Region	X	X	X	X
VS-REQ-15	Distress Notification ID, not in Phase 4	X	X	X	
VS-REQ-15.1	Log, not in Phase 4	X	X	X	
VS-REQ-16	Create Distress Notification, not in Phase 4	X	X	X	
VS-REQ-16.1	System-Generated Distress Notification	X	X	X	
VS-REQ-16.2	Driver-Generated Distress Notification, not in Phase 4	X	X	X	
VS-REQ-17	DNM-Region, not in Phase 4	X	X	X	
VS-REQ-18	DN PSID, not in Phase 4	X	X	X	
VS-REQ-19	WZW TIM	X	X	X	X
VS-REQ-20	WZW TIM-Region	X	X	X	X
VS-REQ-21	SWIW TIM	X	X	X	X
VS-REQ-22	SWIW TIM-Region	X	X	X	X
VS-REQ-23	IVAA Rank	X	X	X	X
VS-REQ-24	IVAA Level	X	X	X	X
VS-REQ-25	IVAA Priority Alert	X	X	X	X
VS-REQ-26	IVAA FCW	X	X	X	X
VS-REQ-27	IVAA DN, not in Phase 4	X	X	X	
VS-REQ-28	IVAA SA-Advisory	X	X	X	X
VS-REQ-29	IVAA SA-VSL	X	X	X	X
VS-REQ-30	IVAA SWIW	X	X	X	X
VS-REQ-31	IVAA WZW	X	X	X	X
VS-REQ-32	HMI Characteristics	X	X	X	X
VS-REQ-32.1	HMI-Location	X	X	X	X
VS-REQ-32.2	HMI-Distracted	X	X	X	X
VS-REQ-32.3	HMI-Readability	X	X	X	X
VS-REQ-32.4	Visual and Auditory Interface	X	X	X	X
VS-REQ-32.4.1	Visual Consistency	X	X	X	X
VS-REQ-32.4.2	Audio Signals	X	X	X	X
VS-REQ-32.5	Customizations	X	X	X	X
VS-REQ-32.6	System Status	X	X	X	X

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System Requirement		MV	HPV	IT	RFV
VS-REQ-32.6.1	Power Status	X	X	X	X
VS-REQ-32.6.2	System Settings	X	X	X	X
VS-REQ-32.6.3	Application Availability	X	X	X	X
VS-REQ-32.6.4	Pending Update Status	X	X	X	X
VS-REQ-32.7	Distress Notification, not in Phase 4	X	X	X	
VS-REQ-32.8	Non-Distress Information, not in Phase 4	X	X	X	X
VS-REQ-33	BCVI Messages	X	X	X	X
VS-REQ-34	BCVI Distress, not in Phase 4	X	X	X	
VS-REQ-34.1	Received Distress, not in Phase 4	X	X	X	
VS-REQ-34.2	Generated Distress, not in Phase 4	X	X	X	
VS-REQ-35	BCVI General Broadcast Requirements	X	X	X	X
VS-REQ-36	Transmit Data	X	X	X	X
VS-REQ-36.1	Transmit Environmental Data, not in Phase 4	X			
VS-REQ-36.2	TVI Data Management-Log	X	X	X	X
VS-REQ-37	Communication Performance				
VS-REQ-38	SLD Information	X	X	X	X
VS-REQ-39	SLD Rolling Log	X	X	X	X
VS-REQ-40	SLD Log Format	X	X	X	X
VS-REQ-41	SLD Log Data	X	X	X	X
VS-REQ-42	VSM SCMS	X	X	X	X
VS-REQ-43	VSM SCMS Encryption	X	X	X	X
VS-REQ-44	VSM SCMS Sign	X	X	X	X
VS-REQ-45	VSM SCMS Encryption-Log	X	X	X	X
VS-REQ-46	VSM SCMS Sign-Log	X	X	X	X
VS-REQ-47	VSM App Availability Log	X	X	X	X
VS-REQ-48	VSM Updates	X	X	X	X
VS-REQ-49	Architectural	X	X	X	X
VS-REQ-50	Safety Communication	X	X	X	X
VS-REQ-51	VS Equipment	X	X	X	X
External Interfaces					
LTS-REQ-4	VS LTS Time	X	X	X	X
LTS-REQ-5	VS LTS Time Standard	X	X	X	X
LTS-REQ-6	VS LTS Location	X	X	X	X
USDOT Interfaces					
SCMS-REQ-2	Vehicle System SCMS Use	X	X	X	X
SCMS-REQ-2.1	SCMS Vehicle System Certificates	X	X	X	X
SCMS-REQ-2.2	SCMS Vehicle System Misbehavior Reporting	X	X	X	X
SCMS-REQ-2.3	SCMS Vehicle System Certificates Revocation List (CRL)	X	X	X	X
SCMS-REQ-2.4	SCMS Vehicle System Rejection	X	X	X	X

5.2.1 WYDOT Maintenance Vehicle (MV). Not part of Phase 4

The following unique requirements are identified.

MV-REQ-1 Environmental Sensors – WYDOT Maintenance Vehicles shall transmit environment information collected through equipped external environmental sensors to the *Wyoming CV system*. External environmental sensors will provide the information detailed in Table 7-4 of the ICD. **Not in Phase 4.**

MV-REQ-1.1 Environmental Sensors Equipment – Environmental Sensor equipment shall conform to the characteristics described in Appendix A of the CAP. **Not in Phase 4.**

MV-REQ-2 Can Bus – WYDOT Maintenance Vehicles shall provide connection to the Can Bus as part of the Vehicle System. The information extracted from the Can Bus is detailed in Table 7-1 of the ICD, where column #1 contains the value "yes/CAN." This requirement no longer applies to this system.

MV-REQ-3 Static Identifier – WYDOT Maintenance Vehicles' DSRC communications shall have a static identifier. **Not in Phase 4.**

MV-REQ-4 Receive TIM over DSRC – WYDOT Maintenance Vehicles shall receive a packet containing traveler information from the Wyoming CV System over DSRC. Each packet may contain one or more individual traveler information message as defined in Section 5.16 of SAE J2735. **Not in Phase 4.**

MV-REQ-5 Receive TIM over Satellite – WYDOT Maintenance Vehicles shall receive a packet containing traveler information from the Wyoming CV System (via the Situation Data Exchange) over Satellite communication. Each packet may contain one or more individual traveler information message as defined in Section 5.16 (SAE J2735). **Not in Phase 4.**

MV-REQ-6 OTA Updates – WYDOT Maintenance Vehicles shall receive software updates OTA, as defined in Section 5.16.2 of the ICD. **Not in Phase 4.**

MV-REQ-7 Time – WYDOT Maintenance Vehicles shall obtain time as defined in LTS-REQ-4. **Not in Phase 4.**

MV-REQ-8 Location – WYDOT Maintenance Vehicles shall obtain location as defined in LTS-REQ-6. **Not in Phase 4.**

MV-REQ-9 General – All vehicle system requirements identified in Section 4.2 of the SyRS shall apply to this Sub-system. **Not in Phase 4.**

MV-REQ-10 OBU Equipment – MV OBU equipment shall conform to the characteristics described in Appendix A of the CAP. **Not in Phase 4.**

5.2.2 Highway Patrol Vehicle. Not part of Phase 4.

HP-REQ-1 General – All vehicle system requirements identified in Section 4.2 of the SyRS shall apply to this Sub-system except: **Not in Phase 4.**

- VS-REQ-4.2 Collect Dimension Data
- VS-REQ-5 External Environment Sensor Data
- VS-REQ-5.1 External Environment Sensor Data Configuration
- VS-REQ-5.2 External Environment Sensor Data Management
- VS-REQ-36.1 Transmit Environmental Data

HP-REQ-2 Receive TIM over DSRC – Highway Patrol vehicles shall receive traveler information from the Wyoming CV System over DSRC. Traveler information may contain one or more packets of traveler information as defined in Section 5.16 (SAE J2735). **Not in Phase 4.**

HP-REQ-3 Time – Highway Patrol vehicles shall obtain time as defined in LTS-REQ-4. **Not in Phase 4.**

HP-REQ-4 Location – Highway Patrol vehicles shall obtain location as defined in LTS-REQ-6. **Not in Phase 4.**

HP-REQ-5 OBU Equipment – Highway Patrol OBU equipment shall conform to the characteristics described in Appendix A of the CAP. **Not in Phase 4.**

HP-REQ-6 Receive TIM over Satellite – Highway Patrol vehicles shall receive a packet containing traveler information from the *Wyoming CV System* (via the Situation Data Exchange) over Satellite communication. Each packet may contain one or more individual traveler information message as defined in Section 5.16 (SAE J2735). **Not in Phase 4.**

HP-REQ-7 OTA Updates – Highway Patrol vehicles shall receive software updates OTA, as defined in Section 5.16.2 of the ICD. **Not in Phase 4.**

5.2.3 Integrated Truck (IT). Not part of Phase 4.

The following unique requirements are identified.

IT-REQ-1 Receive TIM over DSRC – Integrated Truck Fleet vehicles shall receive a packet containing traveler information from the *Wyoming CV System* over DSRC. Each packet may contain one or more individual traveler information message as defined in Section 5.16 (SAE J2735). **Not in Phase 4.**

IT-REQ-2 Receive TIM over Satellite – Integrated Truck Fleet vehicles shall receive a packet containing traveler information from the *Wyoming CV System* (via the Situation Data Exchange) over Satellite communication. Each packet may contain one or more individual traveler information message as defined in Section 5.16 (SAE J2735). **Not in Phase 4.**

IT-REQ-3 OTA Updates – Integrated Truck Fleet vehicles shall receive software updates OTA, as defined in Section 5.16.2 of the ICD. **Not in Phase 4.**

IT-REQ-4 Time – Integrated Truck Fleet vehicles shall obtain time as defined in LTS-REQ-4. **Not in Phase 4.**

IT-REQ-5 Location – Integrated Truck Fleet vehicles shall obtain location as defined in LTS-REQ-6. **Not in Phase 4.**

IT-REQ-6 General – All vehicle system requirements identified in Section 4.2 of the SyRS shall apply to this Sub-system except: **Not in Phase 4.**

- VS-REQ-5 External Environment Sensor Data
- VS-REQ-5.1 External Environment Sensor Data Configuration
- VS-REQ-5.2 External Environment Sensor Data Management
- VS-REQ-36.1 Transmit Environmental Data

IT-REQ-7 OBU Equipment – Integrated Truck OBU equipment shall conform to the characteristics described in Appendix A of the CAP. **Not in Phase 4.**

IT-REQ-8 Can Bus – ~~Integrated Truck Fleet vehicles shall provide connection to the Can Bus as part of the *Vehicle System*. The information extracted from the Can Bus is detailed in Table 7-1 of the ICD, where column #1 contains the value "yes/CAN."~~ *This requirement no longer applies to this subsystem.*

5.2.4 Retrofit Vehicles (RFV). Not part of Phase 4.

The following unique requirements are identified for this Sub-system.

RFV-REQ-1 Receive TIM over DSRC – Retrofit Fleet vehicles shall receive traveler information from the *Wyoming CV System* over DSRC. Traveler information may contain one or more packets of traveler information as defined in Section 5.16 (SAE J2735). **Not in Phase 4.**

RFV-REQ-2 Receive TIM over Satellite – Retrofit Fleet vehicles shall receive a packet containing traveler information from the *Wyoming CV System* (via the Situation Data Exchange) over Satellite communication. Each packet may contain one or more individual traveler information message as defined in Section 5.16 (SAE J2735). **Not in Phase 4.**

RFV-REQ-3 Time – Retrofit Fleet vehicles shall obtain time as defined in LTS-REQ-4. **Not in Phase 4.**

RFV-REQ-4 Location – Retrofit Fleet vehicles shall obtain location as defined in LTS-REQ-6. **Not in Phase 4.**

RFV-REQ-5 General – All vehicle system requirements identified in Section 4.2 of the SyRS shall apply to this Sub-system except the following requirements pertaining to distress notifications and updates: **Not in Phase 4.**

- VS-REQ-3 Receive Distress Information
- VS-REQ-4.1 Collect Vehicle Status Data
- VS-REQ-5 External Environment Sensor Data
- VS-REQ-5.1 External Environment Sensor Data Configuration
- VS-REQ-5.2 External Environment Sensor Data Management
- VS-REQ-15 Distress Notification ID
- VS-REQ-15.1 Log
- VS-REQ-16 Create Distress Notification
- ~~VS-REQ-16.1 System-Generated Distress Notification~~
- VS-REQ-16.2 Driver-Generated Distress Notification
- VS-REQ-17 DNM-Region
- VS-REQ-18 DN PSID
- VS-REQ-27 IVAA DN
- VS-REQ-32.5 Customizations
- VS-REQ-32.7 Distress Notification
- VS-REQ-34 BCVI Distress
- VS-REQ-34.1 Received Distress
- VS-REQ-34.2 Generated Distress
- VS-REQ-35 BCVI General Broadcast Requirements
- VS-REQ-36.1 Transmit Environmental Data

RFV-REQ-6 OBU Equipment – RFV OBU equipment shall conform to the characteristics described in Appendix A of the CAP. **Not in Phase 4.**

RFV-REQ-7 OTA Updates – Retrofit Fleet vehicles shall receive software updates OTA, as defined in Section 5.16.2 of the ICD **Not in Phase 4.**

5.2.5 Test Vehicles for Phase 4.

The following unique requirements are identified for this Sub-system.

TV-REQ-1 Receive TIM over C-V2X – Test vehicles shall receive traveler information from the *Wyoming CV System* over C-V2X. Traveler information may contain one or more packets of traveler information as defined in Section 5.16 (SAE J2735).

TV-REQ-2 Receive TIM over Satellite – Test vehicles should receive a packet containing traveler information from the *Wyoming CV System* (via the Situation Data Exchange) over Satellite communication. Each packet may contain one or more individual traveler information message as defined in Section 5.16 (SAE J2735).

TV-REQ-3 Time – Test vehicles shall obtain time as defined in LTS-REQ-4.

TV-REQ-4 Location – Test vehicles shall obtain location as defined in LTS-REQ-6.

TV-REQ-5 General – All vehicle system requirements identified in Section 4.2 of the SyRS shall apply to this Sub-system except the following requirements pertaining to distress notifications and updates:

- VS-REQ-3 Receive Distress Information
- VS-REQ-4.1 Collect Vehicle Status Data
- VS-REQ-5 External Environment Sensor Data
- VS-REQ-5.1 External Environment Sensor Data Configuration
- VS-REQ-5.2 External Environment Sensor Data Management
- VS-REQ-15 Distress Notification ID
- VS-REQ-15.1 Log
- VS-REQ-16 Create Distress Notification
- ~~VS-REQ-16.1 System-Generated Distress Notification~~
- VS-REQ-16.2 Driver-Generated Distress Notification
- VS-REQ-17 DNM-Region
- VS-REQ-18 DN PSID
- VS-REQ-27 IVAA DN
- VS-REQ-32.5 Customizations
- VS-REQ-32.7 Distress Notification
- VS-REQ-34 BCVI Distress
- VS-REQ-34.1 Received Distress
- VS-REQ-34.2 Generated Distress
- VS-REQ-35 BCVI General Broadcast Requirements
- VS-REQ-36.1 Transmit Environmental Data

TV-REQ-6 OBU Equipment – Test OBU equipment shall conform to the characteristics described in Appendix A of the CAP. **In Phase 4 the OBU should have GPIO electrical signal line inputs to support conditional use case triggering for BSM part II in support of light bars, spreaders, plow down, etc.).**

TV-REQ-7 OTA Updates – Test vehicles shall receive signed software updates OTA, as defined in Section 5.16.2 of the ICD. **OTA updates will be integrated from a vendor solution in Phase 4. This system shall support rollback if the OTA fails. In Phase 4 it is expected that OTA files will be received outside of C-V2X communications (Wi-Fi).**

5.3 Sub-System Internal Interfaces

Sub-systems have interaction(s) with others within their respective System through internal and external interfaces. At the *Wyoming CV System* level, the following internal interfaces exists:

1. ODE – RSU: This interface defines the information exchanged between the ODE and the RSU.

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2. ODE – Pikalert: This interface defines the information exchanged between the ODE and Pikalert. **Pikalert will not be part of Phase 4.**
3. ODE – Data Broker: This interface defines the information exchanged between the ODE and the Data Broker.
4. ODE – Data Warehouse: This interface defines the information exchanged between the ODE and the Data Warehouse.
5. ODE – Hardware Secure Module: This interface defines the information and certificate exchange between the ODE and the HSM. **In Phase 4 the HSM will be outsourced with the SCMS and called the TMCA, this is not part of the Wyoming CV System.**
6. Pikalert – Data Warehouse: This interface defines the information exchanged between the ODE and the Data Warehouse. **Pikalert is not part of Phase 4.**
7. Pikalert – Data Broker: This interface defines the information exchanged between the ODE and the Data Broker. **Pikalert is not part of Phase 4.**
8. Data Warehouse – Data Broker: This interface defines the information exchanged between the Data Warehouse and the Data Broker.

At the *Vehicle System* level, the following internal interfaces exists (all related to V2V communications):

1. WYDOT Maintenance Vehicles to other vehicle Sub-systems, **not part of Phase 4**
2. Highway Patrol Vehicles to other vehicle Sub-systems, **not part of Phase 4**
3. Integrated Trucks to other vehicle Sub-systems, **not part of Phase 4**
4. Retrofit Trucks to other vehicle Sub-systems, **not part of Phase 4**
5. **Test vehicles will be used for Phase 4**

These interfaces are described in detail in the Interface Control Document, which complements this System Requirement Specification document.

6 Performance Requirements

This section provides a list of requirements that detail the performance of the different components of the Wyoming CV Pilot System. Figure 6-1 illustrates how these performance requirements are linked to the overall systems requirements of the Pilot, and consequently to the sub-systems requirements as well. It should be noted that most of these performance requirements are focused on the Vehicle System, as this is largely the “new” component that is introduced within the Pilot. The performance of the Wyoming CV System, and its sub-systems, will mainly follow WYDOT TMC’s established guidelines of performance.

Except for the performance of Distress Notification, these Vehicle System performance requirements are predominantly standard connected vehicle capability. As these are standard capabilities, they will be lightly tested in Phase 4. Specific tests will be detailed in the test plan.

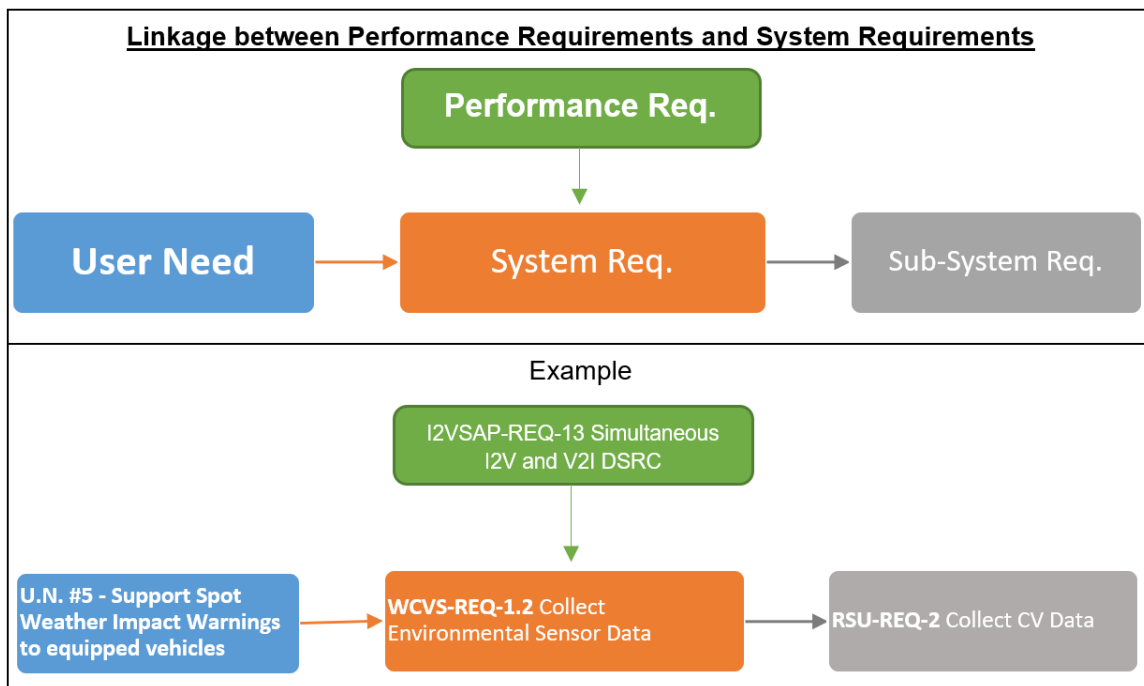


Figure 6-1. Illustration of the Sequential Logic of the System Requirements.

Source: WYDOT

A complete trace of these performance requirements to the system-level requirements is provided in Table 7-4 of the SyRS.

6.1 Performance of Forward Collision Warning

Note: For all FCWP requirements, the FCW application developer is responsible for verifying the functionality of the application over the range of vehicle speeds the application is specified to cover.

FCWP-REQ-1 FCW Advisory Alert Performance – The Vehicle System shall issue an advisory FCW alert when the Time-to-Collision is below a configurable threshold for advising the driver of potential for collision with a stopped vehicle ahead in the same lane of travel. Guidance for FCW Time-to Collision, Advisories and Alerts is provided in SyRS Section 6.1.1.

FCWP-REQ-2 FCW Imminent Alert Performance – The Vehicle System shall issue an imminent FCW alert when the Time-to-Collision is below a configurable threshold for alerting the driver that there is an imminent threat of forward collision with a stopped vehicle ahead in the same lane of travel and immediate action is required from the driver to avoid the collision. Guidance for FCW Time-to Collision, Advisories and Alerts is provided in SyRS Section 6.1.1.

FCWP-REQ-3 Passing a Stopped Vehicle Performance – The Vehicle System shall not issue an FCW advisory or alert when passing a stopped vehicle in an adjacent lane.

FCWP-REQ-4 Following a Vehicle Performance – The Vehicle System shall not issue an imminent FCW alert when following a remote vehicle traveling at a constant speed above 30 mph.

FCWP-REQ-5 Decelerating Vehicle Performance – The Vehicle System shall issue an imminent FCW alert when the Time-to-Collision is below a configurable threshold for alerting the driver that there is an imminent threat of forward collision with a decelerating vehicle ahead in the same lane of travel and immediate action is required from the driver to avoid the collision. Guidance for FCW Time-to Collision, Advisories and Alerts is provided in SyRS Section 6.1.1.

FCWP-REQ-6 FCW Advisory Alert in a Curve Performance – The Vehicle System shall issue an advisory FCW alert when the Time-to-Collision is below a configurable threshold for advising the driver of potential for collision with a stopped vehicle ahead in the same lane of travel in a curve. Guidance for FCW Time-to Collision, Advisories and Alerts is provided in SyRS Section 6.1.1.

FCWP-REQ-7 FCW Imminent Alert in a Curve Performance – The Vehicle System shall issue an imminent FCW alert when the Time-to-Collision is below a configurable threshold for alerting the driver that there is an imminent threat of forward collision with a stopped vehicle ahead in the same lane of travel in a curve and immediate action is required from the driver to avoid the collision. Guidance for FCW Time-to Collision, Advisories and Alerts is provided in SyRS Section 6.1.1.

FCWP-REQ-8 Passing a Stopped Vehicle in a Curve Performance – The Vehicle System shall not issue an FCW advisory or alert when passing a stopped vehicle in an adjacent lane in a curve.

FCWP-REQ-9 Slow Moving Vehicle Advisory Alert in a Curve Performance – The Vehicle System shall issue an advisory FCW alert when the Time-to-Collision is below a configurable threshold for advising the driver of potential for collision with a moving vehicle ahead in the same lane of travel in a curve. Guidance for FCW Time-to Collision, Advisories and Alerts is provided in SyRS Section 6.1.1.

FCWP-REQ-10 Slow Moving Vehicle Imminent Alert in a Curve Performance – The Vehicle System shall issue an imminent FCW alert when the Time-to-Collision is below a configurable threshold for alerting the driver that there is an imminent threat of forward collision with a moving vehicle ahead in the same lane of travel in a curve and immediate action is required from the driver to avoid the collision. Guidance for FCW Time-to Collision, Advisories and Alerts is provided in SyRS Section 6.1.1.

6.1.1 FCW Time-to-Collision, Advisories, and Alerts Background and Rationale

Typically, FCW advisories and alerts must be tuned for each class of vehicles (because of their different stopping distances and stopping times) while avoiding the need to alert the driver so frequently that they become a nuisance. The threshold values for issuing advisories and alerts are based upon empirical testing and human factors and engineering judgement. Threshold values for issuing advisories and alerts are based on Time-to-Collision (TTC). Total TTC is the sum of the Driver Brake Reaction Time and the Vehicle Response Time. Driver Response Time includes Driver Mental Processing Time (Sensation + Perception + Response Selection & Preparation) plus movement time. Following is background information references for assistance in estimating TTC and in configuring FCW advisories and alerts.

- For estimating the Driver Brake Reaction Time, Campbell (2016) notes that "values from research [2] indicate that a primed (expectant of the cue) driver under optimal conditions may have a brake reaction time of under 1 s, while analysis of naturalistic data [7] suggest that brake reaction time could range from 1.5 s to 2.5 s (and occasionally greater depending on driver state, such as distraction)."
- As for Vehicle Response Time, this is the vehicle's braking or deceleration capacity for its given weight. NHTSA FMVSS specifies a maximum stopping distance of 250 ft. to safely stop a fully loaded (new) tractor trailer from 60 mph, equivalent to a 0.48g uniform deceleration rate and a 5.67 seconds vehicle response (stopping) time. NHTSA FMVSS 135 specifies a maximum stopping distance of 230 ft. to safely stop a passenger vehicle from 62.1 mpg, equivalent to a 0.56g uniform deceleration rate and a 5.06 seconds vehicle response (stopping) time.
- Furthermore, *Vehicle Response Only Time to Collision (TTC) = $t - (1/(2v)) * a * t^2$* where t is the time prior to impact when braking is initiated, v is vehicle speed when braking is initiated, and a is the constant braking deceleration (Kusano & Gabler, 2011).
- The AASHTO "Policy on Geometric Design of Highways and Streets" indicates that most drivers decelerate at a rate that is greater than 14.8 ft/s² (4.5 m/s²) (0.46g) when there is a sudden need to stop for an unexpected object in the roadway, while 90 percent of drivers decelerate at a rate over 11.2 ft/s² (3.4 m/s²) (0.35g). These deceleration rates account for the comfort level of drivers, the ability of the driver to maintain steering control on wet surfaces in tandem with tire-pavement friction levels, and vehicle braking systems capabilities.
- Bogard and LeBlanc (2014) uses a Total TTC criterion of 6.5 ± 1.0 s for imminent FCW alert for an unloaded commercial vehicle stopping behind a passenger vehicle.
- Industry guidelines and/or local policy should provide guidance on deceleration rates for specific circumstances.

6.2 Performance of Distress Notification. DN is not part of Phase 4.

DNP-REQ-1 Distress Notification OBU DSRC Performance 1 – Remote vehicles shall receive distress notification via DSRC between at least 2 and 300 meters from the distressed vehicle. **Not part of Phase 4.**

DNP-REQ-2 Distress Notification OBU DSRC Performance 2 – Remote vehicles shall receive distress notification from other remote "relay" vehicles via DSRC between at least 2 and 300 meters from the other remote vehicle. **Not part of Phase 4.**

DNP-REQ-3 Distress Notification RSU DSRC Performance – ODE shall receive Distress Notification Messages (through RSU) from distressed vehicle or remote "relay" vehicles via DSRC from a distance between at least 2 and 300 meters between vehicles and RSU. **Not part of Phase 4.**

DNP-REQ-4 Distress Notification Driver Display Performance – Distress Notification Caution shall be issued to the driver of the receiving vehicle at least at a configurable distance from the distressed vehicle. Note: the configurable distance is to be determined empirically by system engineers during development and testing. **Not part of Phase 4.**

DNP-REQ-5 Distressed Vehicle Distance – Distress Notification Cautions shall indicate the approximate distance to the distressed vehicle. **Not part of Phase 4.**

DNP-REQ-6 Distressed Vehicle Direction of Travel – Distress Notification Cautions shall indicate if the distressed vehicle is in the same direction of travel as the receiving vehicle. **Not part of Phase 4.**

DNP-REQ-7 Distressed Vehicle Roadway – Distress Notification Cautions shall be issued to drivers approaching the distressed vehicle on the same roadway. **Not part of Phase 4.**

DNP-REQ-8 Distress Vehicle Passing – Distress Notification Cautions shall not be issued to drivers after passing the distressed vehicle. **Not part of Phase 4.**

DNP-REQ-9 Remote Vehicle Distress Notification Distance 1 – Remote Vehicles receiving the broadcast DNM shall continue to broadcast it for a configurable distance and configurable time. Note: Initially this distance would be set to 5 miles. **Not part of Phase 4.**

DNP-REQ-10 Remote Vehicle Distress Notification Distance 2 – After broadcasting for the configurable distance or configurable time, a remote Relay Vehicle shall stop broadcasting the DNM and go silent until it receives an RSU WSA broadcast for the ODE server's IPv6 address. **Not part of Phase 4.**

DNP-REQ-11 Remote Vehicle Distress Notification Upload to ODE – When a remote Relay Vehicle receives an RSU WSA broadcast for the ODE server's IPv6 address, the OBU shall copy a log for the DNM to the ODE server. **Not part of Phase 4.**

DNP-REQ-12 Remote Vehicle Distress Notification Upload Termination – When a remote Relay Vehicle OBU completes copying a log for the DNM to the ODE server, the Relay Vehicle shall stop further broadcasting the DNM and will stop copying it to RSUs to the ODE. **Not part of Phase 4.**

6.3 Performance of I2V Situational Awareness

Note: 16 meters is the distance traveled in 1 second at 35 mph and the distance traveled in 500 milliseconds at 70 mph. Design processing speed for message processing and display of alerts and advisories to driver is 500 milliseconds (Bogard 2014).

I2VSAP-REQ-1 Message Display in Travel Lanes – Situational Awareness Message(s) shall display in vehicles traveling in all travel lanes of the roadway in the direction specified in the I2V SA TIM.

I2VSAP-REQ-2 Message Display in Shoulder Lanes – Situational Awareness Message(s) shall display in vehicles traveling on shoulders of the roadway in the direction specified in the I2V SA TIM.

I2VSAP-REQ-3 Message Display in Acceleration Lane – Situational Awareness Message(s) shall display in vehicles in entrance acceleration lane of the roadway in the direction specified in the I2V SA TIM.

I2VSAP-REQ-4 Message Display Geofence Beginning – Situational Awareness Message(s) shall display within 8 meters, at a speed of 35 miles per hour, of beginning of geofence specified in the I2V SA TIM.

I2VSAP-REQ-5 Message Display Geofence Ending – Situational Awareness Message(s) shall cease display within 8 meters, at a speed of 35 miles per hour, of end of geofence specified in the I2V SA TIM.

I2VSAP-REQ-6 Message Display in Opposing Travel Lanes – Situational Awareness Message(s) shall not display in vehicles traveling in a direction other than that specified in the I2V SA TIM.

I2VSAP-REQ-7 Message Display on Adjacent Service Road – Situational Awareness Message(s) shall not display in vehicles on roadways adjacent to that specified in the I2V SA TIM.

I2VSAP-REQ-8 Message Display in Perpendicular to Travel Lanes – Situational Awareness Message(s) shall not display in vehicles on roadways intersecting that specified in the I2V SA TIM.

I2VSAP-REQ-9 Message Display Start Time – Situational Awareness Message(s) shall begin display within 1 second of the time specified in the I2V SA TIM.

I2VSAP-REQ-10 Message Display Stop Time – Situational Awareness Message(s) shall cease display within 1 second of the time specified in the I2V SA TIM.

I2VSAP-REQ-11 Verify I-80 Map and Geofences – Vehicle Systems shall be capable of displaying Situational Awareness Message(s) in vehicles traveling in all travel lanes anywhere on I-80 across Wyoming.

I2VSAP-REQ-12 Satellite TIM Coverage – Vehicle Systems shall be capable of receiving I2V SA TIMs via satellite in vehicles traveling on I-80 across Wyoming. **In Phase 4 the vehicle system should be capable of receiving I2V SA TIMs via satellite in vehicles traveling on I-80 across Wyoming.**

I2VSAP-REQ-13 Simultaneous I2V and V2I DSRC Communications – The WYDOT CV Pilot System shall support simultaneous capture of vehicle system BSMs, capture of vehicle system

log files, and broadcast of I2V SA TIMs via DSRC. **In Phase 4 this will be C-V2X rather than DSRC.**

I2VSAP-REQ-14 Simultaneous DSRC and Satellite TIM Processing – Vehicle Systems shall support processing of identical I2V SA TIMs received via DSRC and satellite without conflict or error. **In Phase 4 this will be C-V2X rather than DSRC** and the satellite should be test (not shall).

6.4 Performance of Message Communication

MCP-REQ-1 V2V Exchange of BSMS – Host vehicles shall receive BSM from remote vehicles via DSRC from between at least 2 and 300 meters distance. **In Phase 4 this will be C-V2X rather than DSRC.**

MCP-REQ-2 V2I & End-to-end Communication of BSMS – RSUs shall receive BSM from Remote Vehicles via DSRC from between at least 2 and 300 meters distance. **In Phase 4 this will be C-V2X rather than DSRC.**

MCP-REQ-3 OBU Shakedown – The WYDOT CV Pilot System shall support periodic testing to verify functionality and DSRC range performance of WYDOT controlled Pilot vehicles. **In Phase 4 this will be C-V2X rather than DSRC.**

MCP-REQ-4 RSU and Backhaul Communications Shakedown 1 – The WYDOT CV Pilot System shall support periodic testing to verify functionality and DSRC range performance of RSUs. **In Phase 4 this will be C-V2X rather than DSRC.**

MCP-REQ-5 RSU and Backhaul Communications Shakedown 2 – The WYDOT CV Pilot System shall support periodic testing to verify functionality and DSRC range performance of RSUs after major storm events. **In Phase 4 this will be C-V2X rather than DSRC.**

MCP-REQ-6 OBU Installation Robustness – WYDOT CV Pilot OBUs shall maintain functionality and DSRC communications range performance after up to five installations and removal. **In Phase 4 this will be C-V2X rather than DSRC.**

MCP-REQ-7 RSU Installation Robustness – WYDOT CV Pilot RSUs shall maintain functionality and DSRC communications range performance after up to three installations and removal. **In Phase 4 this will be C-V2X rather than DSRC.**

7 Traceability to User Needs and System-level Requirements

This section provides a series of tables that links the user needs to the System, Sub-system and Performance requirements, following the structure depicted in Figure 1-2 and Figure 6-1. A total of four (4) tables are presented here:

- Table 7-1 links the system-level requirements to the 13 user needs identified for this pilot.
- Table 7-2 links the Wyoming CV System requirements to its Sub-systems.
- Table 7-3 links the Vehicle System requirements to its Sub-systems.
- Table 7-4 links the performance requirements to their respective system-level requirement.

Table 7-2 and Table 7-3 identify the “parent” and “child” requirement relationships to be used as guidance for requirement traceability. However, it should be noted that this relationship may be different from the parent-child relationships that are identified for requirement verification procedures—these ones can be found in the Operational Readiness Plan – WYDOT CV Pilot, Attachment B - Operational Readiness Test Plan (FHWA-JPO-17-472B).

The following table maps the user needs identified for the pilot with the system- and interface-level requirement. A column has been added that indicates whether a requirement is Mandatory (M), Mandatory, but part of the requirement no longer applies (M*) or not part of Phase 4 (O).

Table 7-1. Needs to System Requirements Traceability Matrix

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
1) Support warnings of impending forward collision in a host vehicle based on information received from a remote vehicle.				
Vehicle System (VS)	VS-REQ-1	Receive BSM	M	The Vehicle System shall receive Basic Safety Message (as defined in SAE J2945/1) over DSRC from other connected vehicles consistent with Section 6.3.8 of SAE J2945/1 (BSM Scheduling and Congestion Control).
Vehicle System (VS)	VS-REQ-4	Collect Vehicle Data	O	The Vehicle System shall have the capability to collect vehicle information from the host vehicle and the driver as stated below Not part of Phase 4
Vehicle System (VS)	VS-REQ-4.1	Collect Vehicle Status Data	O	The Vehicle System shall have the capability to collect vehicle status information from the host vehicle, as stated in Section 5.4.2 of the ICD. Not part of Phase 4

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-4.2	Collect Dimension Data	O	The Vehicle System shall have the capability to collect information from the host vehicle driver. The VS will maintain these values across power cycles and OTA updates. The data will be included in BSMs broadcasted by the Vehicle System. The list of fields are shown in Table 7-1 of the ICD, where column #1 contains the value "yes/driver". Not part of Phase 4
Vehicle System (VS)	VS-REQ-4.2.1	Vehicle Dimension Data	O	The Vehicle System shall have the capability to collect vehicle dimension from the host vehicle driver through the Human Machine Interface. Not part of Phase 4
Vehicle System (VS)	VS-REQ-4.2.2	Vehicle Trailer Data	O	The Vehicle System shall have the capability to collect information from the host vehicle driver regarding the dimensions of attached trailers, including capability to indicate that no trailer is present, through the Human Machine Interface. Not part of Phase 4
Vehicle System (VS)	VS-REQ-6	FCW Stopped Vehicles	M	The Vehicle System shall ingest BSM Parts I and II data received from remote vehicles to identify stopped remote vehicles directly ahead in the same lane and direction of travel (defined in J2945/1 section 4.2.4.2 (a)). Data ingest is defined as obtaining and importing data for use or storage.
Vehicle System (VS)	VS-REQ-7	FCW Decelerating/ Slow Moving Vehicles	M	The Vehicle System shall ingest BSM Parts I and II data received from remote vehicles to identify decelerating or slower moving remote vehicles directly ahead in the same lane and direction of travel (defined in J2945/1 section 4.2.4.2 (c)). Data ingest is defined as obtaining and importing data for use or storage
Vehicle System (VS)	VS-REQ-8	FCW Stopped and Obstructed Vehicles	M	The Vehicle System shall ingest BSM Parts I and II data received from remote vehicles to identify stopped and obstructed remote vehicles directly ahead in the same lane and direction of travel (defined in J2945/1 section 4.2.4.2 (d)). Data ingest is defined as obtaining and importing data for use or storage
Vehicle System (VS)	VS-REQ-9	FCW Rear-End Crash	M	The Vehicle System shall ingest BSM Parts I and II data received from remote vehicles to identify imminent danger of a rear-end crash with a remote vehicle in its lane of travel (defined in J2945/1 section 4.2.4.3). Data ingest is defined as obtaining and importing data for use or storage.
Vehicle System (VS)	VS-REQ-9.1	Rear-End Crash in Straight Road	M	The Vehicle System shall identify imminent danger of a rear-end crash with a remote vehicle lead vehicle in its lane of travel in a straight roadway geometry.
Vehicle System (VS)	VS-REQ-9.2	Rear-End Crash in Curved Road	M	The Vehicle System shall identify imminent danger of a rear-end crash with a remote vehicle lead vehicle in its lane of travel in a curved roadway geometry.
Vehicle System (VS)	VS-REQ-10	FCW No Warning	M	The Vehicle System shall ingest BSM Parts I and II data received from remote vehicles to identify when there is no need to display a warning on the HMI of the host vehicle. Data ingest is defined as obtaining and importing data for use or storage.
Vehicle System (VS)	VS-REQ-10.1	Safely Following a Vehicle	M	The Vehicle System shall identify when no imminent danger of a rear-end crash is present with a remote vehicle in its lane of travel in common roadway geometries.
Vehicle System (VS)	VS-REQ-10.2	Passing a Stopped Vehicle	M	The Vehicle System shall identify when no imminent danger of a rear-end crash is present with a remote vehicle that is stopped and not in its lane of travel in common roadway geometries.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-23	IVAA Rank	M*	The Vehicle System shall provide prioritized in-vehicle alerts based on the rank order presented in Table 4-1 of the SyRS, with the highest rank on top. Distress Message not included in Phase 4.
Vehicle System (VS)	VS-REQ-24	IVAA Level	M*	The Vehicle System shall have three levels of alert, as described in Table 4-2 of the SyRS. For Phase 4 we will use the off the shelf vendor alerting system.
Vehicle System (VS)	VS-REQ-25	IVAA Priority Alert	M	The Vehicle System shall provide only the highest priority alert to the vehicle operator when more than one alert is currently active
Vehicle System (VS)	VS-REQ-26	IVAA FCW	M*	The Vehicle System shall alert the vehicle operator for forward collision warning based on the warning distance calculation algorithm in section 3.1 of the Connected Commercial Vehicles—Retrofit Safety Device Kit Project Safety Applications and Development Plan (FHWA-JPO-14-106) and guidance for FCW Time-to Collision, Advisories and Alerts provided in SyRS Section 6.1.1. This could be an inform message, warning 1 or warning 2 based on the calculated deceleration rate required. During the design phase a deceleration rate will be selected for a warning 1 and for warning 2 based on vehicle type and weight. During Phase 4 these will be based on the selected vendor standard for alerting, no customization required.
Vehicle System (VS)	VS-REQ-35	BCVI General Broadcast Requirements	O	The Vehicle System shall use the general broadcast requirements defined in Appendix A.4 Broadcast Traveler Information of the SyRS. Phase 4 will not include the broadcast of traveler information.
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
2) Support ability to provide situational awareness of road conditions on the corridor to an equipped vehicle				
Situation Data Exchange (SDX)	SDX-REQ-1	Data Provided to the SDX	M	The Wyoming CV System shall transmit traveler information messages (TIMs) generated by the system to the SDX within five minutes of generation. TIMs are formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM).
Situation Data Exchange (SDX)	SDX-REQ-2	Distribute TIM to VS	M	The Situation Data Exchange shall distribute TIMs to the <i>Vehicle System</i> through satellite, as defined in WCVS-REQ-10.2 Distribute TIM to SDX.
WYDOT 511 Application (511App)	511-REQ-1	511App Parking Data Collection	M	The Wyoming CV System shall receive parking status data from Wyoming 511 App.
WYDOT 511 Application (511App)	511-REQ-1.1	Availability	M	The Wyoming CV System shall categorize parking availability for the facility of interest as follows: i) Full – No parking availability, ii) Spaces available, or iii) Only a few spaces available.
WYDOT 511 Application (511App)	511-REQ-1.2	Default	M	The Wyoming CV System shall set parking availability default to available if not provided.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
WYDOT 511 Application (511App)	511-REQ-1.3	Time	M	The Wyoming CV System shall timestamp parking availability reports.
WYDOT 511 Application (511App)	511-REQ-1.4	Location	M	The Wyoming CV System shall associate parking availability with a parking facility on I-80.
WYDOT 511 Application (511App)	511-REQ-1.5	Protocol	M	The Wyoming CV System shall receive information, based on HTTP protocol, from the 511App.
WYDOT 511 Application (511App)	511-REQ-1.6	Schema	M	The Wyoming CV System shall receive information based on the parking schema defined by WYDOT (WYDOT Truck Parking Map – as of 07/2016).
WYDOT 511 Application (511App)	511-REQ-2	Timeframe	M	The Wyoming CV System shall receive Parking availability data from the WYDOT 511 application within thirty minutes of generation.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1	RCRS Data Sharing	M	The Wyoming CV System shall receive road condition information from the RCRS.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.1	Road Condition	M	The Wyoming CV System shall receive road condition information from the RCRS following the 8 Code System.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.2	Weather	M	The Wyoming CV System shall receive atmospheric information from the RCRS following the 9 Code System.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.3	Other Road Condition	M	The Wyoming CV System shall receive other road information from RCRS following the 10 Code System.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.4	Report Time	M	The Wyoming CV System shall receive reports from RCRS containing a timestamp of when the operator entered the information into the app.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.5	Location	M	The Wyoming CV System shall receive reports from RCRS containing a location reference of when the operator entered the information into the app
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.6	Transmit Time	M	The Wyoming CV System shall receive reports from RCRS containing a timestamp of when the report was transmitted to the TMC. The transmitting timestamp may be different from the reporting time
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2	WTI Outputs	M	The Wyoming CV System shall receive the current information for corridor roadway segments available from the WTI within five minutes of generation. Roadway segments are defined by WYDOT as sections of roadway between variable mileposts.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.1	Posted Speed	M	The Wyoming CV System shall receive notification that current posted speed for a segment is changed
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.2	Vehicle Restrictions	M	The Wyoming CV System shall receive the notification of vehicle restrictions that have been set for a roadway segment
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.2.1	Restriction Information	M	The Wyoming CV System shall receive details on the restriction in effect for affected segments. Restrictions can consist of one or more of the following: • Width restriction, • Height restriction, • Weight restrictions, • High-Profile restrictions, • Chain Law Level 1, • Chain Law Level 2
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.2.2	Restriction Start Time	M	Wyoming CV System shall receive the start time of restrictions in effect for segments.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.3	Posted Messages	M	The Wyoming CV System shall receive the notification of DMS messages that have been set in the corridor

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.3.1	Message Information	M	Wyoming CV System shall receive the content of the posted DMS message
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.4	Posted Closures	M	The Wyoming CV System shall receive the notification of closures that have been set for a roadway segment
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.4.1	Closure Beginning	M	The Wyoming CV System shall receive notification of the beginning point of the closure.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.4.2	Closure End	M	The Wyoming CV System shall receive notification of the ending point of the closure.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-2.4.3	Closure Start Time	M	The Wyoming CV System shall receive notification of the starting time of the closure.
WYDOT Incident Console (IC)	IC-REQ-1	IC Data Sharing	M	The Wyoming CV System shall receive timestamped incident information from the IC.
WYDOT Incident Console (IC)	IC-REQ-2	Protocol	M	The Wyoming CV System shall receive incident information, based on HTTP protocol, from the IC. The HTTP protocol used will be based on the six part specifications RFC 7230-RFC 7235.
WYDOT Incident Console (IC)	IC-REQ-3	Schema	M	The Wyoming CV System shall receive incident information from WYDOT IC, as described in Section 5.31.1 of the ICD.
WYDOT Incident Console (IC)	IC-REQ-4	Transmission	M	The Wyoming CV System shall receive Road Incident data from WYDOT Incident Console within five minutes of generation
Weather Interface (WI)	WI-REQ-1	External Data Acquisition	O	The Wyoming CV System shall collect weather information from external sources, as defined in the Section 4.1 - Data Ingest Module Requirements of the Motorist Alert and Warning Application (NCAR, 2014) The External Data Acquisition will not be part of Phase 4.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Weather Interface (WI)	WI-REQ-2	Fixed Data Acquisition	O	The Wyoming CV System shall receive road weather information system (RWIS) data from the WYDOT RWIS Server as defined in Section 4.1 – Data Ingest Module Requirements of the Motorist Alert and Warning Application (NCAR 2014). Fixed Data Acquisition will not be part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-1	Collect CV Data	M	The Wyoming CV System shall collect data from the Vehicle System.
Wyoming CV System (WCVS)	WCVS-REQ-1.2	Collect Environmental Sensor Data	O	The Wyoming CV System shall collect environment sensor data using secure copy (SCP) from the Vehicle System consistent with secure shell (SSH). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-3	Ingest Data for Road Weather information	M*	The Wyoming CV System shall use one or more of the following sources of data to generate road weather information: <ul style="list-style-type: none"> • Collected CV Information defined in WCVS-REQ-1. • Segment road and weather conditions from the WYDOT RCRS in RCRS-REQ-1. • Weather conditions from weather interfaces defined in WI-REQ-1 and WI-REQ-2. WI-REQ-1 and WI-REQ-2 is not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4	Contents of Alerts and Advisories	M*	The Wyoming CV System shall generate alerts and advisories of roadway hazard conditions as defined in the following requirements.
Wyoming CV System (WCVS)	WCVS-REQ-4.1	Precipitation Hazard	O	The Wyoming CV System shall generate a precipitation type and intensity report every 5 minutes, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.2	Road Condition Hazard	O	The Wyoming CV System shall generate a pavement state and slickness flag report every 5 minutes, depending on input data, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.3	Visibility Hazard	O	The Wyoming CV System shall generate a visibility report, along with the condition causing it, every 5 minutes, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.4	Work Zone Hazard	M	The Wyoming CV System shall generate a work zone report within 5 minutes of receiving work zone information from the Construction Administration (defined in CA-REQ-1), as specified in Section 3.1.5.4 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-4.5	Incident Hazard	M	The Wyoming CV System shall generate an incident report within 5 minutes of receiving incident notifications from the Incident Console (defined in IC-REQ-1), as specified in Section 3.1.4.3 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-4.6	Parking	M	The Wyoming CV System shall generate a parking report within 5 minutes of receiving parking availability notification, as specified in Section 3.1.4.3 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-5	Forecast Conditions	O	The Wyoming CV System shall generate forecasts of conditions as defined in the following requirements Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.1	Atmospheric Forecasts	O	The Wyoming CV System shall produce atmospheric weather forecasts, at a minimum, for (a) atmospheric temperature, (b) probability of precipitation, (c) wind speed, and (d) wind direction Not part of Phase 4.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-5.2	Road Weather Forecasts	O	The Wyoming CV System shall produce road weather forecasts, at a minimum, for (a) pavement temperature, and (b) subsurface temperature Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.3	Forecast Time	O	The Wyoming CV System shall generate forecast reports for customizable forecast windows. The windows of interest will be determined by WYDOT (6, 12, 24, 48 hours for example). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.4	Forecast Update	O	The Wyoming CV System shall generate forecast updates for customizable intervals. The update frequency will be determined by WYDOT and may vary based on time of year (every 3 hours for example in winter to 12 hours during summer). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-6	Associate Alerts and Forecast to Segments	O	The Wyoming CV System shall associate each alert and forecast to one or more road segments on I-80. Roadway segments are defined by WYDOT as sections of roadway between variable mileposts. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-9	Create TIM	M	The Wyoming CV System shall create a Traveler Information Message (TIM) formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM).
Wyoming CV System (WCVS)	WCVS-REQ-10	Distribute TIM	M	The Wyoming CV System shall distribute signed TIMs to the Vehicle System and the Situation Data Exchange (SDX).
Wyoming CV System (WCVS)	WCVS-REQ-10.1	Distribute TIM to VS	M	The Wyoming CV System shall distribute signed TIM to the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067
Wyoming CV System (WCVS)	WCVS-REQ-10.2	Distribute TIM to SDX	M	The Wyoming CV System shall distribute signed TIM to the SDX consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. The SDX may not be available going forward. This requirement is for general compliance with the national communication of TIMs and is one way that the Wyoming pilot can get TIMs to third parties for broader distribution. If the SDX becomes unavailable, the pilot can directly send TIMs to the third parties for distribution. The SDX is not required for the Wyoming pilot.
Vehicle System (VS)	VS-REQ-2	Receive TIM	M	VS-REQ-2 Receive TIM – The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System. Each packet may contain one or more individual traveler information message as defined in Section 5.16 of SAE J2735.
Vehicle System (VS)	VS-REQ-2.1	Receive TIM through DSRC	M	The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System through DSRC In Phase 4 this will be done with C-V2X rather than DSRC.
Vehicle System (VS)	VS-REQ-2.2	Receive TIM through Satellite	M	The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System (via the Situation Data Exchange) through satellite.
Vehicle System (VS)	VS-REQ-4	Collect Vehicle Data	O	The Vehicle System shall have the capability to collect vehicle information from the host vehicle and the driver as stated below Not part of Phase 4.
Vehicle System (VS)	VS-REQ-4.1	Collect Vehicle Status Data	O	The Vehicle System shall have the capability to collect vehicle status information from the host vehicle, as stated in Section 5.4.2 of the ICD. Not part of Phase 4.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-11	SA TIM-Advisories	M	The Vehicle System shall ingest received TIMs to identify advisories (Part III content choice ITIS.ITIScodesAndText defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage
Vehicle System (VS)	VS-REQ-12	SA TIM-Speed Limit	M	The Vehicle System shall ingest received TIMs to identify speed limits (Part III content choice speedLimit defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage
Vehicle System (VS)	VS-REQ-13	SA TIM-Exit Services	M	The Vehicle System shall ingest received TIMs to identify Exit Services (Part III content choice exitService defined in J2735 section 6.142). This is used to provide parking information if necessary. Data ingest is defined as obtaining and importing data for use or storage
Vehicle System (VS)	VS-REQ-14	SA TIM-Region	M	The Vehicle System shall ingest received TIMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage
Vehicle System (VS)	VS-REQ-23	IVAA Rank	M*	The Vehicle System shall provide prioritized in-vehicle alerts based on the rank order presented in Table 4-1 of the SyRS, with the highest rank on top. Distress Message not included in Phase 4.
Vehicle System (VS)	VS-REQ-24	IVAA Level	M*	The Vehicle System shall have three levels of alert, as described in Table 4-2 of the SyRS. For Phase 4 we will use the off the shelf vendor alerting system.
Vehicle System (VS)	VS-REQ-25	IVAA Priority Alert	M	The Vehicle System shall provide only the highest priority alert to the vehicle operator when more than one alert is currently active
Vehicle System (VS)	VS-REQ-28	IVAA SA-Advisory	M	The Vehicle System shall alert the vehicle operator for a situational awareness advisory using an inform message when the host vehicle is traveling towards the segment where the situational awareness applies.
Vehicle System (VS)	VS-REQ-29	IVAA SA-VSL	M	The Vehicle System shall inform the vehicle operator of the current speed limit of the variable speed limit zone the vehicle is within using an inform message.
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
3) Support notification of distress conditions to and from equipped vehicles				
WYDOT Transportati on Reports and Action Console (TRAC)	TRAC-REQ-1	TRAC Updates	O	The Wyoming CV System shall transmit CV pilot events to the TRAC. Distress Messages will not be part of Phase 4.
WYDOT Transportati on Reports	TRAC-REQ-1.1	Distress Notification	O	The Wyoming CV System shall transmit received distress notifications to TRAC. Distress notifications are defined in WCVS-REQ-1.3. Distress Messages will not be part of Phase 4.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
and Action Console (TRAC)				
WYDOT Transportation Reports and Action Console (TRAC)	TRAC-REQ-1.1.1	Transmission Time	O	They Wyoming CV System shall transmit distress notifications to TRAC within five minutes of its generation in the system. Distress Messages will not be part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-1	Collect CV Data	M*	The Wyoming CV System shall collect data from the Vehicle System. Distress Messages will not be part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-1.3	Collect Distress Messages	O	The Wyoming CV System shall collect distress messages using the Traveler Information Message (as defined in section 5.16 of J2735) from the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067 Distress Messages will not be part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-2	Validate Data	M	The Wyoming CV System shall provide validation- and sanitization-related functions of CV Data as defined in Section 3.1.4.1 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-11	Store VS Data	M*	The Wyoming CV System shall store processed data collected by the Vehicle Systems and retain it for the duration of the CV Pilot. Data Processing is defined in ODE-REQ-2. Distress Messages will not be part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-11.3	Store Distress Messages	O	The Wyoming CV System shall store processed distress messages using the Traveler Information Message (as defined in section 5.16 of J2735) received from the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. As the distress message will be previously validated, only core data will be stored (defined in sections 5.16, and 6.142 of J2735). Distress Messages will not be part of Phase 4.
Vehicle System (VS)	VS-REQ-3	Receive Distress Information	O	The Vehicle System shall wirelessly receive a packet containing distress information from other connected vehicles over DSRC. Distress information is a high priority messages based on the received distress broadcast (defined in J3067 3.5.9.2.1), but has the content of the TIM (defined in J2735 5.16 Part III advisory ITIS data elements 6.1 from J2540-2 Accidents and Incidents). Distress information will not be part of Phase 4.
Vehicle System (VS)	VS-REQ-4	Collect Vehicle Data	O	The Vehicle System shall have the capability to collect vehicle information from the host vehicle and the driver as stated below Not part of Phase 4
Vehicle System (VS)	VS-REQ-4.1	Collect Vehicle Status Data	O	The Vehicle System shall have the capability to collect vehicle status information from the host vehicle, as stated in Section 5.4.2 of the ICD. Not part of Phase 4
Vehicle System (VS)	VS-REQ-15	Distress Notification ID	O	The Vehicle System shall identify received distress notifications. Distress information is a high priority messages loosely based on the mayday broadcast (defined in J3067 3.5.9.2.1), but has the content of the TIM (defined in J2735 5.16 Part III advisory ITIS data elements 6.1 from J2540_2 Accidents and Incidents). Not part of Phase 4
Vehicle System (VS)	VS-REQ-15.1	Log	O	The Vehicle System shall log received distress notifications to include the DNM. Not part of Phase 4

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-16	Create Distress Notification	O	The Vehicle System shall have the ability to generate a distress notification. Not part of Phase 4
Vehicle System (VS)	VS-REQ-16.1	System-Generated Distress Notification	O	The Vehicle System shall have the ability to self-generate a distress notification when the vehicle Event Status reports airbag deployment or disabled vehicle code. Vehicle Status data is specified in Section 5.4.2 of the ICD.
Vehicle System (VS)	VS-REQ-16.2	Driver-Generated Distress Notification	O	The Vehicle System shall have the ability to generate a distress notification when the vehicle operator selects the distress notification activation alternative in the HMI. Not part of Phase 4
Vehicle System (VS)	VS-REQ-17	DNM-Region	O	The Vehicle System shall ingest received DNMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage. Not part of Phase 4
Vehicle System (VS)	VS-REQ-18	DN PSID	O	The Vehicle System shall use a unique high priority Provider Service Identifier (PSID) for the distress notification application as per IEEE 1609.12. Not part of Phase 4
Vehicle System (VS)	VS-REQ-23	IVAA Rank	M*	The Vehicle System shall provide prioritized in-vehicle alerts based on the rank order presented in Table 4-1 of the SyRS, with the highest rank on top. Distress Message not included in Phase 4.
Vehicle System (VS)	VS-REQ-24	IVAA Level	M*	The Vehicle System shall have three levels of alert, as described in Table 4-2 of the SyRS. For Phase 4 we will use the off the shelf vendor alerting system.
Vehicle System (VS)	VS-REQ-25	IVAA Priority Alert	M	The Vehicle System shall provide only the highest priority alert to the vehicle operator when more than one alert is currently active
Vehicle System (VS)	VS-REQ-27	IVAA DN	O	The Vehicle System shall alert the vehicle operator for a distress message when the direction of travel of the host vehicle moving toward the distressed vehicle and is within five miles of the location of a distressed vehicle using an inform message. Distress Notification functionality is described in Section 2.6.3 of the SyRS. DN is not part of Phase 4.
Vehicle System (VS)	VS-REQ-32	HMI Characteristics	M*	All Vehicle Sub-Systems shall contain a HMI that conforms to the following characteristics. Phase 4 will not include distress notification.
Vehicle System (VS)	VS-REQ-32.7	Distress Notification	O	The HMI shall include a distress button to allow a driver to notify the Vehicle System that the driver has initiated a distress condition. This button enables the distress notification application as defined in section 2.6.3 of the SyRS. Phase 4 will not include distress notification.
Vehicle System (VS)	VS-REQ-34	BCVI Distress	O	The Vehicle System shall wirelessly broadcast distress messages to other connected devices. Phase 4 will not include BCVI Distress.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-34.1	Received Distress	O	The Vehicle System shall broadcast distress notifications (over DSRC), received from remote vehicles, for five miles from the location where the distressed vehicle is located. Phase 4 will not include received distress messages.
Vehicle System (VS)	VS-REQ-34.2	Generated Distress	O	The Vehicle System, in distress (described in Section 2.6 of the SyRS), shall broadcast distress notifications over DSRC, until the vehicle event code that triggered the distress notification is reset or power is lost (whichever comes first). Phase 4 will not include generated distress notifications.
Vehicle System (VS)	VS-REQ-35	BCVI General Broadcast Requirements	O	The Vehicle System shall use the general broadcast requirements defined in Appendix A.4 Broadcast Traveler Information of the SyRS. Phase 4 will not include the broadcast of traveler information
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
4) Support notification of warnings about work zones to equipped vehicles				
Situation Data Exchange (SDX)	SDX-REQ-1	Data Provided to the SDX	M	The Wyoming CV System shall transmit traveler information messages (TIMs) generated by the system to the SDX within five minutes of generation. TIMs are formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM).
Situation Data Exchange (SDX)	SDX-REQ-2	Distribute TIM to VS	M	The Situation Data Exchange shall distribute TIMs to the <i>Vehicle System</i> through satellite, as defined in WCVS-REQ-10.2 Distribute TIM to SDX.
WYDOT Construction Administration (CA)	CA-REQ-1	CA Data Sharing	M	The Wyoming CV System shall receive timestamped work zone information from the CA.
WYDOT Construction Administration (CA)	CA-REQ-2	Protocol	M	The Wyoming CV System shall receive work zone information, based on HTTP protocol, from the CA.
WYDOT Construction Administration (CA)	CA-REQ-3	Schema	M	The Wyoming CV System shall receive work zone information from WYDOT CA, as described in Section 5.32.1 of the ICD.
WYDOT Construction Administration (CA)	CA-REQ-4	Transmission	M	The Wyoming CV System shall receive work zone data from WYDOT Construction Administrator within thirty minutes of generation.
Wyoming CV System (WCVS)	WCVS-REQ-9	Create TIM	M	The Wyoming CV System shall create a Traveler Information Message (TIM) formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM).

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-10	Distribute TIM	M	The Wyoming CV System shall distribute signed TIMs to the Vehicle System and the Situation Data Exchange (SDX).
Wyoming CV System (WCVS)	WCVS-REQ-10.1	Distribute TIM to VS	M	The Wyoming CV System shall distribute signed TIM to the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067
Wyoming CV System (WCVS)	WCVS-REQ-10.2	Distribute TIM to SDX	M	The Wyoming CV System shall distribute signed TIM to the SDX consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. The SDX may not be available going forward. This requirement is for general compliance with the national communication of TIMs and is one way that the Wyoming pilot can get TIMs to third parties for broader distribution. If the SDX becomes unavailable, the pilot can directly send TIMs to the third parties for distribution. The SDX is not required for the Wyoming pilot.
Vehicle System (VS)	VS-REQ-2	Receive TIM	M	VS-REQ-2 Receive TIM – The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System. Each packet may contain one or more individual traveler information message as defined in Section 5.16 of SAE J2735.
Vehicle System (VS)	VS-REQ-19	WZW TIM	M	The Vehicle System shall ingest received TIMs to identify work zone warnings (Part III content choice workZone defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.
Vehicle System (VS)	VS-REQ-20	WZW TIM-Region	M	The Vehicle System shall ingest received TIMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.
Vehicle System (VS)	VS-REQ-23	IVAA Rank	M*	The Vehicle System shall provide prioritized in-vehicle alerts based on the rank order presented in Table 4-1 of the SyRS, with the highest rank on top. Distress Message not included in Phase 4.
Vehicle System (VS)	VS-REQ-24	IVAA Level	M*	The Vehicle System shall have three levels of alert, as described in Table 4-2 of the SyRS. For Phase 4 we will use the off the shelf vendor alerting system.
Vehicle System (VS)	VS-REQ-25	IVAA Priority Alert	M	The Vehicle System shall provide only the highest priority alert to the vehicle operator when more than one alert is currently active
Vehicle System (VS)	VS-REQ-31	IVAA WZW	M	The Vehicle System shall alert the vehicle operator of a work zone, based on the information defined in requirement CA-REQ-3, when host vehicle is traveling towards and within two miles of the location of a work zone using an inform message as defined in Section 2.6.4 of the SyRS.
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
5) Support Spot Weather Impact Warnings to equipped vehicles				
Situation Data Exchange (SDX)	SDX-REQ-1	Data Provided to the SDX	M	The Wyoming CV System shall transmit traveler information messages (TIMs) generated by the system to the SDX within five minutes of generation. TIMs are formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM).

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Situation Data Exchange (SDX)	SDX-REQ-2	Distribute TIM to VS	M	The Situation Data Exchange shall distribute TIMs to the <i>Vehicle System</i> through satellite, as defined in WCVS-REQ-10.2 Distribute TIM to SDX.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.1	Road Condition	M	The Wyoming CV System shall receive road condition information from the RCRS following the 8 Code System.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.2	Weather	M	The Wyoming CV System shall receive atmospheric information from the RCRS following the 9 Code System.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.3	Other Road Condition	M	The Wyoming CV System shall receive other road information from RCRS following the 10 Code System.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.4	Report Time	M	The Wyoming CV System shall receive reports from RCRS containing a timestamp of when the operator entered the information into the app.
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.5	Location	M	The Wyoming CV System shall receive reports from RCRS containing a location reference of when the operator entered the information into the app
WYDOT Road Condition Reporting (RCRS)	RCRS-REQ-1.6	Transmit Time	M	The Wyoming CV System shall receive reports from RCRS containing a timestamp of when the report was transmitted to the TMC. The transmitting timestamp may be different from the reporting time
Wyoming CV System (WCVS)	WCVS-REQ-1	Collect CV Data	M*	The Wyoming CV System shall collect data from the Vehicle System.
Wyoming CV System (WCVS)	WCVS-REQ-1.2	Collect Environmental Sensor Data	O	The Wyoming CV System shall collect environment sensor data using secure copy (SCP) from the Vehicle System consistent with secure shell (SSH). Not part of Phase 4.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-3	Ingest Data for Road Weather information	M*	The Wyoming CV System shall use one or more of the following sources of data to generate road weather information: <ul style="list-style-type: none"> • Collected CV Information defined in WCVS-REQ-1. • Segment road and weather conditions from the WYDOT RCRS in RCRS-REQ-1. • Weather conditions from weather interfaces defined in WI-REQ-1 and WI-REQ-2. WI-REQ-1 and WI-REQ-2 is not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4	Contents of Alerts and Advisories	M*	The Wyoming CV System shall generate alerts and advisories of roadway hazard conditions as defined in the following requirements.
Wyoming CV System (WCVS)	WCVS-REQ-4.1	Precipitation Hazard	O	The Wyoming CV System shall generate a precipitation type and intensity report every 5 minutes, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.2	Road Condition Hazard	O	The Wyoming CV System shall generate a pavement state and slickness flag report every 5 minutes, depending on input data, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.3	Visibility Hazard	O	The Wyoming CV System shall generate a visibility report, along with the condition causing it, every 5 minutes, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5	Forecast Conditions	O	The Wyoming CV System shall generate forecasts of conditions as defined in the following requirements Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.1	Atmospheric Forecasts	O	The Wyoming CV System shall produce atmospheric weather forecasts, at a minimum, for (a) atmospheric temperature, (b) probability of precipitation, (c) wind speed, and (d) wind direction Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.2	Road Weather Forecasts	O	The Wyoming CV System shall produce road weather forecasts, at a minimum, for (a) pavement temperature, and (b) subsurface temperature Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.3	Forecast Time	O	The Wyoming CV System shall generate forecast reports for customizable forecast windows. The windows of interest will be determined by WYDOT (6, 12, 24, 48 hours for example). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.4	Forecast Update	O	The Wyoming CV System shall generate forecast updates for customizable intervals. The update frequency will be determined by WYDOT and may vary based on time of year (every 3 hours for example in winter to 12 hours during summer). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-6	Associate Alerts and Forecast to Segments	O	The Wyoming CV System shall associate each alert and forecast to one or more road segments on I-80. Roadway segments are defined by WYDOT as sections of roadway between variable mileposts. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-9	Create TIM	M	The Wyoming CV System shall create a Traveler Information Message (TIM) formatted as defined in J2735 – 5.16 Message: MSG_TravelerInformation Message (TIM).

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-10	Distribute TIM	M	The Wyoming CV System shall distribute signed TIMs to the Vehicle System and the Situation Data Exchange (SDX).
Wyoming CV System (WCVS)	WCVS-REQ-10.1	Distribute TIM to VS	M	The Wyoming CV System shall distribute signed TIM to the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067
Wyoming CV System (WCVS)	WCVS-REQ-10.2	Distribute TIM to SDX	M	The Wyoming CV System shall distribute signed TIM to the SDX consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. The SDX may not be available going forward. This requirement is for general compliance with the national communication of TIMs and is one way that the Wyoming pilot can get TIMs to third parties for broader distribution. If the SDX becomes unavailable, the pilot can directly send TIMs to the third parties for distribution. The SDX is not required for the Wyoming pilot.
Vehicle System (VS)	VS-REQ-2	Receive TIM	M	VS-REQ-2 Receive TIM – The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System. Each packet may contain one or more individual traveler information message as defined in Section 5.16 of SAE J2735.
Vehicle System (VS)	VS-REQ-2.1	Receive TIM through DSRC	M	The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System through DSRC In Phase 4 this will be done with C-V2X rather than DSRC.
Vehicle System (VS)	VS-REQ-2.2	Receive TIM through Satellite	M	The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System (via the Situation Data Exchange) through satellite.
Vehicle System (VS)	VS-REQ-4	Collect Vehicle Data	O	The Vehicle System shall have the capability to collect vehicle information from the host vehicle and the driver as stated below Not part of Phase 4.
Vehicle System (VS)	VS-REQ-4.1	Collect Vehicle Status Data	O	The Vehicle System shall have the capability to collect vehicle status information from the host vehicle, as stated in Section 5.4.2 of the ICD. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-5	External Environment Sensor Data	O	The Vehicle System shall collect additional environmental sensor data from host vehicles equipped with external environmental sensors. Additional data collected from external environmental sensors is shown in Table 7-4 of the Interface Control Document. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-5.1	External Environment Sensor Data Configuration	O	The collection of sensor data by the Vehicle System shall be configurable as specified in Section 3.2.5.1 of the SDD. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-5.2	External Environment Sensor Data Management	O	The application shall support a data management mechanism, specified in Section 3.2.5.1 of the SDD. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-21	SWIW TIM	M	The Vehicle System shall ingest received TIMs to identify advisories for wind and weather conditions (Part III content choice advisories defined in J2735 section 6.142 for ITIS - data elements 6.54 Weather Conditions and 6.55 Winds defined in J2540_2). Data ingest is defined as obtaining and importing data for use or storage.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-22	SWIW TIM-Region	M	The Vehicle System shall ingest received TIMs to identify the applicable regions of use geographical path (Part II defined in J2735 section 6.142). Data ingest is defined as obtaining and importing data for use or storage.
Vehicle System (VS)	VS-REQ-23	IVAA Rank	M*	The Vehicle System shall provide prioritized in-vehicle alerts based on the rank order presented in Table 4-1 of the SyRS, with the highest rank on top. Distress Message not included in Phase 4.
Vehicle System (VS)	VS-REQ-24	IVAA Level	M*	The Vehicle System shall have three levels of alert, as described in Table 4-2 of the SyRS. For Phase 4 we will use the off the shelf vendor alerting system.
Vehicle System (VS)	VS-REQ-25	IVAA Priority Alert	M	The Vehicle System shall provide only the highest priority alert to the vehicle operator when more than one alert is currently active
Vehicle System (VS)	VS-REQ-30	IVAA SWIW	M	The Vehicle System shall alert the vehicle operator of a spot weather incident when the host vehicle is traveling toward and within five miles of the incident's location using an inform message as defined in Section 2.6.5 of the SyRS.
Vehicle System (VS)	VS-REQ-36	Transmit Data	M*	The Vehicle System shall transmit data over DSRC. Phase 4 shall not use DSRC and should test Wi-Fi.
Vehicle System (VS)	VS-REQ-36.1	Transmit Environmental Data	O	The Vehicle System shall transmit over DSRC environmental data, defined in Table 7-4 of the SDD, to the Wyoming CV System when available from a vehicle Sub-System. Phase 4 will not include transmitting of environmental data.
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
6) Support WYDOT Corridor Management & Traditional Traveler Information Program Services				
WYDOT 511 Application (511App)	511-REQ-1	511App Parking Data Collection	M	The Wyoming CV System shall receive parking status data from Wyoming 511 App.
WYDOT 511 Application (511App)	511-REQ-1.1	Availability	M	The Wyoming CV System shall categorize parking availability for the facility of interest as follows: i) Full – No parking availability, ii) Spaces available, or iii) Only a few spaces available.
WYDOT 511 Application (511App)	511-REQ-1.2	Default	M	The Wyoming CV System shall set parking availability default to available if not provided.
WYDOT 511 Application (511App)	511-REQ-1.3	Time	M	The Wyoming CV System shall timestamp parking availability reports.
WYDOT 511 Application (511App)	511-REQ-1.4	Location	M	The Wyoming CV System shall associate parking availability with a parking facility on I-80.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
WYDOT 511 Application (511App)	511-REQ-1.5	Protocol	M	The Wyoming CV System shall receive information, based on HTTP protocol, from the 511App.
WYDOT 511 Application (511App)	511-REQ-1.6	Schema	M	The Wyoming CV System shall receive information based on the parking schema defined by WYDOT (WYDOT Truck Parking Map – as of 07/2016).
WYDOT 511 Application (511App)	511-REQ-2	Timeframe	M	The Wyoming CV System shall receive Parking availability data from the WYDOT 511 application within thirty minutes of generation.
WYDOT Third Party Interface (TPI)	TPI-REQ-1	TPI Data	O	The Wyoming CV System shall transmit traffic condition information to the WYDOT TPI, as described in Section 5.36.1 of the ICD. This is outside the scope of Phase 4.
WYDOT Transportation Reports and Action Console (TRAC)	TRAC-REQ-1	TRAC Updates	O	The Wyoming CV System shall transmit CV pilot events to the TRAC. Not part of Phase 4
WYDOT Transportation Reports and Action Console (TRAC)	TRAC-REQ-1.1	Distress Notification	O	The Wyoming CV System shall transmit received distress notifications to TRAC. Distress notifications are defined in WCVS-REQ-1.3. Not part of Phase 4
WYDOT Transportation Reports and Action Console (TRAC)	TRAC-REQ-1.1.1	Transmission Time	O	The Wyoming CV System shall transmit distress notifications to TRAC within five minutes of its generation in the system. Not part of Phase 4
WYDOT Transportation Reports and Action Console (TRAC)	TRAC-REQ-1.2	Segment Alerts	O	The Wyoming CV System shall transmit segment-level alerts, defined in WCVS-REQ-4, to TRAC. Not part of Phase 4
WYDOT Transportation Reports and Action Console	TRAC-REQ-1.2.1	Transmission Time	O	The Wyoming CV System shall transmit alerts to TRAC within five minutes of its generation in the system. Not part of Phase 4

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Console (TRAC)				
WYDOT Transportation Reports and Action Console (TRAC)	TRAC-REQ-1.2.2	Segment Alerts-Pikalert	O	The Wyoming CV System shall transmit Pikalert segment-level alerts, defined in WCVS-REQ-4, to TRAC Not part of Phase 4
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-1	WTI Inputs	O	The Wyoming CV System shall transmit CV Pilot event information to the WTI. Not part of Phase 4.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-1.1	Current Segment Alerts	O	The Wyoming CV System shall transmit current segment-specific alerts, defined in WCVS-REQ-4, to the WTI. Not part of Phase 4.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-1.1.1	Transmission Time	O	The Wyoming CV System shall transmit alerts within five minutes of its generation in the system to the WTI. Not part of Phase 4.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-1.2	Forecast Segment Alerts	O	The Wyoming CV System shall transmit forecast segment-specific alerts, defined in WCVS-REQ-5, to the WTI. Not part of Phase 4.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-1.2.1	Forecast Time	O	The Wyoming CV System shall transmit forecast reports to WTI for pre-specified forecast windows determined by WYDOT (6, 12, 24, 48, 72 hours). Not part of Phase 4.
WYDOT Wyoming Traveler Information (WTI)	WTI-REQ-1.2.2	Forecast Update	O	The Wyoming CV System shall update its forecast reports in WTI at WYDOT-determined intervals (every 12 hours for example). Not part of Phase 4.
WYDOT Commercial Vehicle Operator	CVOP-REQ-1	CVOP Inputs	M	The Wyoming CV System shall transmit CV Pilot event information to the CVOP.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Portal (CVOP)				
WYDOT Commercial Vehicle Operator Portal (CVOP)	CVOP-REQ-1.1	Current Segment Alerts	M	The Wyoming CV System shall transmit current segment-specific alerts, defined in WCVS-REQ-4, to the CVOP.
WYDOT Commercial Vehicle Operator Portal (CVOP)	CVOP-REQ-1.1.1	Transmission Time	M	The Wyoming CV System shall transmit alerts within five minutes of its generation in the system to the CVOP.
WYDOT Commercial Vehicle Operator Portal (CVOP)	CVOP-REQ-1.2	Forecast Segment Alerts	O	The Wyoming CV System shall transmit forecast segment-specific alerts, defined in WCVS-REQ-5, to the CVOP. Not part of Phase 4.
WYDOT Commercial Vehicle Operator Portal (CVOP)	CVOP-REQ-1.2.1	Forecast Time	O	The Wyoming CV System shall transmit forecast reports to the CVOP for pre-specified forecast windows determined by WYDOT (6, 12, 24, 48, 72 hours). Not part of Phase 4.
WYDOT Commercial Vehicle Operator Portal (CVOP)	CVOP-REQ-1.2.2	Forecast Update	O	The Wyoming CV System shall update its forecast reports in CVOP at WYDOT-determined intervals (every 12 hours for example). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-3	Ingest Data for Road Weather information	M*	The Wyoming CV System shall use one or more of the following sources of data to generate road weather information: <ul style="list-style-type: none"> • Collected CV Information defined in WCVS-REQ-1. • Segment road and weather conditions from the WYDOT RCRS in RCRS-REQ-1. • Weather conditions from weather interfaces defined in WI-REQ-1 and WI-REQ-2. WI-REQ-1 and WI-REQ-2 is not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4	Contents of Alerts and Advisories	M*	The Wyoming CV System shall generate alerts and advisories of roadway hazard conditions as defined in the following requirements.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-4.1	Precipitation Hazard	O	The Wyoming CV System shall generate a precipitation type and intensity report every 5 minutes, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.2	Road Condition Hazard	O	The Wyoming CV System shall generate a pavement state and slickness flag report every 5 minutes, depending on input data, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.3	Visibility Hazard	O	The Wyoming CV System shall generate a visibility report, along with the condition causing it, every 5 minutes, as specified in Section 3.1.4.2 of the SDD. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-4.4	Work Zone Hazard	M	The Wyoming CV System shall generate a work zone report within 5 minutes of receiving work zone information from the Construction Administration (defined in CA-REQ-1), as specified in Section 3.1.5.4 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-4.5	Incident Hazard	M	The Wyoming CV System shall generate an incident report within 5 minutes of receiving incident notifications from the Incident Console (defined in IC-REQ-1), as specified in Section 3.1.4.3 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-4.6	Parking	M	The Wyoming CV System shall generate a parking report within 5 minutes of receiving parking availability notification, as specified in Section 3.1.4.3 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-5	Forecast Conditions	O	The Wyoming CV System shall generate forecasts of conditions as defined in the following requirements Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.1	Atmospheric Forecasts	O	The Wyoming CV System shall produce atmospheric weather forecasts, at a minimum, for (a) atmospheric temperature, (b) probability of precipitation, (c) wind speed, and (d) wind direction Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.2	Road Weather Forecasts	O	The Wyoming CV System shall produce road weather forecasts, at a minimum, for (a) pavement temperature, and (b) subsurface temperature Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.3	Forecast Time	O	The Wyoming CV System shall generate forecast reports for customizable forecast windows. The windows of interest will be determined by WYDOT (6, 12, 24, 48 hours for example). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-5.4	Forecast Update	O	The Wyoming CV System shall generate forecast updates for customizable intervals. The update frequency will be determined by WYDOT and may vary based on time of year (every 3 hours for example in winter to 12 hours during summer). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-6	Associate Alerts and Forecast to Segments	O	The Wyoming CV System shall associate each alert and forecast to one or more road segments on I-80. Roadway segments are defined by WYDOT as sections of roadway between variable mileposts. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-7	External Brokerage with WYDOT Interfaces	M*	The Wyoming CV System shall transfer data with WYDOT systems as defined in WCVS-REQ-7.1 and WCVS-REQ-7.2.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-7.2	Distribute to WYDOT External Interfaces	M*	The Wyoming CV System shall distribute information to WYDOT systems as defined in TPI-REQ-1, TRAC-REQ-1, WTI-REQ-1, CVOP-REQ-1, and ITSM-REQ-1. TPI-REQ-1 is not supported with Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-8	Internal Brokerage	M*	The Wyoming CV System shall support internal brokerage of data as defined in RSU-REQ-1, RSU-REQ-2, ODE-REQ-1, ODE-REQ-3, PA-REQ-2, PA-REQ-4, DB-REQ-4, DB-REQ-5, DB-REQ-6, DB-REQ-7, DW-REQ-1, DW-REQ-2, DW-REQ-4, HSM-REQ-1, HSM-REQ-2, HSM-REQ-3, and HSM-REQ-4. PA-REQ-2 and PA-REQ-4 are not supported with Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-18	Management and Performance Policy	O	The Wyoming CV System's infrastructure-related elements shall manage the policy for data collection and performance data following requirements defined in Appendix B.4 RSU Performance Data of the SyRS. Performance measures and performance data will not be part of Phase 4.
7) Need capability to monitor and update CV Pilot field devices system health (up-time, communication strength, device status) remotely during normal and adverse weather conditions				
WYDOT ITS Maintenance (ITSM)	ITSM-REQ-1	WYDOT ITS Alerts	M	The Wyoming CV System shall send alerts, defined in WCVS-REQ-16, to the WYDOT ITS Maintenance team within five minutes of a system becoming unavailable.
Wyoming CV System (WCVS)	WCVS-REQ-15	Notifications	M	The Wyoming CV System shall notify designated personnel within five minutes of a monitored function becoming unavailable
Wyoming CV System (WCVS)	WCVS-REQ-16	Monitored Functions	M	The Wyoming CV System shall monitor the functions described in WCVS-REQ-16.1 through WCVS-REQ-16.4.
Wyoming CV System (WCVS)	WCVS-REQ-16.1	Sub-System Availability	M	The Wyoming CV System shall monitor the Sub-systems for availability of ping services running. The WYDOT maintenance team will be sent a notification after a device, web service or running service is non-responsive for five minutes.
Wyoming CV System (WCVS)	WCVS-REQ-16.2	Sus-System Performance	M	The Wyoming CV System shall monitor the system's ability to transmit information in a timely manner. This will be done by monitoring message input queues age of oldest entry not processed. If the messages are not processed within five minutes the WYDOT maintenance team will be notified.
Wyoming CV System (WCVS)	WCVS-REQ-16.3	Availability for Interfaces	M	The Wyoming CV System shall monitor the external interfaces for availability of ping services running. The WYDOT maintenance team will be sent a notification after a device, web service or running service is non-responsive for five minutes.
Wyoming CV System (WCVS)	WCVS-REQ-16.4	Availability for Data Storage	M	The Wyoming CV System shall monitor available data storage of ping services running. The WYDOT maintenance team will be sent a notification after a device, web service or running service is non-responsive for five minutes. Notification will also be sent for disk space under 10% availability.
Wyoming CV System (WCVS)	WCVS-REQ-18	Management and Performance Policy	O	The Wyoming CV System's infrastructure-related elements shall manage the policy for data collection and performance data following requirements defined in Appendix B.4 RSU Performance Data of the SyRS. Performance measures and performance data will not be part of Phase 4.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-21	Manage CV Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to add/edit/delete equipment from the internal inventory list
Wyoming CV System (WCVS)	WCVS-REQ-22	Test WCVS Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to test the RSUs by allowing a series of Python testing scripts to be run on an RSU and results of the test returned to the user.
Wyoming CV System (WCVS)	WCVS-REQ-23	Track WCVS Equipment	M	The Wyoming CV System shall provide the TMC administrator the geolocation of RSUs.
Wyoming CV System (WCVS)	WCVS-REQ-24	Update WCVS Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to push out updates to the RSU firmware.
Wyoming CV System (WCVS)	WCVS-REQ-25	Update VS Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to push out OTA updates to the OBU firmware.
Vehicle System (VS)	VS-REQ-48	VSM Updates	M	The Vehicle System shall support Over-the-Air (OTA) software updates from the Wyoming CV System based on WAVE Service Announcements (WSA).
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
8) Need to develop human machine interface that minimizes the distraction and does not pose a burden on the work load of the driver.				
Vehicle System (VS)	VS-REQ-32	HMI Characteristics	M	All Vehicle Sub-Systems shall contain a HMI that conforms to the following characteristics.
Vehicle System (VS)	VS-REQ-32.1	HMI-Location	M	The location where the devices will be mounted/installed shall be selected so that they do not obstruct the line of sight of the driver nor distract the driver from the primary task of driving.
Vehicle System (VS)	VS-REQ-32.2	HMI-Distraction	M	The HMI shall minimize the 'eyes off the road' time when presenting information for an application
Vehicle System (VS)	VS-REQ-32.3	HMI-Readability	M	The HMI shall provide messages that can be read from the driver's normal seating position
Vehicle System (VS)	VS-REQ-32.4	Visual and Auditory Interface	M	The HMI shall include both a visual and auditory interface for sharing traveler information
Vehicle System (VS)	VS-REQ-32.4.1	Visual Consistency	M	The HMI shall maintain a consistent structure across applications with respect to presenting information to drivers and inputs to the system.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-32.4.2	Audio Signals	M	Auditory signals shall be loud enough to overcome masking sounds from road noise, the cab environment, and other equipment.
Vehicle System (VS)	VS-REQ-32.5	Customizations	M	HMI characteristics shall be customizable to reflect driver preferences. Preferences that shall be customizable are: <ul style="list-style-type: none"> • Volume • Brightness • Contrast text size • Display contrast • Mounting eye position
Vehicle System (VS)	VS-REQ-32.6	System Status	M	The HMI shall provide system status information to drivers. Information included in the system status includes power status, system settings, status of applications availability, and pending update status
Vehicle System (VS)	VS-REQ-32.6.1	Power Status	M	The HMI shall notify the driver of the power status of device with the screen graphics (e.g., off, powering up and online).
Vehicle System (VS)	VS-REQ-32.6.2	System Settings	M	The HMI shall allow the driver to see the system settings of the device with screen graphics. (e.g., version, brightness, volume font size).
Vehicle System (VS)	VS-REQ-32.6.3	Application Availability	M	The HMI shall allow the driver to see application availability with screen graphics (e.g., failed, operating, disabled).
Vehicle System (VS)	VS-REQ-32.6.4	Pending Update Status	M	The HMI shall allow the driver see pending updates for the device with screen graphics (e.g., applications, firmware, operating system).
Vehicle System (VS)	VS-REQ-32.7	Distress Notification	O	The HMI shall include a distress button to allow a driver to notify the Vehicle System that the driver has initiated a distress condition. This button enables the distress notification application as defined in section 2.6.3 of the SyRS. Phase 4 will not include distress notification.
Vehicle System (VS)	VS-REQ-32.8	Non-Distress Information	O	The HMI shall allow the driver to input data, as defined in VS-REQ-4.2 Phase 4 will not include non-distress information.
9)Need capability through the pilot of logging time-stamped data for various pilot elements				
Location and Time Source (LTS)	LTS-REQ-1	WCVS Time	M	The Wyoming CV System shall acquire time as specified below.
Location and Time Source (LTS)	LTS-REQ-1.1	WCVS LTS Time	M	The Wyoming CV System shall acquire time from the LTS interface in accordance with Section 5.10.1 of the ICD.
Location and Time Source (LTS)	LTS-REQ-1.2	WCVS Time Synchronization	M	The Wyoming CV System shall receive time synchronization information from a Stratum 2 NTP source, as described in Section 5.12.1 of the ICD.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Location and Time Source (LTS)	LTS-REQ-2	WCVS LTS Time Standard	M	The Wyoming CV System shall use Coordinated Universal Time (UTC) time for logged data (e.g., events logs and environmental data) based on the format defined in J2735 section 6.19 and epoch of January 1st 1970.
Location and Time Source (LTS)	LTS-REQ-3	WCVS LTS Location	M	The Wyoming CV System shall acquire location from the LTS interface in accordance with J2945/1 section 6.2.1.
Location and Time Source (LTS)	LTS-REQ-4	VS LTS Time	M	The Vehicle System shall acquire time from the LTS interface in accordance with Section 5.3.1 of the ICD.
Location and Time Source (LTS)	LTS-REQ-5	VS LTS Time Standard	M	The Vehicle System shall use Coordinated Universal Time (UTC) time for logged data (e.g., events logs and environmental data) based on the format defined in J2735 section 6.19 and epoch of January 1st 1970.
Location and Time Source (LTS)	LTS-REQ-6	VS LTS Location	M	The Vehicle System shall acquire location from the LTS interface in accordance with J2945/1 section 6.2.1.
10) Need a capability to collect, manage, store data collected from equipped fleets as part of the pilot				
Wyoming CV System (WCVS)	WCVS-REQ-1	Collect CV Data	M*	The Wyoming CV System shall collect data from the Vehicle System.
Wyoming CV System (WCVS)	WCVS-REQ-1.1	Collect BSM Data	M	The Wyoming CV System shall collect Basic Safety Message Parts I and II (as defined in J2945/1) from the Vehicle System consistent with Section 6.3.8 (BSM Scheduling and Congestion Control) of J2945/1
Wyoming CV System (WCVS)	WCVS-REQ-1.2	Collect Environmental Sensor Data	O	The Wyoming CV System shall collect environment sensor data using secure copy (SCP) from the Vehicle System consistent with secure shell (SSH). Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-1.3	Collect Distress Messages	O	The Wyoming CV System shall collect distress messages using the Traveler Information Message (as defined in section 5.16 of J2735) from the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067 Distress Messages will not be part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-2	Validate Data	M	The Wyoming CV System shall provide validation- and sanitization-related functions of CV Data as defined in Section 3.1.4.1 of the SDD.
Wyoming CV System (WCVS)	WCVS-REQ-8	Internal Brokerage	M*	The Wyoming CV System shall support internal brokerage of data as defined in RSU-REQ-1, RSU-REQ-2, ODE-REQ-1, ODE-REQ-3, PA-REQ-2, PA-REQ-4, DB-REQ-4, DB-REQ-5, DB-REQ-6, DB-REQ-7, DW-REQ-1, DW-REQ-2, DW-REQ-4, HSM-REQ-1, HSM-REQ-2, HSM-REQ-3, and HSM-REQ-4. PA-REQ-2 and PA-REQ-4 are not supported with Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-11	Store VS Data	M*	The Wyoming CV System shall store processed data collected by the Vehicle Systems and retain it for the duration of the CV Pilot. Data Processing is defined in ODE-REQ-2.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-11.1	Store BSM	M	The Wyoming CV System shall store processed BSM Parts I and II data received from the Vehicle System. As the BSM will be previously validated, only core data elements will be stored (defined in sections 6.8, 6.147, 6.128, and 6.133 of J2735).
Wyoming CV System (WCVS)	WCVS-REQ-11.2	Store Environment Sensor Data	O	The Wyoming CV System shall store processed environment sensor data consistent with Section 5.19.2 of the ICD. Environmental Sensor Data is not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-11.3	Store Distress Messages	O	The Wyoming CV System shall store processed distress messages using the Traveler Information Message (as defined in section 5.16 of J2735) received from the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. As the distress message will be previously validated, only core data will be stored (defined in sections 5.16, and 6.142 of J2735). Distress Messages will not be part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-12	Store Generated Alerts/Advisories	O	The Wyoming CV System shall store generated road weather alerts and advisories (defined WCVS-REQ-4) and retained for the duration of the CV Pilot. Not part of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-13	Store TIM	M	The Wyoming CV System shall store TIMs distributed to the Vehicle System and the Situation Data Exchange (SDX) and retain it for the duration of the CV Pilot.
Wyoming CV System (WCVS)	WCVS-REQ-14	Store System Monitoring Data	M	The Wyoming CV System shall store system monitoring data, as defined by WCVS-REQ-16 Monitored Functions, and retain it for the duration of the CV Pilot.
Wyoming CV System (WCVS)	WCVS-REQ-17	Archive Data	M	The Wyoming CV System shall provide the TMC administrator the ability to archive data used by the CV pilot by writing CV data to the WYDOT Data Warehouse, data written to the Data Warehouse is automatically archived per existing TMC best practices.
Vehicle System (VS)	VS-REQ-4	Collect Vehicle Data	O	The Vehicle System shall have the capability to collect vehicle information from the host vehicle and the driver as stated below Not part of Phase 4.
Vehicle System (VS)	VS-REQ-4.1	Collect Vehicle Status Data	O	The Vehicle System shall have the capability to collect vehicle status information from the host vehicle, as stated in Section 5.4.2 of the ICD. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-4.2	Collect Dimension Data	O	The Vehicle System shall have the capability to collect information from the host vehicle driver. The VS will maintain these values across power cycles and OTA updates. The data will be included in BSMs broadcasted by the Vehicle System. The list of fields are shown in Table 7-1 of the ICD, where column #1 contains the value "yes/driver". Not part of Phase 4.
Vehicle System (VS)	VS-REQ-4.2.1	Vehicle Dimension Data	O	The Vehicle System shall have the capability to collect vehicle dimension from the host vehicle driver through the Human Machine Interface. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-4.2.2	Vehicle Trailer Data	O	The Vehicle System shall have the capability to collect information from the host vehicle driver regarding the dimensions of attached trailers, including capability to indicate that no trailer is present, through the Human Machine Interface. Not part of Phase 4.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-5	External Environment Sensor Data	O	The Vehicle System shall collect additional environmental sensor data from host vehicles equipped with external environmental sensors. Additional data collected from external environmental sensors is shown in Table 7-4 of the Interface Control Document. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-5.1	External Environment Sensor Data Configuration	O	The collection of sensor data by the Vehicle System shall be configurable as specified in Section 3.2.5.1 of the SDD. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-5.2	External Environment Sensor Data Management	O	The application shall support a data management mechanism, specified in Section 3.2.5.1 of the SDD. Not part of Phase 4.
Vehicle System (VS)	VS-REQ-36	Transmit Data	M*	The Vehicle System shall transmit data over DSRC. Phase 4 shall not use DSRC and should test Wi-Fi.
Vehicle System (VS)	VS-REQ-36.1	Transmit Environmental Data	O	The Vehicle System shall transmit over DSRC environmental data, defined in Table 7-4 of the SDD, to the Wyoming CV System when available from a vehicle Sub-System. Phase 4 will not include transmitting of environmental data.
Vehicle System (VS)	VS-REQ-36.2	TVI Data Management-Log	M*	The Vehicle System shall transmit log files via secure copy (SCP) to the Wyoming CV System over DSRC that contain event logs data defined in VS-REQ-41. Phase 4 should transmit logs via Wi-Fi.
Vehicle System (VS)	VS-REQ-38	SLD Information	O	The Vehicle System shall store information generated by the host vehicle on local storage. Information to be stored is detailed in Table 4-3 of the SyRS. SLD information is not part of Phase 4.
Vehicle System (VS)	VS-REQ-39	SLD Rolling Log	M*	The Vehicle System shall maintain rolling logs for in vehicle generated CV data for 10 seconds. Table 4-4 of the SyRS lists one or more sources of the rolling logs that may be available in a vehicle Sub-System.
Vehicle System (VS)	VS-REQ-40	SLD Log Format	M	The event log format shall contain UTC time stamped text or binary data.
Vehicle System (VS)	VS-REQ-41	SLD Log Data	M*	The Vehicle System shall create event logs for all interactions with the Wyoming CV System or Vehicle System that is retained until it is sent to the Wyoming CV System or is older than seven (7) days. An interaction is defined as a received message from the Wyoming CV System or the Vehicle System. Each log should contain the information in Table 4-5 of the SyRS. Phase 4 excludes distress messages.
Vehicle System (VS)	VS-REQ-42	VSM SCMS	M	The Vehicle System shall use the USDOT SCMS Certificates in accordance with the security and privacy requirements in Section 6.5 of J2945/1
Vehicle System (VS)	VS-REQ-48	VSM Updates	M	The Vehicle System shall support Over-the-Air (OTA) software updates from the Wyoming CV System based on WAVE Service Announcements (WSA).

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
11) Need to be able to share data to/from vehicles from/to field, and back-office systems in both real-time and non-real time for various CV applications.				
Wyoming CV System (WCVS)	SDC-REQ-1	Data Provided to the SDC	O	The Wyoming CV System shall transmit information to the Secure Data Commons. The SDC will not be supported in Phase 4.
Wyoming CV System (WCVS)	RDE-REQ-1	Data Provided to the RDE	O	The Wyoming CV System shall transmit information to the Research Data Exchange. The RDE will not be supported in Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-7	External Brokerage with WYDOT Interfaces	M	The Wyoming CV System shall transfer data with WYDOT systems as defined in WCVS-REQ-7.1 and WCVS-REQ-7.2.
Wyoming CV System (WCVS)	WCVS-REQ-7.1	Receive from WYDOT External Interfaces	M	The Wyoming CV System shall receive data from WYDOT systems as defined in 511-REQ-1, RCRS-REQ-1, WTI-REQ-2, IC-REQ-1, and CA-REQ-1.
Wyoming CV System (WCVS)	WCVS-REQ-7.2	Distribute to WYDOT External Interfaces	M*	The Wyoming CV System shall distribute information to WYDOT systems as defined in TPI-REQ-1, TRAC-REQ-1, WTI-REQ-1, CVOP-REQ-1, and ITSM-REQ-1. TPI-REQ-1 is not supported with Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-10	Distribute TIM	M	The Wyoming CV System shall distribute signed TIMs to the Vehicle System and the Situation Data Exchange (SDX).
Wyoming CV System (WCVS)	WCVS-REQ-10.1	Distribute TIM to VS	M	The Wyoming CV System shall distribute signed TIM to the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067
Wyoming CV System (WCVS)	WCVS-REQ-10.2	Distribute TIM to SDX	M	The Wyoming CV System shall distribute signed TIM to the SDX consistent with Section 3.5.8 (Traveler Information Requirements) of J3067. The SDX may not be available going forward. This requirement is for general compliance with the national communication of TIMs and is one way that the Wyoming pilot can get TIMs to third parties for broader distribution. If the SDX becomes unavailable, the pilot can directly send TIMs to the third parties for distribution. The SDX is not required for the Wyoming pilot.
Vehicle System (VS)	VS-REQ-2	Receive TIM	M	VS-REQ-2 Receive TIM – The Vehicle System shall wirelessly receive a packet containing traveler information from the Wyoming CV System. Each packet may contain one or more individual traveler information message as defined in Section 5.16 of SAE J2735.
Vehicle System (VS)	VS-REQ-3	Receive Distress Information	O	The Vehicle System shall wirelessly receive a packet containing distress information from other connected vehicles over DSRC. Distress information is a high priority messages based on the received distress broadcast (defined in J3067 3.5.9.2.1), but has the content of the TIM (defined in J2735 5.16 Part III advisory ITIS data elements 6.1 from J2540-2 Accidents and Incidents). Distress information will not be part of Phase 4.

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-33	BCVI Messages	M*	The Vehicle System shall wirelessly broadcast over DSRC a basic safety message (BSM) to other connected devices. Phase 4 will use C-V2X rather than DSRC for wireless broadcasts of BSMS.
Vehicle System (VS)	VS-REQ-34	BCVI Distress	O	The Vehicle System shall wirelessly broadcast distress messages to other connected devices. Phase 4 will not include BCVI Distress.
Vehicle System (VS)	VS-REQ-35	BCVI General Broadcast Requirements	O	The Vehicle System shall use the general broadcast requirements defined in Appendix A.4 Broadcast Traveler Information of the SyRS. Phase 4 will not include the broadcast of traveler information.
Vehicle System (VS)	VS-REQ-36	Transmit Data	M*	The Vehicle System shall transmit data over DSRC. Phase 4 shall not use DSRC and should test Wi-Fi.
Vehicle System (VS)	VS-REQ-36.1	Transmit Environmental Data	O	The Vehicle System shall transmit over DSRC environmental data, defined in Table 7-4 of the SDD, to the Wyoming CV System when available from a vehicle Sub-System. Phase 4 will not include transmitting of environmental data.
Vehicle System (VS)	VS-REQ-38	SLD Information	O	The Vehicle System shall store information generated by the host vehicle on local storage. Information to be stored is detailed in Table 4-3 of the SyRS. SLD information is not part of Phase 4.
Vehicle System (VS)	VS-REQ-47	VSM App Availability Log	O	The Vehicle System shall log local application availability to the local event logs by vehicle type. Phase 4 will not include any app availability logs.
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
12) Need to ensure that data transfer is secure. Non-reputable, signed, and secured data sent and received by vehicles in this pilot				
Security Credential Management System (SCMS)	SCMS-REQ-1	Wyoming CV System (WCVS) SCMS Use	M*	The Wyoming CV System shall interface with the ISS SCMS based on the requirements in the current version of the End Entity Requirements document found at the SCMS Managers forum (https://www.scmsmanager.org/wp-content/uploads/2022/06/SCMS-Manager-End-Entity-Requirements-Design-Guidance-and-Validation-Approach-v1.00.pdf) Phase 4 will use the ISS SCMS.
Security Credential Management System (SCMS)	SCMS-REQ-1.1	SCMS Wyoming CV System Certificates	M*	The Wyoming CV System shall download certificates from the ISS SCMS. Phase 4 will use the ISS SCMS.
Security Credential Management System (SCMS)	SCMS-REQ-1.2	SCMS Wyoming CV System Misbehavior Reporting	O	The Wyoming CV System shall send misbehavior reports after they are published to the USDOT SCMS within 24 hours. This is outside the scope of Phase 4.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Security Credential Management System (SCMS)	SCMS-REQ-1.3	SCMS Wyoming CV System Certificates Revocation List (CRL)	O	The Wyoming CV System shall download the CRL from the USDOT SCMS. This is outside the scope of Phase 4.
Security Credential Management System (SCMS)	SCMS-REQ-1.4	SCMS Wyoming CV System Rejection	O	The Wyoming CV System shall reject messages received from any vehicles on the current CRL. This is outside the scope of Phase 4.
Security Credential Management System (SCMS)	SCMS-REQ-2	Vehicle System SCMS Use	M	The Vehicle System used in the Wyoming Pilot shall be certified from a USDOT authorized testing facility based on the current version of the Security Credential Management System Proof-of-Concept Implementation EE Requirements and Specifications Supporting SCMS Software (available at https://wiki.campllc.org/display/SCP/SCMS+CV+Pilots+Documentation). Phase 4 will use the ISS SCMS. The FCC has not delivered final rules regarding LTE-V2X usage and it is unclear when those rules will be published, in this context certification of devices means devices tested by an authorized test facility against the known standards and FCC guidance as of XXXX
Security Credential Management System (SCMS)	SCMS-REQ-2.1	SCMS Vehicle System Certificates	M*	The Vehicle System shall download certificates from the USDOT SCMS. Phase 4 will use the ISS SCMS.
Security Credential Management System (SCMS)	SCMS-REQ-2.2	SCMS Vehicle System Misbehavior Reporting	O	The Vehicle System shall send misbehavior reports after they are defined to the USDOT SCMS This is outside the scope of Phase 4.
Security Credential Management System (SCMS)	SCMS-REQ-2.3	SCMS Vehicle System Certificates Revocation List (CRL)	O	The Vehicle System shall download and utilize the CRL from the USDOT SCMS. This is outside the scope of Phase 4.
Security Credential Management System (SCMS)	SCMS-REQ-2.4	SCMS Vehicle System Rejection	O	The Vehicle System shall reject messages received from any vehicles on the current CRL This is outside the scope of Phase 4.
Wyoming CV System (WCVS)	WCVS-REQ-2	Validate Data	M	The Wyoming CV System shall provide validation- and sanitization-related functions of CV Data as defined in Section 3.1.4.1 of the SDD.

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Wyoming CV System (WCVS)	WCVS-REQ-20	Manage Safe Communications	M	The Wyoming CV System's infrastructure-related elements shall conform to the core safety communications requirements defined in Appendix B.2 V2I Core Safety Communication Requirements of the SyRS.
Wyoming CV System (WCVS)	WCVS-REQ-21	Manage CV Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to add/edit/delete equipment from the internal inventory list
Wyoming CV System (WCVS)	WCVS-REQ-22	Test WCVS Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to test the RSUs by allowing a series of Python testing scripts to be run on an RSU and results of the test returned to the user.
Wyoming CV System (WCVS)	WCVS-REQ-23	Track WCVS Equipment	M	The Wyoming CV System shall provide the TMC administrator the geolocation of RSUs.
Wyoming CV System (WCVS)	WCVS-REQ-24	Update WCVS Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to push out updates to the RSU firmware.
Wyoming CV System (WCVS)	WCVS-REQ-25	Update VS Equipment	M	The Wyoming CV System shall provide the TMC administrator the ability to push out OTA updates to the OBU firmware.
Vehicle System (VS)	VS-REQ-42	VSM SCMS	M	The Vehicle System shall use the ISS SCMS Certificates in accordance with the security and privacy requirements in Section 6.5 of J2945/1
Vehicle System (VS)	VS-REQ-43	VSM SCMS Encryption	O	The Vehicle System shall use the USDOT SCMS Certificates to sign and encrypt messages transmitted. The approved encryption algorithms are defined in IEEE 1609.2 and explained in USDOT SCMS CAMP Wiki Cryptography. Phase 4 will not include any encryption of messages.
Vehicle System (VS)	VS-REQ-44	VSM SCMS Sign	M	The Vehicle System shall use the ISS SCMS Certificates to sign, but not encrypt, all broadcasted messages.
Vehicle System (VS)	VS-REQ-45	VSM SCMS Encryption-Log	O	The Vehicle System shall use the USDOT SCMS Certificates to encrypt log files stored locally using the Public Key Encryption defined in USDOT SCMS CAMP Wiki Cryptography. Password protection is also allowable protection for log files. Phase 4 will not include any encryption of messages.
Vehicle System (VS)	VS-REQ-46	VSM SCMS Sign-Log	O	The Vehicle System shall use the USDOT SCMS Certificates to sign log files stored locally. Password protection is also allowable for in place of signing log files. Phase 4 will not include any signing of log files.
Vehicle System (VS)	VS-REQ-47	VSM App Availability Log	O	The Vehicle System shall log local application availability to the local event logs by vehicle type. Phase 4 will not include any app availability logs
Vehicle System (VS)	VS-REQ-48	VSM Updates	M	The Vehicle System shall support Over-the-Air (OTA) software updates from the Wyoming CV System based on WAVE Service Announcements (WSA).

7. Traceability to User Needs and System-level Requirements

(Sub-) System / Interface	Req. Number	Requirement Title	Phase 4 Mandatory / Optional	Requirement Description
Vehicle System (VS)	VS-REQ-49	Architectural	M	All Vehicle Sub-systems shall follow all core architectural requirements defined in Appendix A.2 OBU Core Architecture Requirements of the SyRS.
Vehicle System (VS)	VS-REQ-50	Safety Communication	M	All Vehicle Sub-systems shall follow all core safety communication requirements defined in Appendix A.3 V2V Core Safety Communication Requirements of the SyRS.
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.
13) Need to be able to share mobile data at required latency for various pilot applications				
Wyoming CV System (WCVS)	WCVS-REQ-10	Distribute TIM	M	The Wyoming CV System shall distribute signed TIMs to the Vehicle System and the Situation Data Exchange (SDX).
Wyoming CV System (WCVS)	WCVS-REQ-10.1	Distribute TIM to VS	M	The Wyoming CV System shall distribute signed TIM to the Vehicle System consistent with Section 3.5.8 (Traveler Information Requirements) of J3067
Vehicle System (VS)	VS-REQ-33	BCVI Messages	M*	The Vehicle System shall wirelessly broadcast over DSRC a basic safety message (BSM) to other connected devices. Phase 4 will use C-V2X rather than DSRC for wireless broadcasts of BSMs.
Vehicle System (VS)	VS-REQ-34	BCVI Distress	O	The Vehicle System shall wirelessly broadcast distress messages to other connected devices. Phase 4 will not include BCVI Distress.
Vehicle System (VS)	VS-REQ-35	BCVI General Broadcast Requirements	O	The Vehicle System shall use the general broadcast requirements defined in Appendix A.4 Broadcast Traveler Information of the SyRS. Phase 4 will not include the broadcast of traveler information.
Vehicle System (VS)	VS-REQ-36	Transmit Data	M*	The Vehicle System shall transmit data over DSRC. Phase 4 shall not use DSRC and should test Wi-Fi.
Vehicle System (VS)	VS-REQ-36.1	Transmit Environmental Data	O	The Vehicle System shall transmit over DSRC environmental data, defined in Table 7-4 of the SDD, to the Wyoming CV System when available from a vehicle Sub-System. Phase 4 will not include transmitting of environmental data.
Vehicle System (VS)	VS-REQ-38	SLD Information	O	The Vehicle System shall store information generated by the host vehicle on local storage. Information to be stored is detailed in Table 4-3 of the SyRS. SLD information is not part of Phase 4.
Vehicle System (VS)	VS-REQ-50	Safety Communication	M	All Vehicle Sub-systems shall follow all core safety communication requirements defined in Appendix A.3 V2V Core Safety Communication Requirements of the SyRS.
Vehicle System (VS)	VS-REQ-51	VS Equipment	M	All Vehicle System equipment shall conform to the characteristics described in Appendix A of the CAP.

The following table traces the Sub-System requirements to applicable System- and Interface-level requirements.

Table 7-2. Wyoming CV System Requirements to Sub-System Requirements Mapping Matrix.

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/Optional	System Req. Title
WCVS-REQ-1	Collect CV Data	RSU-REQ-1	M	Collect CV Data
		RSU-REQ-13	M	RSU Equipment
		ODE-REQ-1	M	Collect CV Data
WCVS-REQ-1.1	Collect BSM Data	RSU-REQ-1	M	Collect CV Data
		RSU-REQ-13	M	RSU Equipment
		ODE-REQ-1	M	Collect CV Data
WCVS-REQ-1.2	Collect Environmental Sensor Data	ODE-REQ-1	M	Collect CV Data
WCVS-REQ-1.3	Collect Distress Messages	RSU-REQ-1	M	Collect CV Data
		RSU-REQ-13	M	RSU Equipment
		ODE-REQ-1	M	Collect CV Data
WCVS-REQ-2	Validate Data	ODE-REQ-2	M	Data Processing
WCVS-REQ-3	Ingest Data for Road Weather information	ODE-REQ-1	M	Collect CV Data
		PA-REQ-1	O	External Weather Data Not in Phase 4
		PA-REQ-2	O	Wyoming CV Sub-Systems Data Not in Phase 4
		PA-REQ-2.1	O	ODE Data Not in Phase 4
		PA-REQ-2.2	O	TMC Data Not in Phase 4
		DB-REQ-1	M	Receive from External Interfaces
WCVS-REQ-4	Contents of Alerts and Advisories	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-4.1	Precipitation Hazard	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
WCVS-REQ-4.2	Road Condition Hazard	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-4.3	Visibility Hazard	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-4.4	Work Zone Hazard	DB-REQ-5	M	Distribute to ODE
WCVS-REQ-4.5	Incident Hazard	DB-REQ-5	M	Distribute to ODE
WCVS-REQ-4.6	Parking	DB-REQ-5	M	Distribute to ODE
WCVS-REQ-5	Forecast Conditions	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-5.1	Atmospheric Forecasts	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-5.2	Road Weather Forecasts	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-5.3	Forecast Time	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-5.4	Forecast Update	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-6	Associate Alerts and Forecast to Segments	PA-REQ-3	O	Generate Alerts/Advisories and Forecasts Not in Phase 4
WCVS-REQ-7	External Brokerage with WYDOT Interfaces	DB-REQ-1	M	Receive from External Interfaces
		DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase 4.
		PA-REQ-1	O	External Weather Data Not in Phase 4
WCVS-REQ-7.1	Receive from WYDOT External Interfaces	DB-REQ-1	M	Receive from External Interfaces
		PA-REQ-1	O	External Weather Data Not in Phase 4
WCVS-REQ-7.2	Distribute to WYDOT External Interfaces	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase 4.
		RSU-REQ-11	M	Distribute to ODE

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
WCVS-REQ-8		ODE-REQ-3	M	Distribute Data
		ODE-REQ-3.1	M	Distribute TIM to RSU
		ODE-REQ-3.3	O	Distribute to Pikalert Pikalert will not be part of Phase 4.
		ODE-REQ-3.4	M*	Distribute to Data Warehouse
		ODE-REQ-3.4.1	M	Distribute to Data Warehouse-BSM
		ODE-REQ-3.4.2	M	Distribute to Data Warehouse-DNM
		ODE-REQ-3.4.3	O	Distribute to Data Warehouse-ES Environmental sensor data will not be collected in Phase 4.
		ODE-REQ-3.5	O	Distribute to Data Broker Distress information will not be part of Phase 4.
		ODE-REQ-7	M	Receive from Data Broker
		PA-REQ-2	O	Wyoming CV Sub-Systems Data Not in Phase 4
		PA-REQ-2.1	O	ODE Data Not in Phase 4
		PA-REQ-2.2	O	TMC Data Not in Phase 4
		PA-REQ-4	O	Distribute Alerts/Advisories and Forecasts Not in Phase 4
		PA-REQ-4.1	O	Distribute to DB Not in Phase 4
		DB-REQ-4	O	Receive from Pikalert Pikalert will not be part of Phase 4.
		DB-REQ-4.1	O	Receive Alerts and Advisories Not in Phase 4
		DB-REQ-4.2	O	Receive Forecast Not in Phase 4
		DB-REQ-5	M	Distribute to ODE
		DB-REQ-6	O	Receive from ODE Distress information will not be part of Phase 4.
		DB-REQ-7	M*	Distribute to Data Warehouse Distress Notifications and Forecasts not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
		DB-REQ-8	M	Receive Data from DW
		DW-REQ-2	M*	Share Data
		DW-REQ-2.1	O	Share Data with TPI Not in Phase 4
		DW-REQ-2.4	M	Share Data with DB
		DW-REQ-4	M	Receive Data
WCVS-REQ-9	Create TIM	ODE-REQ-8	M	Generate TIMs for Connected Vehicles
WCVS-REQ-10	Distribute TIM	RSU-REQ-2	M	Distribute TIM to VS
		RSU-REQ-7	M	Broadcast
		ODE-REQ-3	M	Distribute Data
		ODE-REQ-3.1	M	Distribute TIM to RSU
		ODE-REQ-3.2	M	Distribute TIM to SDX
		HSM-REQ-1	O	Receive from ODE Not in Phase 4
		HSM-REQ-2	O	Share with ODE Not in Phase 4
		HSM-REQ-3	O	Receive from SCMS Not in Phase 4
		HSM-REQ-4	O	Share with SCMS Not in Phase 4
WCVS-REQ-10.1	Distribute TIM to VS	RSU-REQ-2	M	Distribute TIM to VS
		RSU-REQ-7	M	Broadcast
		HSM-REQ-2	O	Share with ODE Not in Phase 4
		ODE-REQ-3.1	M	Distribute TIM to RSU
WCVS-REQ-10.2	Distribute TIM to SDX	ODE-REQ-3.2	M	Distribute TIM to SDX
		HSM-REQ-2	O	Share with ODE Not in Phase 4
WCVS-REQ-11	Store VS Data	DW-REQ-1	M	Store Data
		DW-REQ-1.2	M	Store Vehicle System Data

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/Optional	System Req. Title
WCVS-REQ-11.1	Store BSM	DW-REQ-1.2	M	Store Vehicle System Data
WCVS-REQ-11.2	Store Environment Sensor Data	DW-REQ-1.2	M	Store Vehicle System Data
WCVS-REQ-11.3	Store Distress Messages	DW-REQ-1.2	M	Store Vehicle System Data
WCVS-REQ-12	Store Generated Alerts/Advisories	DW-REQ-1.1	M*	Store Alerts/Advisories
		DW-REQ-1.1.1	O	Store Alerts/Advisories-Precipitation Hazard Not in Phase 4
		DW-REQ-1.1.2	O	Store Alerts/Advisories-Road Condition Hazard Not in Phase 4
		DW-REQ-1.1.3	O	Store Alerts/Advisories-Visibility Hazard Not in Phase 4
		DW-REQ-1.1.4	M	Store Alerts/Advisories-Work Zone Hazard
		DW-REQ-1.1.5	M	Store Alerts/Advisories-Incident Hazard
		DW-REQ-1.1.6	M	Store Alerts/Advisories-Parking
WCVS-REQ-13	Store TIM	DW-REQ-1.3	M	Store TIM
WCVS-REQ-14	Store System Monitoring Data	DW-REQ-1.4	M	Store System Monitoring Data
		DW-REQ-3	M	Data Storage Administration
		DW-REQ-3.1	M	Maintain System Data Tables
		DW-REQ-3.1.1	M	CVE Data
		DW-REQ-3.2	M	Manage Data Storage Security
		DW-REQ-3.2.1	M	User Access
		DW-REQ-3.2.2	M	Unauthorized Access
		DW-REQ-3.3	M	Manage Data System
		DW-REQ-3.3.1	M	System Back-ups
		DW-REQ-3.3.2	M	Import/Export

7. Traceability to User Needs and System-level Requirements

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
		DW-REQ-3.3.3	M	Version Control
WCVS-REQ-15	Notifications	System-level Req.	M	System-level Req.
WCVS-REQ-16	Monitored Functions	System-level Req.	M	System-level Req.
WCVS-REQ-16.1	Sub-System Availability	System-level Req.	M	System-level Req.
WCVS-REQ-16.2	Sub-System Performance	System-level Req.	M	System-level Req.
WCVS-REQ-16.3	Availability for Interfaces	System-level Req.	M	System-level Req.
WCVS-REQ-16.4	Availability for Data Storage	System-level Req.	M	System-level Req.
WCVS-REQ-17	Archive Data	DW-REQ-3.4	M	Manage Data Archive
WCVS-REQ-18	Management and Performance Policy	RSU-REQ-10	O	Management and Performance Phase 4 will not include management and performance data collection.
WCVS-REQ-19	Manage Architecture		O	<i>This requirement no longer applies to this system.</i>
WCVS-REQ-20	Manage Safe Communications	RSU-REQ-6	M	Safety Communication
WCVS-REQ-21	Manage CV Equipment	System-level Req.	M	System-level Req.
WCVS-REQ-22	Test WCVS Equipment	System-level Req.	M	System-level Req.
WCVS-REQ-23	Track WCVS Equipment	System-level Req.	M	System-level Req.
WCVS-REQ-24	Update WCVS Equipment	RSU-REQ-12	M	Receive Update
WCVS-REQ-25	Update VS Equipment	ODE-REQ-6	O	OBU Update The ODE will not be part of OTA firmware updates in Phase 4.

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/Optional	System Req. Title
SCMS-REQ-1	WCVS SCMS Use	RSU-REQ-3	M*	SCMS Will use ISS SCMS
		ODE-REQ-4	M	SCMS
		HSM-REQ-3	O	Receive from SCMS Not in Phase 4
		HSM-REQ-4	O	Share with SCMS Not in Phase 4
SCMS-REQ-1.1	SCMS WCVS Certificates	RSU-REQ-3	M*	SCMS Will use ISS SCMS
		ODE-REQ-4	M	SCMS
SCMS-REQ-1.2	SCMS WCVS Misbehavior Reporting	RSU-REQ-3	M*	SCMS Will use ISS SCMS
		ODE-REQ-4	M	SCMS
SCMS-REQ-1.3	SCMS WCVS Certificates Revocation List (CRL)	RSU-REQ-3	M*	SCMS Will use ISS SCMS
		ODE-REQ-4	M	SCMS
SCMS-REQ-1.4	SCMS WCVS Rejection	RSU-REQ-3	M*	SCMS Will use ISS SCMS
		ODE-REQ-4	M	SCMS
SDX-REQ-1	Data Provided to the SDX	ODE-REQ-3.2	M	Distribute TIM to SDX
SDX-REQ-2	Distribute TIM to VS	ODE-REQ-3.2	M	Distribute TIM to SDX
SDC-REQ-1	Data Provided to the SDC	ODE-REQ-3.6	O	Distribute to SDC The SDC will not be part of Phase 4.
		DW-REQ-2.2	O	Share Data with SDC The SDC will not be part of Phase 4.
RDE-REQ-1	Data Provided to the RDE	ODE-REQ-3.7	O	Distribute to RDE The RDE will not be part of Phase 4.
		DW-REQ-2.3	O	Share Data with RDE The RDE will not be part of Phase 4.
LTS-REQ-1	WCVS Time	RSU-REQ-4	M	LTS
		ODE-REQ-5	M	LTS
LTS-REQ-1.1	WCVS LTS Time	RSU-REQ-4	M	LTS
		ODE-REQ-5	M	LTS

7. Traceability to User Needs and System-level Requirements

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
LTS-REQ-1.2	WCVS Time Synchronization	RSU-REQ-4	M	LTS
		ODE-REQ-5	M	LTS
LTS-REQ-2	WCVS LTS Time Standard	RSU-REQ-4	M	LTS
		ODE-REQ-5	M	LTS
LTS-REQ-3	WCVS LTS Location	RSU-REQ-4	M	LTS
		ODE-REQ-5	M	LTS
511-REQ-1	511App Parking Data Collection	DB-REQ-1	M	Receive from External Interfaces
511-REQ-1.1	Availability	DB-REQ-1	M	Receive from External Interfaces
511-REQ-1.2	Default	DB-REQ-1	M	Receive from External Interfaces
511-REQ-1.3	Time	DB-REQ-1	M	Receive from External Interfaces
511-REQ-1.4	Location	DB-REQ-1	M	Receive from External Interfaces
511-REQ-1.5	Protocol	DB-REQ-1	M	Receive from External Interfaces
511-REQ-1.6	Schema	DB-REQ-1	M	Receive from External Interfaces
511-REQ-2	Timeframe	DB-REQ-1	M	Receive from External Interfaces
TPI-REQ-1	TPI Data	DB-REQ-2	O	Distribute to External Interfaces TPI-REQ-1 is not part of Phase 4
TRAC-REQ-1	TRAC Updates	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
TRAC-REQ-1.1	Distress Notification	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
TRAC - REQ-1.1.1	Transmission Time	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
TRAC-REQ-1.2	Segment Alerts	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
TRAC-REQ-1.2.1	Transmission Time	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
TRAC-REQ-1.2.2	Segment Alerts-Pikalert	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
RCRS-REQ-1	RCRS Data Sharing	DB-REQ-1	M	Receive from External Interfaces
RCRS-REQ-1.1	Road Condition	DB-REQ-1	M	Receive from External Interfaces
RCRS-REQ-1.2	Weather	DB-REQ-1	M	Receive from External Interfaces
RCRS-REQ-1.3	Other Road Condition	DB-REQ-1	M	Receive from External Interfaces
RCRS-REQ-1.4	Report Time	DB-REQ-1	M	Receive from External Interfaces
RCRS-REQ-1.5	Location	DB-REQ-1	M	Receive from External Interfaces
RCRS-REQ-1.6	Transmit Time	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-1	WTI Inputs	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
WTI-REQ-1.1	Current Segment Alerts	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
WTI-REQ-1.1.1	Transmission Time	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
WTI-REQ-1.2	Forecast Segment Alerts	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
WTI-REQ-1.2.1	Forecast Time	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
WTI-REQ-1.2.2	Forecast Update	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
WTI-REQ-2	WTI Output	DB-REQ-1	M	Receive from External Interfaces

7. Traceability to User Needs and System-level Requirements

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
WTI-REQ-2.1	Posted Speed	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.2	Vehicle Restrictions	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.2.1	Restriction Information	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.2.2	Restriction Start Time	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.3	Posted Messages	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.3.1	Message Information	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.4	Posted Closures	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.4.1	Closure Beginning	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.4.2	Closure End	DB-REQ-1	M	Receive from External Interfaces
WTI-REQ-2.4.3	Closure Start Time	DB-REQ-1	M	Receive from External Interfaces
CVOP-REQ-1	CVOP Outputs	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
CVOP-REQ-1.1	Current Segment Alerts	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
CVOP-REQ-1.1.1	Transmission Time	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
CVOP-REQ-1.2	Forecast Segment Alerts	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
CVOP-REQ-1.2.1	Forecast Time	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
CVOP-REQ-1.2.2	Forecast Update	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase

System Req. ID	System Req. Title	Sub-System Req. ID	Phase 4 Mandatory/ Optional	System Req. Title
IC-REQ-1	IC Data Sharing	DB-REQ-1	M	Receive from External Interfaces
IC-REQ-2	Protocol	DB-REQ-1	M	Receive from External Interfaces
IC-REQ-3	Schema	DB-REQ-1	M	Receive from External Interfaces
IC-REQ-4	Transmission	DB-REQ-1	M	Receive from External Interfaces
CA-REQ-1	CA Data Sharing	DB-REQ-1	M	Receive from External Interfaces
CA-REQ-2	Protocol	DB-REQ-1	M	Receive from External Interfaces
CA-REQ-3	Schema	DB-REQ-1	M	Receive from External Interfaces
CA-REQ-4	Transmission	DB-REQ-1	M	Receive from External Interfaces
ITSM-REQ-1	WYDOT ITS Alerts	DB-REQ-2	M*	Distribute to External Interfaces TPI-REQ-1 is not part of Phase
WI-REQ-1	External Data Acquisition	PA-REQ-1	O	External Weather Data Not in Phase 4
WI-REQ-2	Fixed Data Acquisition	PA-REQ-1	O	External Weather Data Not in Phase 4

Table 7-3. Vehicle System Requirements to Sub-System Requirements Mapping Matrix.

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
VS-REQ-1	Receive BSM	MV-REQ-9	O	General Not in Phase 4.
		IT-REQ-6	O	General Not in Phase 4.
		RFV-REQ-5	O	General Not in Phase 4.
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4.
VS-REQ-2	Receive TIM	MV-REQ-4	O	Receive TIM over DSRC Not in Phase 4.
		MV-REQ-5	O	Receive TIM over Satellite Not in Phase 4.

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/Optional	Sub-System Req. Title
		IT-REQ-2	O	Receive TIM over Satellite Not in Phase 4.
		IT-REQ-1	O	Receive TIM over DSRC Not in Phase 4.
		RFV-REQ-1	O	Receive TIM over DSRC Not in Phase 4.
		RFV-REQ-2	O	Receive TIM over Satellite Not in Phase 4.
		TV-REQ-1	M	Receive TIM over C-V2X
		TV-REQ-2	M	Receive TIM over Satellite
		HP-REQ-2	O	Receive TIM over DSRC Not in Phase 4.
		HP-REQ-6	O	Receive TIM over Satellite Not in Phase 4.
VS-REQ-2.1	Receive TIM through DSRC	MV-REQ-4	O	Receive TIM over DSRC Not in Phase 4.
		IT-REQ-1	O	Receive TIM over DSRC Not in Phase 4.
		RFV-REQ-1	O	Receive TIM over DSRC Not in Phase 4.
		TV-REQ-1	M	Receive TIM over C-V2X
		HP-REQ-2	O	Receive TIM over DSRC Not in Phase 4.
VS-REQ-2.2	Receive TIM through Satellite	MV-REQ-5	O	Receive TIM over Satellite Not in Phase 4.
		IT-REQ-2	O	Receive TIM over Satellite Not in Phase 4.
		RFV-REQ-2	O	Receive TIM over Satellite Not in Phase 4.
		TV-REQ-2	M	Receive TIM over Satellite

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		HP-REQ-6	O	Receive TIM over Satellite Not in Phase 4.
VS-REQ-3	Receive Distress Information	MV-REQ-9	O	General Not in Phase 4.
		IT-REQ-6	O	General Not in Phase 4.
		HP-REQ-1	O	General Not in Phase 4.
VS-REQ-4	Collect Vehicle Data	MV-REQ-9	O	General Not in Phase 4.
		IT-REQ-6	O	General Not in Phase 4.
		RFV-REQ-5	O	General Not in Phase 4.
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4.
VS-REQ-4.1	Collect Vehicle Status Data	MV-REQ-2	O	General Not in Phase 4.
		MV-REQ-9	O	General Not in Phase 4.
VS-REQ-4.2	Collect Dimension Data	MV-REQ-9	O	General Not in Phase 4.
		IT-REQ-6	O	General Not in Phase 4.
		RFV-REQ-5	O	General Not in Phase 4.
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4.
VS-REQ-4.2.1	Vehicle Dimension Data	MV-REQ-9	O	General Not in Phase 4.
		IT-REQ-6	O	General Not in Phase 4.
		RFV-REQ-5	O	General Not in Phase 4.
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4.
VS-REQ-4.2.2	Vehicle Trailer Data	MV-REQ-9	O	General Not in Phase 4.
		IT-REQ-6	O	General Not in Phase 4.
		RFV-REQ-5	O	General Not in Phase 4.

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4.
VS-REQ-5	External Environment Sensor Data	MV-REQ-1	O	Environmental Sensors Not in Phase 4.
VS-REQ-5.1	External Environment Sensor Data Configuration	MV-REQ-1	O	Environmental Sensors Not in Phase 4.
VS-REQ-5.2	External Environment Sensor Data Management	MV-REQ-1	O	Environmental Sensors Not in Phase 4.
VS-REQ-6	FCW Stopped Vehicles	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-7	FCW Decelerating/Slow Moving Vehicles	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-8	FCW Stopped and Obstructed Vehicles	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-9	FCW Rear-End Crash	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-9.1	Rear-End Crash in Straight Road	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-9.2	Rear-End Crash in Curved Road	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-10	FCW No Warnings	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-10.1	Safely Following a Vehicle	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-10.2	Passing a Stopped Vehicle	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/Optional	Sub-System Req. Title
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-11	SA TIM-Advisories	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-12	SA TIM-Speed Limit	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-13	SA TIM-Exit Services	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-14	SA TIM-Region	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-15	Distress Notification ID	MV-REQ-9	O	General Not in Phase 4

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-15.1	Log	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-16	Create Distress Notification	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-16.1	System-Generated Distress Notification	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
VS-REQ-16.2	Driver-Generated Distress Notification	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-17	DNM-Region	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-18	DN PSID	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-19	WZW TIM	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
VS-REQ-20	WZW TIM-Region	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-21	SWIW TIM	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-22	SWIW TIM-Region	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-23	IVAA Rank	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-24	IVAA Level	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-25	IVAA Priority Alert	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-26	IVAA FCW	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-27	IVAA DN	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-28	IVAA SA-Advisory	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-29	IVAA SA-VSL	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
VS-REQ-30	IVAA SWIW	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-31	IVAA WZW	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32	HMI Characteristics	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.1	HMI-Location	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.2	HMI-Distracton	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.3	HMI-Readability	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.4	Visual and Auditory Interface	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.4.1	Visual Consistency	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.4.2	Audio Signals	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.5	Customizations	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
VS-REQ-32.6	System Status	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.6.1	Power Status	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.6.2	System Settings	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.6.3	Application Availability	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.6.4	Pending Update Status	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/Optional	Sub-System Req. Title
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.7	Distress Notification	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-32.8	Non-Distress Information	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-33	BCVI Messages	MV-REQ-3	O	Static Identifier Not in Phase 4
		MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-34	BCVI Distress	MV-REQ-3	O	Static Identifier Not in Phase 4
		MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-34.1	Received Distress	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-34.2	Generated Distress	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/Optional	Sub-System Req. Title
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-35	BCVI General Broadcast Requirements	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-36	Transmit Data	MV-REQ-3	O	Static Identifier Not in Phase 4
		MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-36.1	Transmit Environmental Data	MV-REQ-9	O	General Not in Phase 4
VS-REQ-36.2	TVI Data Management-Log	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-37	Communication Performance		O	Requirement Deleted
VS-REQ-38	SLD Information	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-39	SLD Rolling Log	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-40	SLD Log Format	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-41	SLD Log Data	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-42	VSM SCMS	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-43	VSM SCMS Encryption	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-44	VSM SCMS Sign	MV-REQ-9	O	General Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-45	VSM SCMS Encryption-Log	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-46	VSM SCMS Sign-Log	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-47	VSM App Availability Log	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-48	VSM Updates	MV-REQ-6	O	OTA Updates Not in Phase 4
		HP-REQ-7	O	OTA Updates Not in Phase 4
		IT-REQ-3	O	OTA Updates Not in Phase 4
		TV-REQ-7	M	OTA Updates
		RFV-REQ-7	O	OTA Updates Not in Phase 4

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
VS-REQ-49	Architectural	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-50	Safety Communication	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
VS-REQ-51	VS Equipment	MV-REQ-1.1	O	Environmental Sensor Equipment Not in Phase 4
		MV-REQ-10	O	OBU Equipment Not in Phase 4
		IT-REQ-7	O	OBU Equipment Not in Phase 4
		RFV-REQ-6	O	OBU Equipment Not in Phase 4
		TV-REQ-6	M	OBU Equipment
		HP-REQ-5	O	OBU Equipment Not in Phase 4
LTS-REQ-4	VS LTS Time	MV-REQ-7	O	Time Not in Phase 4
		IT-REQ-4	O	Time Not in Phase 4
		RFV-REQ-3	O	Time Not in Phase 4
		TV-REQ-3	M	Time
		HP-REQ-3	O	Time Not in Phase 4
LTS-REQ-5	VS LTS Time Standard	MV-REQ-7	O	Time Not in Phase 4
		IT-REQ-4	O	Time Not in Phase 4
		RFV-REQ-3	O	Time Not in Phase 4

7. Traceability to User Needs and System-level Requirements

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		TV-REQ-3	M	Time
		HP-REQ-3	O	Time Not in Phase 4
LTS-REQ-6	VS LTS Location	MV-REQ-8	O	Location Not in Phase 4
		IT-REQ-5	O	Location Not in Phase 4
		RFV-REQ-4	O	Location Not in Phase 4
		TV-REQ-4	M	Location
		HP-REQ-4	O	Location Not in Phase 4
SCMS-REQ-2	Vehicle System SCMS Use	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
SCMS-REQ-2.1	SCMS Vehicle System Certificates	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
SCMS-REQ-2.2	SCMS Vehicle System Misbehavior Reporting	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
SCMS-REQ-2.3	SCMS Vehicle System Certificates Revocation List (CRL)	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4

System Req.	System Req. Title	Sub-System Req.	Phase 4 Mandatory/ Optional	Sub-System Req. Title
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4
SCMS-REQ-2.4	SCMS Vehicle System Rejection	MV-REQ-9	O	General Not in Phase 4
		IT-REQ-6	O	General Not in Phase 4
		RFV-REQ-5	O	General Not in Phase 4
		TV-REQ-5	M	General
		HP-REQ-1	O	General Not in Phase 4

The following table traces the performance requirements to applicable system-level requirements.

Table 7-4. Trace of Performance Requirements to System Requirements

Performance Req. ID	Performance Req. Title	System Req. ID	System Req. Title
FCWP-REQ-1	FCW Advisory Alert Performance	VS-REQ-6	FCW Stopped Vehicles
		VS-REQ-7	FCW Decelerating/Slow Moving Vehicles
		VS-REQ-8	FCW Stopped and Obstructed Vehicles
		VS-REQ-9	FCW Rear-End Crash
		VS-REQ-9.1	Rear-End Crash in Straight Road
FCWP-REQ-2	FCW Imminent Alert Performance	VS-REQ-6	FCW Stopped Vehicles
		VS-REQ-7	FCW Decelerating/Slow Moving Vehicles
		VS-REQ-8	FCW Stopped and Obstructed Vehicles
		VS-REQ-9	FCW Rear-End Crash
		VS-REQ-9.1	Rear-End Crash in Straight Road
FCWP-REQ-3	Passing a Stopped Vehicle Performance	VS-REQ-10	FCW No Warning

7. Traceability to User Needs and System-level Requirements

Performance Req. ID	Performance Req. Title	System Req. ID	System Req. Title
		VS-REQ-10.2	Passing a Stopped Vehicle
FCWP-REQ-4	Following a Vehicle Performance	VS-REQ-10	FCW No Warning
		VS-REQ-10.1	Safely Following a Vehicle
FCWP-REQ-5	Decelerating Vehicle Performance	VS-REQ-7	FCW Decelerating/Slow Moving Vehicles
		VS-REQ-9	FCW Rear-End Crash
		VS-REQ-9.1	Rear-End Crash in Straight Road
FCWP-REQ-6	FCW Advisory Alert in a Curve Performance	VS-REQ-6	FCW Stopped Vehicles
		VS-REQ-7	FCW Decelerating/Slow Moving Vehicles
		VS-REQ-8	FCW Stopped and Obstructed Vehicles
		VS-REQ-9	FCW Rear-End Crash
		VS-REQ-9.2	Rear-End Crash in Curved Road
FCWP-REQ-7	FCW Imminent Alert in a Curve Performance	VS-REQ-6	FCW Stopped Vehicles
		VS-REQ-7	FCW Decelerating/Slow Moving Vehicles
		VS-REQ-8	FCW Stopped and Obstructed Vehicles
		VS-REQ-9	FCW Rear-End Crash
		VS-REQ-9.2	Rear-End Crash in Curved Road
FCWP-REQ-8	Passing a Stopped Vehicle in a Curve Performance	VS-REQ-6	FCW Stopped Vehicles
		VS-REQ-10	FCW No Warning
		VS-REQ-10.2	Passing a Stopped Vehicle
FCWP-REQ-9	Slow Moving Vehicle Advisory Alert in a Curve Performance	VS-REQ-7	FCW Decelerating/Slow Moving Vehicles
		VS-REQ-9	FCW Rear-End Crash
		VS-REQ-9.2	Rear-End Crash in Curved Road
FCWP-REQ-10	Slow Moving Vehicle Imminent Alert in a Curve Performance	VS-REQ-7	FCW Decelerating/Slow Moving Vehicles
		VS-REQ-9	FCW Rear-End Crash
		VS-REQ-9.2	Rear-End Crash in Curved Road

Performance Req. ID	Performance Req. Title	System Req. ID	System Req. Title
DNP-REQ-1	Distress Notification OBU DSRC Performance 1	VS-REQ-3	Receive Distress Information
DNP-REQ-2	Distress Notification OBU DSRC Performance 2	VS-REQ-3	Receive Distress Information
DNP-REQ-3	Distress Notification RSU DSRC Performance	WCVS-REQ-1	Collect CV Data
		WCVS-REQ-1.3	Collect Distress Messages
DNP-REQ-4	Distress Notification Driver Display Performance	VS-REQ-23	IVAA Rank
		VS-REQ-24	IVAA Level
		VS-REQ-25	IVAA Priority Alert
		VS-REQ-27	IVAA DN
DNP-REQ-5	Distressed Vehicle Distance	VS-REQ-27	IVAA DN
DNP-REQ-6	Distressed Vehicle Direction of Travel	VS-REQ-27	IVAA DN
DNP-REQ-7	Distressed Vehicle Roadway	VS-REQ-27	IVAA DN
DNP-REQ-8	Distress Vehicle Passing	VS-REQ-27	IVAA DN
DNP-REQ-9	Remote Vehicle Distress Notification Distance 1	VS-REQ-34	BCVI Distress
		VS-REQ-34.1	Received Distress
DNP-REQ-10	Remote Vehicle Distress Notification Distance 2	VS-REQ-34	BCVI Distress
		VS-REQ-34.1	Received Distress
DNP-REQ-11	Remote Vehicle Distress Notification Upload to ODE	VS-REQ-36	Transmit Data
		VS-REQ-36.2	TVI Data Management-Log
DNP-REQ-12	Remote Vehicle Distress Notification Upload Termination	VS-REQ-34	BCVI Distress
		VS-REQ-34.1	Received Distress
I2VSAP-REQ-1	Message Display in Travel Lanes	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-2	Message Display in Shoulder Lanes	VS-REQ-14	SA TIM-Region

7. Traceability to User Needs and System-level Requirements

Performance Req. ID	Performance Req. Title	System Req. ID	System Req. Title
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-3	Message Display in Acceleration Lane	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-4	Message Display Geofence Beginning	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-5	Message Display Geofence Ending	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-6	Message Display Geofence Ending	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-7	Message Display on Adjacent Service Road	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-8	Message Display in Perpendicular to Travel Lanes	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-9	Message Display Start Time	VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-10	Message Display Stop Time	VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-11	Verify I-80 Map and Geofences	VS-REQ-14	SA TIM-Region

Performance Req. ID	Performance Req. Title	System Req. ID	System Req. Title
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-12	Message Display in Travel Lanes	VS-REQ-14	SA TIM-Region
		VS-REQ-28	IVAA SA-Advisory
		VS-REQ-29	IVAA SA-VSL
I2VSAP-REQ-13	Simultaneous I2V and V2I DSRC Communications	WCVS-REQ-1	Collect CV Data
		WCVS-REQ-1.1	Collect BSM Data
		WCVS-REQ-1.2	Collect Environmental Sensor Data
		WCVS-REQ-1.3	Collect Distress Messages
		WCVS-REQ-2	Validate Data
		WCVS-REQ-10	Distribute TIM
		WCVS-REQ-10.1	Distribute TIM to VS
I2VSAP-REQ-14	Simultaneous DSRC and Satellite TIM Processing	VS-REQ-2	Receive TIM
		VS-REQ-2.1	Receive TIM through DSRC
		VS-REQ-2.2	Receive TIM through Satellite
MCP-REQ-1	V2V Exchange of BSMs	VS-REQ-1	Receive BSM
MCP-REQ-2	V2I & End-to-end Communication of BSMs	WCVS-REQ-1	Collect CV Data
		WCVS-REQ-1.1	Collect BSM Data
MCP-REQ-3	OBU Shakedown	N/A	
MCP-REQ-4	RSU and Backhaul Communications Shakedown 1	WCVS-REQ-22	Test WCVS Equipment
MCP-REQ-5	RSU and Backhaul Communications Shakedown 2	WCVS-REQ-22	Test WCVS Equipment
MCP-REQ-6	OBU Installation Robustness	N/A	
MCP-REQ-7	RSU Installation Robustness	N/A	

Appendix A. On-Board Unit Core Requirements

A.1 Introduction

The system requirements for On-Board Units (OBUs) are based on SAE J2945™/1 April 2020 (J2945/1 henceforth) for Vehicle to Vehicle (V2V) safety communications where applicable in the Wyoming Pilot. The Wyoming Pilot will require OBU manufactures to obtain certification from a USDOT approved testing facility for OBUs, so the relevant requirements from J2945/1 will only be referenced and will not be re-tested or verified in the pilot. For Vehicle to Infrastructure (V2I) SAE J3067 August 2014 (J3067 henceforth) is used for applicable applications. Additionally, SAE J2735™ July 2020 is used to update the outdated parts of the J3067 based on the new message set dictionary for DSRC. Here, the original J3067's system requirements numbers and descriptions are kept in order to ensure compatibility with other CV projects and to provide clarity for future standards. The current standard for basic safety messages within J2945/1 is for light vehicles and does not address trailers. The CV pilot developers plan to extend the current specification to include trailer-related standards. For this, the CV pilot team will watch for an outcome in the form of a standard based on the NHTSA research project "V2V Basic Safety Message for Truck/CV Trailers". Operational scenarios are detailed in the Concept of Operations (FHWA-JPO-16-287) Chapter 6. User classes and other involved personnel are described in detail in Section 5.5 of the ConOps. This includes stakeholders, user profiles, responsibilities and interactions with the system, interactions among user classes and the user support environment.

In cases where conflicting information is defined between the J2945/1, J2735, and J3067, J2945/1 will take initial precedence, followed by J2735 and finally J3067. The reason for this is J2945/1 is most specific and up to date for V2V safety communications and is there for most relevant to our pilot. J2735 is the second order of precedence because it has many updates to the message set that were not available when J3067 was written. J3067, while somewhat outdated is still relevant because it covers V2I communications and additional applications that are relevant to the Wyoming Pilot.

As J2945/2 and J2945/x become available the Wyoming Pilot will implement the standard interfaces and messages for Situation Awareness- Weather Condition Application, Situational Awareness Suboptimal Road Segment Conditions Applications and RWINFO for Freight Use Case if applicable.

As this project enters Phase 4 there have been new standards that have been developed recently that may help drive the functionality of OBUs and the messages they broadcast. These include SAE J3161: LTE Vehicle-to-Everything (LTE-V2X) Deployment Profiles and Radio Parameters for Single Radio Channel Multi-Service Coexistence, SAE J2945/1B On-Board V2V Safety Systems Requirements for Non Light Duty Vehicles and SAE J2945/C Requirements for Probe Data Collection Applications. These standards provide more advanced OBU requirements and

capabilities, define use of LTE-V2X radios and new V2X message sets. Moving forward RSU vendor flexibility will be key to supporting some of these capabilities as they are published.

This appendix is organized as follows:

1. Section A.1 is intentionally skipped
2. Section A.2 highlights common architecture-related requirements
3. Section A.3 summarizes the requirements V2V core safety communications used for all OBUs in the pilot.
4. Section A.4 contains the broadcast OBU requirements

A.2 OBU Core Architecture Requirements

The following list of architectural requirements have been identified as being common to all the OBUs used in this pilot.

ARQ-REQ-1 Architectural Requirements -- Connected Device Dialogs (Source: J3067, 3.4.3)
 – A connected device shall be able to establish a private wireless connection with another specific connected device that mutually agrees.

A.3 V2V Core Safety Communication Requirements

CSC-REQ-1 OBU SCMS Use – All OBUs used in the Wyoming Pilot shall be certified from a US DOT authorized testing facility based on the SCMS current version CAMP Wiki: Requirements and Specifications.

- Common Requirements
 - [Cryptography](#)
 - [Hardware, Software and OS Security Requirements](#)
 - A HSM that requires low confidentiality and medium integrity shall store keys in tamper-evident hardware equivalent to FIPS 140-2 level 2.
 - [EE-RA Communications – General Guidance](#)
 - Download requests for GPF, LPG, GCCF, LCCF, OBE pseudonym certificate batch file, OBE identification certificate files.
- Requirements by Use Case
 - [Use Case 2: OBE Bootstrapping \(Manual\)](#)
 - [Use Case 3: OBE Pseudonym Certificates Provisioning](#)
 - [Step 3.1: Request for Pseudonym Certificates](#)
 - OBU downloads Local Policy File and Local Certificate Chain and adopts any changes in the new files before making request.
 - [Step 3.3: Initial Download of Pseudonym Certificates](#)
 - OBU downloads Local Policy File and Local Certificate Chain and adopts any changes in the new files before downloading certificates.
 - [Step 3.5: Top-off Pseudonym Certificates](#)
 - [Use Case 6: CRL Download](#)
 - [Use Case 8: OBE Pseudonym Certificate Revocation](#)
 - [Step 8.4: OBE CRL Check](#)
 - [Use Case 19: OBE Identification Certificate Provisioning](#)
 - [Step 19.1: Request for OBE Identification Certificates](#)

- [Step 19.3: Initial Download of OBE Identification Certificates](#)
- [Step 19.5: Top-off OBE Identification Certificates](#)
- [Use Case 20: EE Re-Enrollment \(currently a preliminary concept, support when defined\)](#)
 - [Step 20.1: EE Enrollment Certificate Rollover](#)

CSC-REQ-2 OBU Certification - All OBUs used in the Wyoming Pilot shall be certified from a USDOT authorized testing facility based on J2945/1. At a minimum, the following applications interfaces and requirements from J2945/1 will be included in the certification testing. If no certification is available, OBU vendors will self-certify and provide documentation of tests.

- Applications
 - Forward Collision Warning
- Interfaces
 - 5.1 V2V Over-the-Air Data Description
 - 5.1.1 Basic Safety Message Exchange
 - 5.1.2 Positioning
 - 5.1.3 Security and Privacy
 - 5.1.3.1 Signing and Verification Algorithm
 - 5.1.3.2 BSM Signature Certificate Transmission
 - 5.1.3.3 BSM Verification
 - 5.1.3.4 SCMS
 - 5.1.3.5 Privacy
 - 5.1.4 Startup and Shutdown
 - 5.1.5 Mapping to the V2V Over-the-Air Data
 - 5.2 System Interfaces
 - 5.2.1 Vehicle to Vehicle Communications Interface
 - 5.2.2 System to SCMS Communication Interface
 - 5.2.3 System to Positioning Sub-System Interface
- Minimum Requirements
 - 6.1 Standard Profiles
 - 6.1.1 IEEE 802.11
 - 6.1.2 IEEE 1609.2
 - 6.1.2.1 PICS Proforma
 - 6.1.2.2 BSM Security Profile Proforma
 - 6.1.2.2.1 IEEE 1609.2 Security Profile Identification
 - 6.1.2.2.2 Sending
 - 6.1.2.2.3 Receiving
 - 6.1.2.2.5 Other
 - 6.1.3 IEEE 1609.3
 - 6.1.4 IEEE 1609.4
 - 6.1.5 IEEE 1609.12
 - 6.1.6 SAE J2735 (2016)
 - 6.1.7 FCC 47 CFR, Parts 0, 1, 2, and 95
 - 6.2 Positioning and Timing Requirements
 - 6.2.1 Position Determination
 - 6.2.2 Wide Area Augmentation
 - 6.2.3 Coordinate System and Reference
 - 6.2.4 System Time Coordination
 - 6.3 BSM Transmission Requirements on Channel vChannelNumber
 - 6.3.1 BSM Contents
 - 6.3.2 Channel and Data Rate

- 6.3.3 Generation of the First BSM after System Device Startup and Generation Timing
- 6.3.4 User Priority and EDCA Setting
- 6.3.5 Minimum Transmission Criteria
- 6.3.6 Data Element (DE) Accuracy
 - 6.3.6.1 DE_DSRC_MessageID
 - 6.3.6.2 DE_MesCount
 - 6.3.6.3 DE_TemporaryID
 - 6.3.6.4 DE_DSecond
 - 6.3.6.5 DE_Latitude & DE_Longitude
 - 6.3.6.6 DE_Elevation
 - 6.3.6.7 DF_PositionalAccuracy
 - 6.3.6.8 DE_Speed
 - 6.3.6.9 DE_TransmissionSpeed
 - 6.3.6.10 DE_Heading
 - 6.3.6.11 DE_SteeringWheelAngle
 - 6.3.6.12 DF_AccelerationSet4Way
 - 6.3.6.13 DF_BrakeSystemStatus
 - 6.3.6.14 DF_VehicleSize
 - 6.3.6.15 DE_VehicleEventFlags
 - 6.3.6.16 DF_PathHistory
 - 6.3.6.17 DF_PathPrediction
 - 6.3.6.18 DE_ExteriorLights
 - 6.3.6.19 Additional Data Elements
- 6.3.7 Data Persistency
 - 6.3.7.1 Heading
 - 6.3.7.2 Path History
- 6.3.8 BSM Scheduling and Congestion Control
 - 6.3.8.1 Inputs
 - 6.3.8.2 Calculate Tracking Error
 - 6.3.8.3 Calculate Transmission Probability
 - 6.3.8.4 Calculate Maximum Inter-Transmit Time
 - 6.3.8.5 Transmission Decision
 - 6.3.8.6 Schedule Transmission
 - 6.3.8.7 Calculate Radiated Power
 - 6.3.8.8 Generate BSM and Schedule Next BSM Generation
- 6.4 RF Performance Requirements
 - 6.4.1 DSRC Radiated Power and Transmit Power Accuracy
 - 6.4.1.1 Transmit Power Accuracy
 - 6.4.2 DSRC Receiver Sensitivity
 - 6.4.28 Psid Ssp Application Permission
- 6.5 Security and Privacy Requirements
 - 6.5.1 Identification Randomization
 - 6.5.2 BSM Signing
 - 6.5.3 Certificate Change
 - 6.5.4 BSM Cryptographic Verification
 - 6.5.5 Certificate Revocation
- 6.6 Security Management
 - 6.6.1 Bootstrap: Initialization and Enrollment Processing
 - 6.6.1.1 Initialization Processing

- 6.6.1.2 Enrollment Processing
- 6.6.2 Certificate Loading
- 6.6.3 Certificate Storage
- 6.6.4 Certificate Revocation List Loading
- 6.6.5 Secure Hardware
- Parameter Settings

A.4 Broadcast Traveler Information

The following requirements relate to the “broadcast” capability of the OBU, which is used for the Distress Notification application.

BC-REQ-1 Traveler Information Requirements (Source: J3067, 3.5.8). Traveler information is used to provide connected devices with travel advisories and information.

BC-REQ-1.1 Broadcast Traveler Information (Source: J3067, 3.5.8.1). A connected device shall broadcast a packet containing traveler information to connected devices. Each packet may contain one or more individual traveler information messages.

BC-REQ-1.2 Broadcast Traveler Information - Mandatory Requirements (Source: J3067, 3.5.8.2). The following are the minimum requirements for a connected device to broadcast traveler information to connected devices.

BC-REQ-1.2.1 Broadcast Traveler Information - Packet Identifier (Source: J3067, 3.5.8.2.1). A connected device shall include a packet identifier for the traveler information packet broadcasted to connected devices.

BC-REQ-1.2.2 Broadcast Traveler Information - Message Identifier Requirements (Source: J3067, 3.5.8.2.2). For each traveler information message in a traveler information packet, a connected device needs to identify each message transmitted as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.2.2.1 Broadcast Traveler Advisories - Message Identifier (Source: J3067, 3.5.8.2.2.1). For traveler advisories, a connected device shall include a message identifier for each traveler advisory message as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3 Broadcast Traveler Information (Source: J3067, 3.5.8.3). The following are the requirements for a connected device to broadcast traveler information to connected devices.

BC-REQ-1.3.1 Broadcast Traveler Information - Validity Duration (Source: J3067, 3.5.8.3.4). For each traveler information message in a traveler information packet, a connected device shall include the duration from the start time that the traveler message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.2 Broadcast Traveler Information – Importance (Source: J3067, 3.5.8.3.5). For each traveler information message in a traveler information packet, a connected device shall include the importance of the message relative to other traveler information messages being broadcasted as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3 Broadcast Traveler Information - Presentation Requirements (Source: J3067, 3.5.8.3.6). Agencies may need to present traveler information messages only to

specific travelers, such as travelers within specific geographic (spatial) regions or a direction of travel.

BC-REQ-1.3.3.1 Broadcast Traveler Information - Default Anchor Point Position

(Source: J3067, 3.5.8.3.6.1). For each traveler information message in a traveler information packet, a connected device shall include the geographic location (latitude, longitude, elevation) of the default anchor point for which valid regions are determined as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.2 Broadcast Traveler Information - Heading Slice

(Source: J3067, 3.5.8.3.6.2). For each traveler information message in a traveler information packet, a connected device shall include the direction of motion (of the connected device) that the message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.3 Broadcast Traveler Information - Circular Valid Region

Requirements (Source: J3067, 3.5.8.3.6.3). A spatial region for which a traveler information message is valid for may be a circular region around an anchor point. The connected device should be located within the circular region for the traveler information message to be presented to the traveler.

BC-REQ-1.3.3.3.1 Broadcast Traveler Information - Circular Region –

Radius (Source: J3067, 3.5.8.3.6.3.1). For each traveler information message in a traveler information packet, a connected device shall include the radius for the circular region defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.3.2 Broadcast Traveler Information - Circular Region -

Anchor Point (Source: J3067, 3.5.8.3.6.3.2). For each traveler information message in a traveler information packet, a connected device shall include the geographic location (latitude, longitude, elevation) of the anchor point for the circular region of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.4 Broadcast Traveler Information - Polygon Valid Region

Requirements (Source: J3067, 3.5.8.3.6.4). A spatial region for which a traveler information message is valid for may be a polygon, which may represent the jurisdictional boundaries of a specific transportation agency or a work zone. The connected device should be located within this polygon region for the traveler information message to be presented to the traveler.

BC-REQ-1.3.3.4.1 Broadcast Traveler Information - Polygon Region –

Offsets (Source: J3067, 3.5.8.3.6.4.1). For each traveler information message in a traveler information packet, a connected device shall include the area of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.4.2 Broadcast Traveler Information - Polygon Region -

Anchor Point (Source: J3067, 3.5.8.3.6.4.2). For each traveler information message in a traveler information packet, a connected device shall include the geographic location (latitude, longitude, elevation) of the anchor point for the area

of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.5 Broadcast Traveler Information - Valid Shape Point Set Region Requirements (Source: J3067, 3.5.8.3.6.5). A spatial region for which a traveler information message is valid for may be a shape point set, which allows a spline-like representation of a geographic area such as a road segment. A connected device should be located within the shape point set region for the traveler information message to be presented to the traveler.

BC-REQ-1.3.3.5.1 Broadcast Traveler Information - Shape Point Set - Default Direction (Source: J3067, 3.5.8.3.6.5.1). For each traveler information message in a traveler information packet, a connected device shall include the default direction of travel along the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.5.2 Broadcast Traveler Information - Shape Point Set - Default Width (Source: J3067, 3.5.8.3.6.5.2). For each traveler information message in a traveler information packet, a connected device shall include the default width of the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.5.3 Broadcast Traveler Information - Shape Point Set – Offsets (Source: J3067, 3.5.8.3.6.5.3). For each traveler information message in a traveler information packet, a connected device shall include the shape point set defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.5.4 Broadcast Traveler Information - Shape Point Set – Direction (Source: J3067, 3.5.8.3.6.5.4). For each shape point set in a traveler information message, a connected device shall include the allowed direction of travel along the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.5.5 Broadcast Traveler Information - Shape Point Set – Width (Source: J3067, 3.5.8.3.6.5.5). For a shape point set in a traveler information message, a connected device shall include the width for the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.5.6 Broadcast Traveler Information - Shape Point Set - Node Width (Source: J3067, 3.5.8.3.6.5.6). For a shape point offset in a traveler information message, a connected device shall include the width of the geographic area at that node as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.3.5.7 Broadcast Traveler Information - Shape Point Set - Anchor Point (Source: J3067, 3.5.8.3.6.5.7). For each shape point set in a traveler information message, a connected device shall include the geographic location (latitude, longitude, elevation) of the anchor point for the shape point set defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.4 Broadcast Traveler Advisories – Content (Source: J3067, 3.5.8.3.7). For traveler advisory message in a traveler information packet, a connected device shall include the contents of the travel advisory information as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.5 Broadcast Road Sign – Content (Source: J3067, 3.5.8.3.8). For each road sign message in a traveler information packet, a connected device shall include the road sign information as part of a traveler information packet broadcasted to connected devices

BC-REQ-1.3.6 Broadcast Traveler Information - Uniform Resource Locator (Source: J3067, 3.5.8.3.9). For each traveler information message in a traveler information packet, an OBU shall include a uniform resource locator (URL) for the traveler information message as part of a traveler information packet broadcasted to connected devices.

BC-REQ-1.3.7 Broadcast Traveler Information - Valid Vehicle Type (Source: J3067, 3.5.8.3.10). For each traveler information message, a connected device shall include the vehicle types that the traveler advisory or road sign is valid for as part of a traveler information message broadcasted to connected vehicles.

Appendix B. Roadside Unit Core Requirements

B.1 Introduction

Some of the system requirements for Road-Side Units (RSUs) are included in SAE J2945™/1 March 2016 (J2945/1 henceforth), while this is designed for Vehicle to Vehicle (V2V) safety communications, it has applicable components for RSUs related to the Wyoming Pilot. The Wyoming Pilot will require RSU manufacturers to obtain certification from a USDOT approved testing facility for RSUs (based on the current version of the USDOT DSRC Roadside Unit Specifications Document). Additionally, the relevant requirements from J2945/1 will only be referenced and will not be re-tested or verified in the pilot. For Vehicle to Infrastructure (V2I) SAE J3067 August 2014 (J3067 henceforth) is used for applicable applications. Additionally, SAE J2735™ March 2016 is used to update the outdated parts of the J3067 based on the new message set dictionary appendix or DSRC. Here, the original J3067's system requirements numbers and descriptions are kept in order to ensure compatibility with other CV projects and to provide clarity for future standards. Operational scenarios are detailed in the Concept of Operations (FHWA-JPO-16-287) Chapter 6. User classes and other involved personnel are described in detail in Section 5.5 of the Concept of Operations (FHWA-JPO-16-287). This includes stakeholders, user profiles, responsibilities and interactions with the system, interactions among user classes and the user support environment.

In cases where conflicting information is defined between the J2945/1, J2735, and J3067, J2945/1 will take initial precedence, followed by J2735 and finally J3067. The reason for this is J2945/1 is most specific and up to date for V2V safety communications and is the most relevant to our pilot. J2735 is the second order of precedence because it has many updates to the message set that were not available when J3067 was written. J3067, while somewhat outdated is still relevant because it covers V2I communications and additional applications that are relevant to the Wyoming Pilot.

As J2945/2 and J2945/x become available the Wyoming Pilot will implement the standard interfaces and messages for Situation Awareness- Weather Condition Application, Situational Awareness Suboptimal Road Segment Conditions Applications and RWINFO for Freight Use Case if applicable.

As this project enters Phase 4 there have been new standards that have been developed recently that may help drive the functionality of RSUs and the messages they broadcast. These include Connected Transportation Interoperability (CTI) 4001 Roadside Unit Standard, SAE J3161: LTE Vehicle-to-Everything (LTE-V2X) Deployment Profiles and Radio Parameters for Single Radio Channel Multi-Service Coexistence, SAE J2945/4 Road Safety Applications and SAE J2945/A Standard for Lane-Level and Road Furniture Mapping for Infrastructure-based V2X Applications. These standards provide more advanced RSU requirements and capabilities, define use of LTE-V2X radios and new V2X message sets. Moving forward RSU vendor flexibility will be key to supporting some of these capabilities as they are published.

This appendix is organized as follows:

1. Section B.1 is intentionally skipped
2. Section B.2 summarizes the requirements from J2945 relevant for RSUs in the pilot
3. Section B.3 contains the broadcast RSU requirements
4. Section 4 contains the RSU performance requirements

B.2 V2I Core Safety Communication Requirements

CSC-REQ-3 RSU SCMS Use - All RSUs used in the Wyoming Pilot shall be certified from a US DOT authorized testing facility based on the [SCMS current version CAMP Wiki: Requirements and Specifications](#).

- Common Requirements
 - [Cryptography](#)
 - [Hardware, Software and OS Security Requirements](#)
 - A HSM that requires medium confidentiality and medium integrity shall store keys in tamper-evident hardware equivalent to FIPS 140-2 level 3.
 - [EE-RA Communications – General Guidance](#)
 - Download requests for GPF, LPG, GCCF, LCCF, RSE Application certificate files.
- Requirements by Use Case
 - [Use Case 6: CRL Download](#)
 - [Use Case 12: RSE Bootstrapping \(Manual\)](#)
 - [Use Case 13: RSE Application Certificate Provisioning](#)
 - [Step 13.1: Request RSE Application Certificate](#)
 - RSU downloads Local Policy File and Local Certificate Chain and adopts any changes in the new files before making request.
 - [Step 13.3: Download RSE Application Certificate](#)
 - RSU downloads Local Policy File and Local Certificate Chain and adopts any changes in the new files before downloading certificate.
 - [Use Case 16: RSE Application and OBE Identification Certificate Revocation](#)
 - [Step 16.4: RSE CRL Check](#)
 - [Use Case 20: EE Re-Enrollment](#)
 - [Step 20.1: EE Enrollment Certificate Rollover](#)

CSC-REQ-4 RSU Certification - All RSUs used in the Wyoming Pilot shall be certified from a US DOT authorized testing facility based on J2945/1. The following interfaces and requirements from J2945/1, at a minimum, will be included in the certification testing.

- Interfaces
 - 5.1 V2V Over-the-Air Data Description
 - 5.1.1 Basic Safety Message Exchange
 - 5.1.2 Positioning
 - 5.1.3 Security and Privacy
 - 5.1.3.1 Signing and Verification Algorithm
 - 5.1.3.3 BSM Verification
 - 5.1.3.4 SCMS
 - 5.1.3.5 Privacy

- 5.1.4 Startup and Shutdown
- 5.1.5 Mapping to the V2V Over-the-Air Data
- 5.2 System Interfaces
 - 5.2.2 System to SCMS Communication Interface
 - 5.2.3 System to Positioning Sub-System Interface
- Minimum Requirements
 - 6.1 Standard Profiles
 - 6.1.1 IEEE 802.11
 - 6.1.2 IEEE 1609.2
 - 6.1.2.1 PICS Proforma
 - 6.1.2.2 BSM Security Profile Proforma
 - 6.1.2.2.1 IEEE 1609.2 Security Profile Identification
 - 6.1.2.2.3 Receiving
 - 6.1.2.2.5 Other
 - 6.1.3 IEEE 1609.3
 - 6.1.4 IEEE 1609.4
 - 6.1.5 IEEE 1609.12
 - 6.1.6 SAE J2735 (2016)
 - 6.1.7 FCC 47 CFR, Parts 0, 1, 2, and 95
 - 6.2 Positioning and Timing Requirements
 - 6.2.1 Position Determination
 - 6.2.2 Wide Area Augmentation
 - 6.2.3 Coordinate System and Reference
 - 6.2.4 System Time Coordination
 - 6.3 BSM Transmission Requirements on Channel vChannelNumber
 - 6.3.1 BSM Contents
 - 6.3.2 Channel and Data Rate
 - 6.3.4 User Priority and EDCA Setting
 - 6.3.5 Minimum Transmission Criteria
 - 6.3.6 Data Element Accuracy
 - 6.3.6.1 DE_DSRC_MessageID
 - 6.3.6.2 DE_MesCount
 - 6.3.6.3 DE_TemporaryID
 - 6.3.6.4 DE_DSecond
 - 6.3.6.5 DE_Latitude & DE_Longitude
 - 6.3.6.6 DE_Elevation
 - 6.3.6.7 DF_PositionalAccuracy
 - 6.3.6.8 DE_Speed
 - 6.3.6.9 DE_TransmissionSpeed
 - 6.3.6.10 DE_Heading
 - 6.3.6.11 DE_SteeringWheelAngle
 - 6.3.6.12 DF_AccelerationSet4Way
 - 6.3.6.13 DF_BrakeSystemStatus
 - 6.3.6.14 DF_VehicleSize
 - 6.3.6.15 DE_VehicleEventFlags
 - 6.3.6.16 DF_PathHistory
 - 6.3.6.17 DF_PathPrediction
 - 6.3.6.18 DE_ExteriorLights
 - 6.3.6.19 Additional Data Elements
 - 6.3.7 Data Persistency

- 6.3.7.1 Heading
 - 6.3.7.2 Path History
- 6.4 RF Performance Requirements
 - 6.4.1 DSRC Radiated Power and Transmit Power Accuracy
 - 6.4.1.1 Transmit Power Accuracy
 - 6.4.2 DSRC Receiver Sensitivity
- 6.5 Security and Privacy Requirements
 - 6.5.1 Identification Randomization
 - 6.5.3 Certificate Change
 - 6.5.4 BSM Cryptographic Verification
 - 6.5.5 Certificate Revocation
- 6.6 Security Management
 - 6.6.1 Bootstrap: Initialization and Enrollment Processing
 - 6.6.1.1 Initialization Processing
 - 6.6.1.2 Enrollment Processing
 - 6.6.2 Certificate Loading
 - 6.6.3 Certificate Storage
 - 6.6.4 Certificate Revocation List Loading
 - 6.6.5 Secure Hardware
- Parameter Settings

CSC-REQ-5 RSU Specification - All RSUs used in the Wyoming Pilot shall be compliant with the following interfaces and requirements from DSRC Roadside Unit (RSU) Specifications Document v4.1.

- Minimum Requirements
 - 3.4 Functional Requirements
 - USDOT_RSU-Req_513-v003 System Time: GPS primary
 - 3.4.8 Security
 - USDOT_RSU-Req_442-v002 Data Protection: NTP Secondary Time
 - 3.7.1.2 IEEE 1609.2
 - USDOT_RSU-Req_579-v001 Secure Storage: HSM

B.3 RSU Broadcast Traveler Information

The following requirements describe the “broadcast” function of the RSU

BC-REQ-3 Traveler Information Requirements (Source: J3067, 3.5.8). Traveler information is used to provide connected devices with travel advisories and information.

BC-REQ-3.1 Broadcast Traveler Information (Source: J3067, 3.5.8.1). A connected device shall broadcast a packet containing traveler information to connected devices. Each packet may contain one or more individual traveler information messages.

BC-REQ-3.2 Broadcast Traveler Information - Mandatory Requirements (Source: J3067, 3.5.8.2). The following are the minimum requirements for a connected device to broadcast traveler information to connected devices.

BC-REQ-3.2.1 Broadcast Traveler Information - Packet Identifier (Source: J3067, 3.5.8.2.1). A connected device shall include a packet identifier for the traveler information packet broadcasted to connected devices.

BC-REQ-3.2.2 Broadcast Traveler Information - Message Identifier Requirements

(Source: J3067, 3.5.8.2.2). For each traveler information message in a traveler information packet, a connected device needs to identify each message transmitted as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.2.2.1 Broadcast Traveler Advisories - Message Identifier (Source: J3067, 3.5.8.2.2.1). For traveler advisories, a connected device shall include a message identifier for each traveler advisory message as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.2.2.2 Broadcast Road Sign - Message Identifier (Source: J3067, 3.5.8.2.2.2). For road sign messages, the message identifier is determined by its geographic location and its viewing angle. Thus, for each road sign message, a connected device shall include the geographic location (latitude, longitude, elevation), based on the WGS-84 coordinate system, and the viewing angle of the road sign as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3 Broadcast Traveler Information (Source: J3067, 3.5.8.3). The following are the requirements for a connected device to broadcast traveler information to connected devices.

BC-REQ-3.3.1 Broadcast Traveler Information - Validity Duration (Source: J3067, 3.5.8.3.4). For each traveler information message in a traveler information packet, a connected device shall include the duration from the start time that the traveler message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.2 Broadcast Traveler Information – Importance (Source: J3067, 3.5.8.3.5). For each traveler information message in a traveler information packet, a connected device shall include the importance of the message relative to other traveler information messages being broadcasted as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3 Broadcast Traveler Information - Presentation Requirements (Source: J3067, 3.5.8.3.6). Agencies may need to present traveler information messages only to specific travelers, such as travelers within specific geographic (spatial) regions or a direction of travel.

BC-REQ-3.3.3.1 Broadcast Traveler Information - Default Anchor Point Position (Source: J3067, 3.5.8.3.6.1). For each traveler information message in a traveler information packet, a connected device shall include the geographic location (latitude, longitude, elevation) of the default anchor point for which valid regions are determined as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.2 Broadcast Traveler Information - Heading Slice (Source: J3067, 3.5.8.3.6.2). For each traveler information message in a traveler information packet, a connected device shall include the direction of motion (of the connected device) that the message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.3 Broadcast Traveler Information - Circular Valid Region Requirements (Source: J3067, 3.5.8.3.6.3). A spatial region for which a traveler information message is valid for may be a circular region around an anchor point.

The connected device should be located within the circular region for the traveler information message to be presented to the traveler.

BC-REQ-3.3.3.3.1 Broadcast Traveler Information - Circular Region – Radius (Source: J3067, 3.5.8.3.6.3.1). For each traveler information message in a traveler information packet, a connected device shall include the radius for the circular region defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.3.2 Broadcast Traveler Information - Circular Region - Anchor Point (Source: J3067, 3.5.8.3.6.3.2). For each traveler information message in a traveler information packet, a connected device shall include the geographic location (latitude, longitude, elevation) of the anchor point for the circular region of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.4 Broadcast Traveler Information - Polygon Valid Region Requirements (Source: J3067, 3.5.8.3.6.4). A spatial region for which a traveler information message is valid for may be a polygon, which may represent the jurisdictional boundaries of a specific transportation agency or a work zone. The connected device should be located within this polygon region for the traveler information message to be presented to the traveler.

BC-REQ-3.3.3.4.1 Broadcast Traveler Information - Polygon Region – Offsets (Source: J3067, 3.5.8.3.6.4.1). For each traveler information message in a traveler information packet, a connected device shall include the area of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.4.2 Broadcast Traveler Information - Polygon Region - Anchor Point (Source: J3067, 3.5.8.3.6.4.2). For each traveler information message in a traveler information packet, a connected device shall include the geographic location (latitude, longitude, elevation) of the anchor point for the area of travel defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.5 Broadcast Traveler Information - Valid Shape Point Set Region Requirements (Source: J3067, 3.5.8.3.6.5). A spatial region for which a traveler information message is valid for may be a shape point set, which allows a spline-like representation of a geographic area such as a road segment. A connected device should be located within the shape point set region for the traveler information message to be presented to the traveler.

BC-REQ-3.3.3.5.1 Broadcast Traveler Information - Shape Point Set - Default Direction (Source: J3067, 3.5.8.3.6.5.1). For each traveler information message in a traveler information packet, a connected device shall include the default direction of travel along the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.5.2 Broadcast Traveler Information - Shape Point Set - Default Width (Source: J3067, 3.5.8.3.6.5.2). For each traveler information message in a traveler information packet, a connected device shall include the

default width of the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.5.3 Broadcast Traveler Information - Shape Point Set – Offsets (Source: J3067, 3.5.8.3.6.5.3). For each traveler information message in a traveler information packet, a connected device shall include the shape point set defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.5.4 Broadcast Traveler Information - Shape Point Set – Direction (Source: J3067, 3.5.8.3.6.5.4). For each shape point set in a traveler information message, a connected device shall include the allowed direction of travel along the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.5.5 Broadcast Traveler Information - Shape Point Set – Width (Source: J3067, 3.5.8.3.6.5.5). For a shape point set in a traveler information message, a connected device shall include the width for the shape point set as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.5.6 Broadcast Traveler Information - Shape Point Set - Node Width (Source: J3067, 3.5.8.3.6.5.6). For a shape point offset in a traveler information message, a connected device shall include the width of the geographic area at that node as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.3.5.7 Broadcast Traveler Information - Shape Point Set - Anchor Point (Source: J3067, 3.5.8.3.6.5.7). For each shape point set in a traveler information message, a connected device shall include the geographic location (latitude, longitude, elevation) of the anchor point for the shape point set defining where the traveler information message is valid for as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.4 Broadcast Traveler Advisories – Content (Source: J3067, 3.5.8.3.7). For traveler advisory message in a traveler information packet, a connected device shall include the contents of the travel advisory information as part of a traveler information packet broadcasted to connected devices.

BC-REQ-3.3.5 Broadcast Road Sign – Content (Source: J3067, 3.5.8.3.8). For each road sign message in a traveler information packet, a connected device shall include the road sign information as part of a traveler information packet broadcasted to connected devices

BC-REQ-3.3.6 Broadcast Traveler Information - Valid Vehicle Type (Source: J3067, 3.5.8.3.10). For each traveler information message, a connected device shall include the vehicle types that the traveler advisory or road sign is valid for as part of a traveler information message broadcasted to connected vehicles.

B.4 RSU Performance Data

MNG-REQ-1 Performance Requirements – Message Transmission Rates (Source: J3067, G.2). This section defines the range of allowable time intervals between consecutive transmissions of the same message between connected devices.

MNG-REQ-1.6 Transmission Rate Requirements - Broadcast Traveler Information (Source: J3067, G.2.11). The detailed transmission rate requirements for an RSU to broadcast traveler information to connected devices are as follows.

MNG-REQ-1.6.1 Maximum Transmission Rate - Broadcast Traveler Information (Source: J3067, G.2.11.1). An RSU shall broadcast a traveler information message to connected devices no more than once per second.

MNG-REQ-1.6.2 Default Transmission Rate - Broadcast Traveler Information (Source: J3067, G.2.11.2). If the specification does not indicate a default transmission rate, the suggested default transmission rate for an RSU to broadcast a traveler information message to connected devices once per second. If there is no need for an RSU to broadcast a message, then it is recommended that no messages be transmitted from the RSU to minimize traffic, i.e., congestion. Otherwise, it is recommended that an RSU transmit a broadcast message frequently enough to ensure that the connected device for which the message is intended, traveling at the expected percentile speed would be within the transmission zone for at least three or four broadcasts.

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